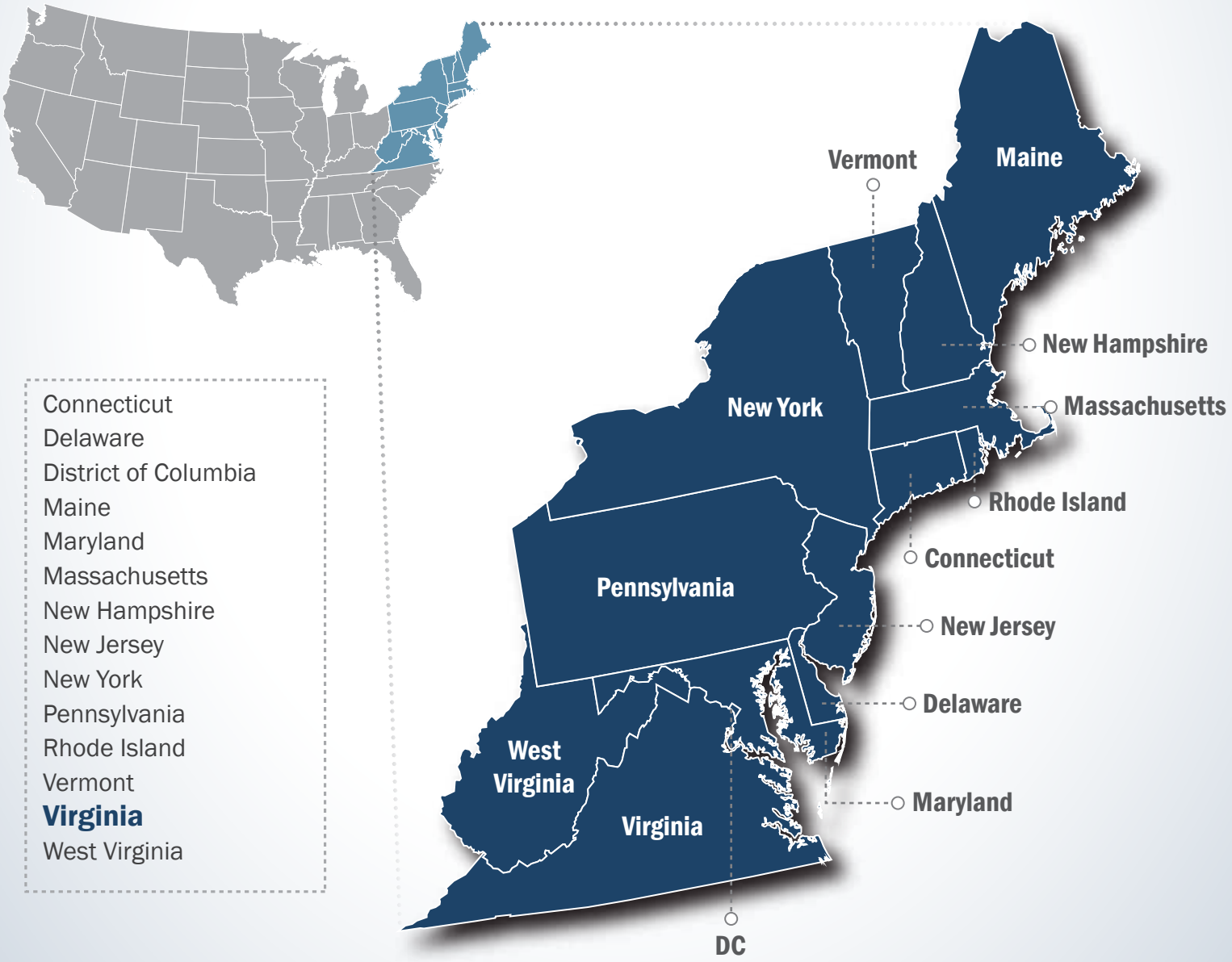
FirstNet®

Nationwide Public Safety Broadband Network

Final Programmatic Environmental Impact Statement for the Eastern United States

VOLUME 13 - CHAPTER 15



SEPTEMBER 2017

First Responder Network Authority

Nationwide Public Safety Broadband Network

Final Programmatic Environmental Impact Statement for the Eastern United States

VOLUME 13 - CHAPTER 15

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 Commerce—National Telecommunications and Information Administration
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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15. VIRGINIA

Jamestown, the first successful permanent European settlement in the United States, was founded in Virginia in 1607. Virginia was also the site of the final British surrender at Yorktown (Commonwealth of Virginia, 2015a). Virginia is bordered by Maryland, the District of Columbia (Washington, DC), and the Potomac River to the north; West Virginia to the west; North Carolina to the south; and the Chesapeake Bay to the east. This chapter provides details about the existing environment of Virginia as it relates to the Proposed Action.

General facts about Virginia are provided below.

- **State Nickname**: Old Dominion
- **Area:** 39,594 square miles; **U.S. Rank:** 35 (USGS, 2012a)
- **Capital:** Richmond
- **Counties:** 95 (U.S. Census Bureau, 2015c)
- **Estimated Population:** Over 8.3 million people; **U.S. Rank:** 12 (U.S. Census Bureau, 2015m)
- **Most Populated Cites:** Virginia Beach, Norfolk, Chesapeake, Richmond, and Northern Virginia Region (Alexandria, Arlington, Fairfax) (U.S. Census Bureau, 2015c)
- **Main Rivers:** Potomac River, James River, Rappahannock River, Shenandoah River, York River, Roanoke River, Chowan River, New River, Tennessee River, and Big Sandy River
- **Bordering Waterbodies:** Chesapeake Bay
- **Mountain Ranges:** Blue Ridge Mountains, Powell Mountains, Brushy Mountains, Allegheny Mountains, Shenandoah Mountains, Masssanutten Mountains, Walker Mountains, and a portion of the Appalachian Mountains
- **Highest Point:** Mt. Rogers (5,729 ft.) (USGS, 2015a)

15.1. AFFECTED ENVIRONMENT

15.1.1. Infrastructure

15.1.1.1. Definition of the Resource

This section provides information on key Virginia (VA) 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 15.1.1.3 provides an overview of Virginia's traffic and transportation infrastructure, including road and rail networks and waterway facilities. Virginia's public safety infrastructure could include any infrastructure utilized by a public safety entity[1] as defined in 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 Virginia are presented in more detail in Section 15.1.1.4. Section 15.1.1.5 describes Virginia's public safety communications infrastructure and commercial telecommunications infrastructure. An overview of Virginia's utilities, such as power, water, and sewer, is presented in Section 15.1.1.6.

15.1.1.2. Specific Regulatory Considerations

Multiple Virginia laws and regulations pertain to the state's public utility and transportation infrastructure and its public safety community. Table 15.1.1-1 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.

Additionally, the Commonwealth of Virginia responded to the Draft PEIS with an extensive amount of state-level requirements that FirstNet is required to follow when working in the Commonweath. Those specific requirements are included in Appendix F, Comment Responses.

[1] The term "public safety entity" means an entity that provides public safety services (7 U.S. Code [U.S.C.] § 140126)).

Table 15.1.1-1: Relevant Virginia Infrastructure Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Code of Virginia: Title 67, Virginia Energy Plan; Virginia Administrative Code: Title 4. Conservation and Natural Resources	Department of Mines, Minerals, and Energy (DMME); Division of Energy	Prepares and updates the Virginia Energy Plan including energy consumption; fuel sources; and costs of electricity, natural gas, gasoline, coal, and renewable resources. Analyzes the adequacy of electricity generation, transmission, and distribution resources; ensures the availability of reliable energy at reasonable costs; promotes conservation and the increased use of sustainably produced biofuels; promotes research and development.
Code of Virginia: Title 9.1. Commonwealth Public Safety	Virginia Department of Emergency Management (VDEM)	Oversees statewide emergency management and implements the statewide emergency communications systems.
Code of Virginia: Title 12.1. State Corporation Commission; Title 56. Public Service Companies	State Corporation Commission (SCC); Division of Public Safety Communications	Regulates every corporation, company, individual, or cooperative that owns, manages, or controls any plant or equipment for the conveyance of telephone messages or for the production, transmission, delivery, or furnishing of heat, chilled air, chilled water, light, power, water, or sewage facilities. Oversees the acts, practices, and rates of public utilities, and establishes alternative regulatory plans for incumbent telephone companies as appropriate.
Code of Virginia: Title 5.1, Aviation; Title 33.2, Highways and Other Surface Transportation Systems; Title 46.2, Motor Vehicles;	Department of Aviation (DOAV); Virginia Department of Transportation (VDOT); Commonwealth Transportation Board; Metropolitan Washington Airports Authority (MWAA); Virginia Port Authority; Northern Virginia Transportation Authority; Department of Motor Vehicles (DMV)	Coordinates state planning for financing transportation projects including highways, railways, seaports, airports, and public transportation; oversees construction, maintenance, and improvement of the state's highways. Regulates airports, landing fields, airfields, aircraft, and pilots; acquires, constructs, and operates airports and air navigation facilities. Administers motor vehicle, title, and registration laws. Plans and implements programs for the establishment, improvement, development, and coordination of public transportation.

Sources: (Virginia Law, 2015a) (Virginia Law, 2015b)

15.1.1.3. Transportation

This section describes the transportation infrastructure in Virginia, including specific information related to the road networks, airport facilities, rail networks, ports, and harbors (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 and adjacent to roads. Roadways can range from multilane road networks with asphalt surfaces to unpaved gravel or private roads. The information regarding existing transportation systems in Virginia are based on a review of maps, aerial photography, and federal and state data sources.

The Virginia Department of Transportation (VDOT) has jurisdiction over freeways and major roads in the state; local counties have jurisdiction for local streets and roads (other than privately owned roads). The mission of the VDOT is to "to plan, deliver, operate and maintain a transportation system that is safe, enables easy movement of people and goods, enhances the economy and improves our quality of life" (VDOT, 2015c). The Virginia Department of Rail and Public Transportation (DRPT) has jurisdiction over railroads and mass transit in the state. The mission of the DRPT is to "improve the mobility of people and goods while expanding transportation choices in the Commonwealth" (DRPT, 2014a).

Virginia has an extensive and complex transportation system across the entire state. The state's transportation network consists of:

- 57,867 miles of state-maintained roads, 10,561 miles of urban streets (VDOT, 2014), and over 20,900 bridges (VDOT, 2015a);
- Almost 3,400 miles of rail network that includes passenger rail and freight (DRPT, 2013);
- 417 aviation facilities, including airstrips and heliports (FAA, 2015a);
- 32 harbors (U.S. Harbors, 2015); and
- 4 major ports that includes both public and private facilities. (Port of Virginia, 2015a)

Road Networks

As identified in Figure 15.1.1-1, the major urban centers of the state are Johnson City-Kingsport-Bristol in the southwest, Harrisonburg-Staunton-Waynesboro in the center, Virginia Beach-Norfolk in the southeast, and Washington-Baltimore-Arlington in the north (USDOC, 2013b). Virginia has six major interstates connecting its major metropolitan areas to one another, as well as to other states. Travel to local towns is conducted mainly via state and county routes outside of the major metropolitan areas. Table 15.1.1-2 lists the interstates and their start/end points in Virginia. 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 15.1.1-2: Virginia Interstates

Interstate	Southern or Western Terminus in VA	Northern or Eastern Terminus in VA
I-64	WV line at Covington	I-664 in Norfolk
I-66	I-81 at Middletown	DC line at Arlington
I-77	NC line at Fancy Gap	WV line at Rocky Gap
I-81	TN line at Bristol	WV line at Stonewall
I-85	NC line at Boydton	I-95 in Petersburg
I-95	NC line at Skippers	DC line at Alexandria

In addition to the Interstate System, Virginia has both National Scenic Byways and State Scenic Byways. Both National and State Scenic Byways are roads that are recognized for one or more archaeological, cultural, historic, natural, recreational, and scenic qualities. Figure 15.1.1-1 illustrates the major transportation networks, including roadways, in Virginia. Section 15.1.8, Visual Resources, describes the National and State Scenic Byways found in Virginia from an aesthetic perspective.

National Scenic Byways are roads with nationwide interest; the byways are designated and managed by the U.S. Department of Transportation's Federal Highway Administration. Virginia has five National Scenic Byways:

- Blue Ridge Parkway: 469 miles through the Blue Ridge Mountains in central and southwestern Virginia (FHA, 2015a);
- Colonial Parkway: 23 miles that connects the historic sites of Jamestown, Williamsburg and Yorktown in southeastern Virginia (FHA, 2015b);
- George Washington Memorial Parkway: 25 miles along the Potomac River overlooking Washington, DC and ending at Mount Vernon, VA (FHA, 2015c);
- Journey Through Hallowed Ground Byway: 180 miles through Maryland, Pennsylvania and Virginia, with the Virginia portion running through the central to northern sections of the state (FHA, 2015d); and
- Skyline Drive: 105 miles in the Shenandoah National Park (FHA, 2015e).

State Scenic Byways are roads with statewide interest; State Scenic Byways are designated and managed by VDOT. Virginia has almost 3,000 miles of roadway designated as State Scenic Byways that crisscross the entire state (VDOT, 2015b). Examples of these State Scenic Byways include (VDOT, 2012):

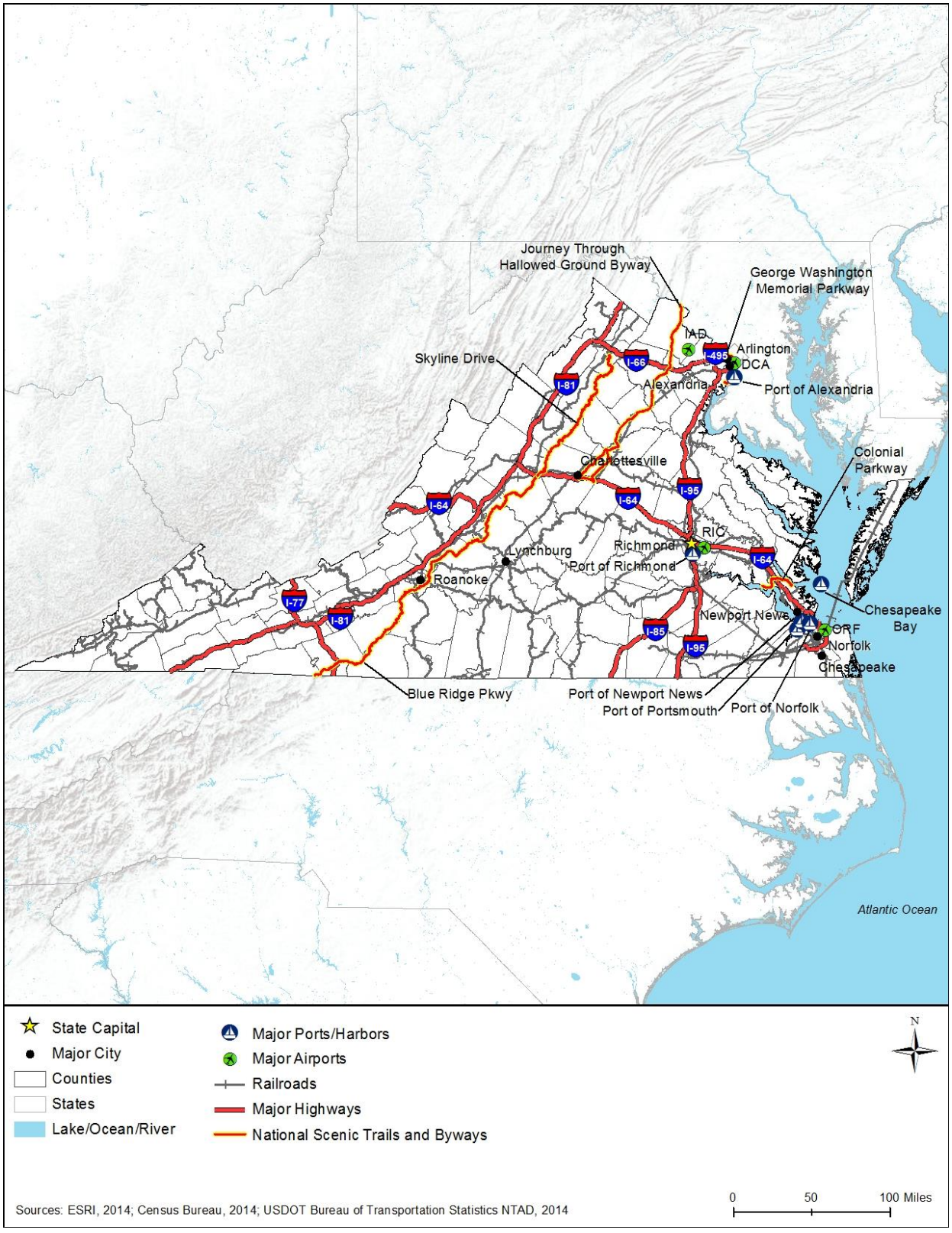
- Alleghany Highlands
- Capital Country
- Virginia's Millennium Legacy Trails
- Northern Virginia
- Southern Highlands
- Virginia Civil War Trails

Airports

Air service to the state is provided by a number of major international airports. Northern Virginia is served by two major airports, which are owned and operated by the MWAA:

- Washington Dulles International Airport (IAD) in Dulles, VA: Owned and operated by the MWAA. In 2014, the airport moved over 21.5 million passengers and over 565.2 million pounds of freight (MWAA, 2015a); and
- Ronald Reagan Washington National Airport (DCA) in Arlington, VA: Owned and operated by the MWAA. In 2014, the airport moved over 20.8 million passengers and over 3.9 million pounds of freight (MWAA, 2015b).

Southeastern Virginia is served by Norfolk International Airport (ORF). The Norfolk Airport Authority operates this airport; the Authority is an independent, autonomous agency of the City of Norfolk (Norfolk Airport, 2015a). In 2014, the airport served 2,965,306 passengers and handled 55,637,623 pounds of cargo (Norfolk Airport, 2015b).



Source: (USDOT Bureau of Transportation Statistics, 2014)

Figure 15.1.1-1: Virginia Transportation Networks

Central Virginia is served by Richmond International Airport (RIC). The Capital Region Airport Commission owns and operates the airport (Richmond Airport, 2015). The airport annually serves over 3 million passengers, moves over 90 million pounds of cargo, and manages approximately 105,000 take-offs and landings (Richmond Airport, 2015). Additional airports in Virginia include the Roanoke Regional/Woodrum Field (ROA), Newport News/Williamsburg International (PHF), Charlottesville-Albemarle airport (CHO), and Lynchburg Regional/Preston Glen Field (LYH). Figure 15.1.1-1 illustrates the major transportation networks, including airports, in the state. Section 15.1.7, Land Use, Recreation, and Airspace, provides greater detail on airports and airspace in the state.

Rail Networks

Virginia is connected by a large rail network of passenger rail (Amtrak), public transportation (commuter rail), and freight rail. All of Virginia's approximately 3,400 miles of railroad tracks are owned by freight railroad companies; the two passenger rail systems operating in the state, Amtrak and the Virginia Railway Express (VRE), run on the freight rail tracks (DRPT, 2013). Figure 15.1.1-1 illustrates the major transportation networks, including rail lines, in Virginia.

Amtrak runs numerous lines throughout Virginia, including the Northeast Regional, which is a popular line, with routes running from Virginia Beach, VA to Boston, MA in 12 hours 30 minutes (Amtrak, 2015a). Virginia is also the starting point for Amtrak's Auto Train, with nonstop service from the Washington, D.C. region to just outside of Orlando, FL. Passengers can load their car or other motor vehicle (e.g., van, motorcycle, small boat, jet ski, etc.) onto the train. Amtrak advertises the service by saying that "This IS the best way to drive I-95" (Amtrak, 2015b). Table 15.1.1-3 provides a complete list of Amtrak lines that run through Virginia.

Table 15.1.1-3: Amtrak Train Routes Serving Virginia

Route	Starting Point	Ending Point	Length of Trip	Major Cities Served in Virginia
Acela Express	Boston, MA	Washington, DC	6 hours 40 minutes	None (Washington, DC)
Auto Train	Lorton, VA	Sanford, FL	17 hours 29 minutes	Lorton
Cardinal/Hoosier State	New York, NY	Chicago, IL	26 hours 30 minutes	Alexandria, Charlottesville
Carolinian/Piedmont	New York, NY	Charlotte, NC	13 hours 30 minutes	Alexandria, Richmond
Crescent	New York, NY	New Orleans, LA	30 hours	Alexandria, Charlottesville
Northeast Regional	Boston, MA	Virginia Beach, VA	12 hours 30 minutes	Alexandria, Charlottesville, Richmond, Norfolk, Newport News
Silver Service/Palmetto	New York, NY	Tampa/Miami, FL	28+ hours	Alexandria, Richmond

Source: (Amtrak, 2015a) (Amtrak, 2015c)

Washington, D.C.'s suburbs in northern Virginia have commuter rail services plus a subway system. The VRE is a joint project of the Northern Virginia Transportation Commission and the Potomac and Rappahannock Transportation Commission. It provides service between D.C.'s Union Station and stations in Virginia along two lines: the Manassas Line and the Fredericksburg Line. VRE stops at 18 stations and currently carries an average of 20,000 passengers daily (Virginia Railyway Express, 2015).

The Washington Metropolitan Area Transit Authority (WMATA) runs Washington, D.C.'s public transportation system, called Metro; service extends into northern Virginia and Maryland. The system includes Metrorail and Metrobus. Metrorail is the subway system with 91 stations that are either above or below ground. Metrorail has approximately 118 miles of track and is the nation's second largest heavy rail transit system. Metrorail served a total of approximately 209 million passengers in 2013. Virginia has 41.17 miles of Metrorail track and 25 stations. (Washington Metropolitan Area Transit Authority, 2013)

In southeastern Virginia, Hampton Roads Transit provides a light rail service called "The Tide." This light rail has one line that runs for 7.4 miles through downtown Norfolk, from the Eastern Virginia Medical Center in the west to the border of Virginia Beach in the east (Hampton Roads Transit, 2015). The Tide has 11 stations.

The Federal Railroad Administration (FRA) classifies railroads as Class I, Class II, or Class III based on corporate revenue thresholds (FRA, 2015a). Two major (Class I) railroad companies own 2,870 miles of railroad track in Virginia: Norfolk Southern and CSX; the remaining 524 miles are owned by nine short line railroads (Class III)[2] (DRPT, 2013). In 2010, 159.9 million tons of freight traveled in Virginia by freight rail (DRPT, 2013). The region in Virginia with the most freight rail lines are the coal producing areas in the west; other high density rail corridors in Virginia include lines running to/from the Port of Virginia and parallel to I-95 (DRPT, 2013).

Harbors and Ports

The Commonwealth of Virginia borders the Chesapeake Bay and Atlantic Ocean; its eastern coast is dotted with harbors, both small and large. The Potomac, Rappahannock, York and James Rivers flow inland from the Chesapeake, allowing areas for more harbors to develop. While the Ports of Newport News, Norfolk, Portsmouth, and Richmond are the larger shipping ports, there are smaller facilities in many areas of the Commonwealth. Many of these are situated on the Chesapeake Bay, such as the marinas in the cities of Cape Charles, Hampton, Onancock, and Reedville. Other facilities such as the marinas in Irvington and Urbanna exist on the four large rivers that extend northwest from the Chesapeake (BayDreaming, 2015). The Ports of Newport News, Norfolk, Portsmouth, and Richmond are all terminals of the overall Port of Virginia, which is operated by the Virginia Port Authority (Port of Virginia, 2015a). According to the U.S. Department of Transportation (USDOT), Norfolk Harbor was the 5th busiest container port in the nation in 2012 (USDOT, 2015a). These large port facilities are presented in Figure 15.1.1-1. Newport News, Norfolk, and Portsmouth are situated in the

[2] These totals of track ownership exclude trackage rights negotiated with third party owners.

Hampton Roads Harbor at the mouth of the Chesapeake, while the Richmond terminal is located on the James River, near Virginia's capital (Port of Virginia, 2015b).

Of the three port terminals located on the Hampton Roads Harbor, Newport News Marine Terminal is the most northern. Located at the meeting point of the James River and the Hampton Roads Harbor on the Chesapeake, it is the Port Authority's main break-bulk terminal[3]. This 165 acre, 40' deep facility can be reached via I-664 and offers overland rail service through CSX (Port of Virginia, 2015c). Next to the Newport News Marine Terminal is Newport News Shipbuilding. This facility occupies 550 acres of space on the east bank of the James River and is the "sole designer, builder and refueler of U.S. Navy aircraft carriers and one of two providers of U.S. Navy submarines" (Newport News Shipbuilding, 2015).

The 567 acre, 50' deep Norfolk International Terminal is located at the juncture of the Elizabeth and Lafayette Rivers, just south of the Hampton Roads Harbor. This terminal offers rail service through Norfolk Southern, which extends into the Midwest United States. It can also be reached via I-64 (Port of Virginia, 2015d). The Portsmouth Terminal is located on the west bank of the Elizabeth River, south of where the river joins the Bay. The 287 acre, 40' deep Portsmouth Marine Terminal has connections to both CSX (direct) and Norfolk Southern (through the Norfolk Portsmouth Beltline Railway) rails. Due to the other two Hampton Roads Harbor terminals approaching capacity, this terminal is expected to see growth in the coming years (Port of Virginia, 2015e). Combined, these three terminal facilities are one of the largest import/export ports in the country. In 2013, they were responsible for the import of 10 million tons of goods worth approximately $37 billion, and the export of 63.5 million tons in cargo, worth $29.6 billion (U.S. Census Bureau, 2015g).

The Virginia Port Authority has leased the 121-acre Port of Richmond facilities from the city of Richmond since 2010. The port is located on the James River near the southern end of the city limits and is served by the James River Barge Service, which transports goods between Richmond and Hampton Roads by way of the James River. In 2013, the U.S. Census Bureau recorded the port importing $33.2 million of cargo, weighing 47.6 thousand tons. It also exported 7.2 thousand tons of goods worth $8 million (U.S. Census Bureau, 2015g). It should also be noted that the Port of Alexandria, housed at the Robinson Terminal Warehouse, handles cargo as well. This facility is located on the Potomac River just south of the District of Columbia. In 2013, it was responsible for the export of $300,000 of cargo goods, weighing 881 tons (U.S. Census Bureau, 2015g).

15.1.1.4. Public Safety Services

Virginia public safety services generally consist of public safety infrastructure and first responder personnel throughout the state. The general abundance and distribution of public safety services may roughly follow key state demographic indicators. Table 15.1.1-4 presents Virginia's key demographics including estimated population; land area; population density; and

[3] Break-bulk terminals are those that focus on general cargo that must be loaded onto ships individually, and not in containers, nor in bulk (as with oil, grain, or other bulk substances).

number of counties, cities/towns, and municipal governments. More information about these demographics is presented in Section 15.1.9, Socioeconomics.

Table 15.1.1-4: Key Virginia Indicators

Virginia Indicators	
Estimated Population (2014)	8,326,289
Land Area (square miles) (2010)	39,594
Population Density (persons per sq. mile) (2010)	202
Municipal Governments (2013)	229

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

Table 15.1.1-5 presents Virginia's public safety infrastructure, including fire and police stations.

Table 15.1.1-6 identifies first responder personnel including dispatch, fire and rescue, law enforcement, and emergency medical personnel in the state.

Table 15.1.1-5: Public Safety Infrastructure in Virginia by Type

Infrastructure Type	Number
Fire and Rescue Stations	1,664
Law Enforcement Agencies	293
Fire Departments	1,115

Source: (National Fire Department Census, 2015)

Table 15.1.1-6: First Responder Personnel in Virginia by Type

First Responder Personnel	Number
Police, Fire and Ambulance Dispatchers	2,960
Fire and Rescue Personnel	35,236
Law Enforcement Personnel	64,434
Emergency Medical Technicians and Paramedics	5,080

Source: (BLS, 2014a)

15.1.1.5. Telecommunications Resources

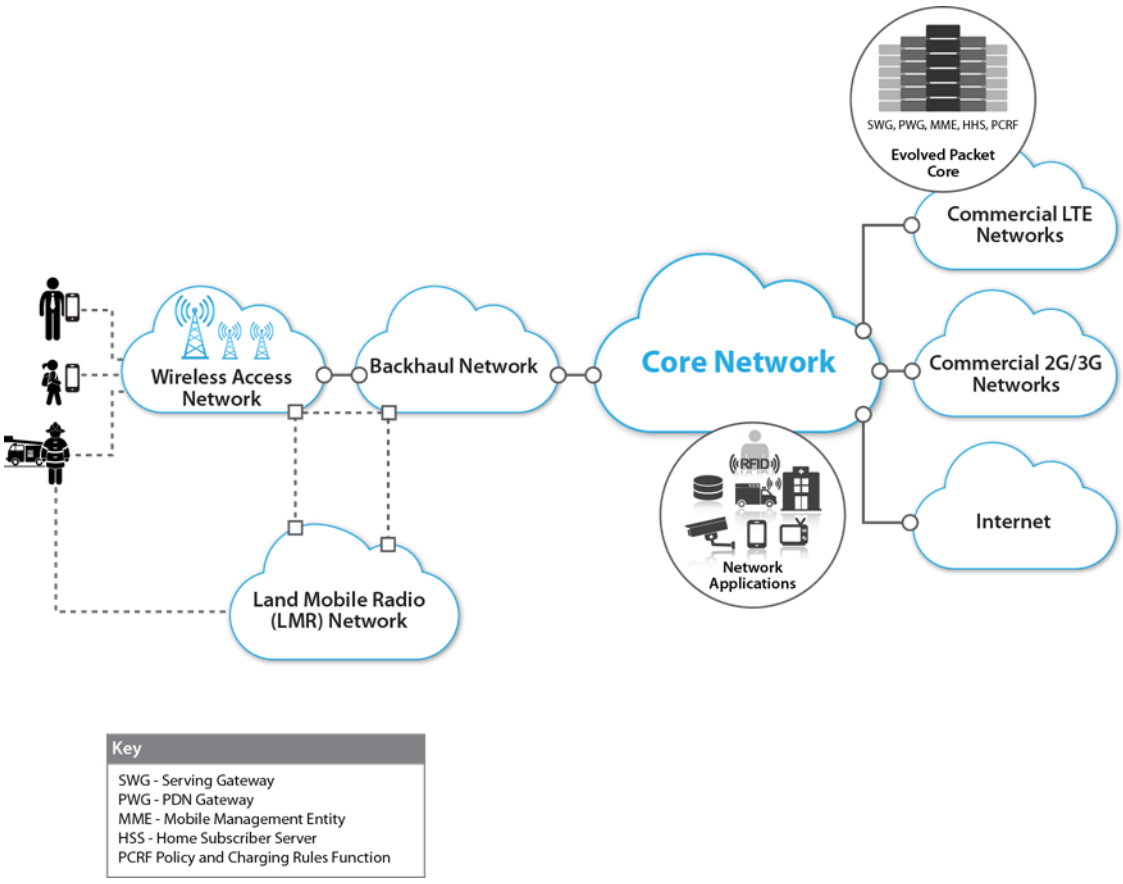
Telecommunication resources in Virginia can be divided into two primary categories: specific public safety communications infrastructure and commercial telecommunications infrastructure (FCC, 2015a) (BLS, 2016). There is no central repository of information for either category; therefore, the following information and data are combined from a variety of sources, as referenced.

In general, the deployment of telecommunications resources in Virginia is widespread and similar to other states in the U.S. 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 15.1.1-2 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).

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 2.1.1), 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).



Prepared by: Booz Allen Hamilton

Figure 15.1.1-2: Wireless Network Configuration

Historically, there have been many challenges and impediments to timely and effective sharing of information, including jurisdictional challenges, funding challenges, the pace of technology

evolution, and communication interoperability. Communication interoperability has 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 at the state level, including in Virginia. 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 help enable the public safety community to incorporate disparate Land Mobile Radio networks into a nationwide public safety LTE broadband network, the U.S. Department of Commerce Public Safety Communications Research Program (PSCR) – Boulder Laboratories, in 2015, prepared a locations-based services (LBS) research and development (R&D) roadmap to examine the current state of location-based technologies, forecast the evolution of LBS capabilities and gaps, and identify 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).

Public safety network communications in Virginia reflect a combination of older Very High Frequency (VHF)[4], Ultra High Frequency (UHF),[5] and analog radios operating across multiple frequency bands, as well as digital P-25 700 MHz and 800 MHz networks.

The Virginia State Police's Statewide Agencies Radio System (STARS) Technology Briefing document summarizes the STARS project's background, approach, and key benefits as follows: "The STARS concept was originally conceived in the mid nineteen-nineties to be an upgrade to the antiquated Virginia State Police land mobile radio network, which was implemented in 1977. As planning progressed, both technology advances and direction from state government led to the present concept of a shared system composed of the 21 state agencies that use two-way radio communication as a regular part of their operations. To support the large increase of user agencies and radios, the microwave network for the system is undergoing a complete renovation. The 87 existing tower sites will increase to 94 sites by 2020, and the network design now includes alternate paths, or rings, to provide continuous high reliability in the event of a path outage. Forty-five of the microwave radio transmitter sites will also be used for two-way communications with user radios. These sites will provide the Commonwealth with quality, geographically statewide, mobile radio coverage utilizing Project-25[6] digital trunked technology in the VHF High Band. STARS will employ an integrated voice and data (IV&D) land mobile radio architecture that follows Project-25, which uses the same mobile radio for both voice and

[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)
[6] Project-25 (P25) is a suite of standards for digital radio communications for use by federal, state, and local public safety agencies in North America to enable them to communicate with other agencies and mutual aid response teams in emergencies.

mobile computer communications. This feature will provide statewide mobile data coverage for law enforcement while saving the Commonwealth the additional expense of a separate data infrastructure and an additional radio/modem in each vehicle" (Virginia State Police, 2015a).

In Virginia, the Communications Division within the Virginia State Police has the responsibility for radio system and network planning and coordination, operations, maintenance and upgrade of the STARS network which supports the State Police, other public safety agencies, and Virginia state agencies (Virginia State Police, 2015b).

Statewide Public Safety Networks

The Commonwealth of Virginia's 2004 System Integrator Request for Proposal for the statewide network, STARS, described the technology, frequencies, and improvements included in the STARS digital P-25 approach as follows:

- "Standards-based technology for narrowband, VHF, high capacity, trunked system;
- Meets the Federal Communications Commission's mandate for improved spectrum efficiency; and
- Compatible with both analog and other APCO P-25 systems (VHF, 700MHz or 800 MHz) used throughout the Commonwealth for direct radio-to-radio interoperability when appropriate." (Commonwealth of Virginia, 2004)

STARS, consists of 121 total towers with 48 dedicated to LMR and supporting microwave connectivity (Virginia State Police, 2015c). The Virginia State Police STARS Technical Facts & Figures document describes STARS network and capabilities as follows: "To support the large increase of user agencies and implement the higher microwave radio frequencies, the microwave backbone of the system is undergoing a complete renovation. The 87 existing tower sites will grow to 121 sites and the network is now designed to have alternate paths, or loops, to provide continuously high reliability in the event of a path outage. Forty-eight of these 121 tower sites will be used for the actual two-way communications with the users' mobile and portable radios. From these sites, the Commonwealth personnel will receive quality, statewide, mobile radio coverage. STARS will be one of the first geographically statewide systems to employ digital trunked technology in the VHF 150 MHz band. This frequency selection greatly reduces the overall cost of the system as compared to the popular 800 MHz systems." (Virginia State Police, 2015c).

Virginia's STARS public safety network also includes a Digital Vehicular Repeater System (DVRS) that translates the lower frequency VHF signal occurring between the car and the tower into a 700 MHz signal utilized for car to portable/handheld communications (Virginia State Police, 2015c).

All STARS law enforcement vehicles are provided with a low band (39.54 MHz) radio as part of Virginia's legacy Statewide Interdepartmental Radio System (SIRS).[7] According to the 2013 Virginia State Police Report to the Governor on the STARS project, this inclusion of the SIRS low-band radio delivers important multi-frequency communication capability through dual-

[7] Virginia's Statewide Interdepartmental Radio System (SIRS) is a legacy low-band VHF system intended to provide interoperability and backup communications capability.

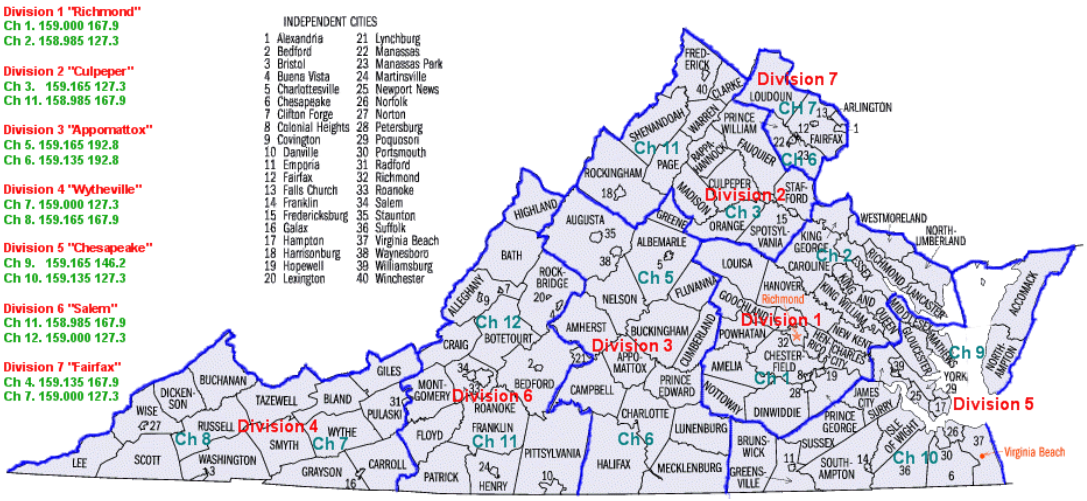
equipping police vehicles with low-band VHF and 700//800 MHz connectivity: "…this [SIRS] radio, being independent of the STARS radio, is always available to send and receive radio transmissions. The STARS mobile radios are programmed to transmit and receive on the VHF interoperability channels while the STARS 700/800 MHz portable radios have the 700 MHz and 800 MHz interoperability channels programmed." (Virginia State Police, 2013). The coverage and management of STARS, depicted in Figure 15.1.1-3, is divided into seven districts which correspond to Virginia State Police territories (PURA, 2013).

In addition, to facilitate easier dispatch and communications across diverse frequencies, Virginia has implemented the Commonwealth Link to Interoperable Communications (COMLINK). COMLINK is a system that allows dispatchers to "patch" communications across diverse frequency bands including VHF, UHF, 700 MHz, and 800 MHz in order to enable interagency communications (Virginia State Police, 2013).

STARS is supported by a Microwave Transmission Network (MTN) with key locations in Richmond and Salem. The red highlighted location markers in Figure 15.1.1-4 indicate the location of the Master Sites in Richmond and Salem. The Virginia STARS Contract describes in detail the MTN network architecture, geographic layout, and number of microwave paths as well as fiber optical carrier (OC) rings8 and communications paths in detail, as follows.

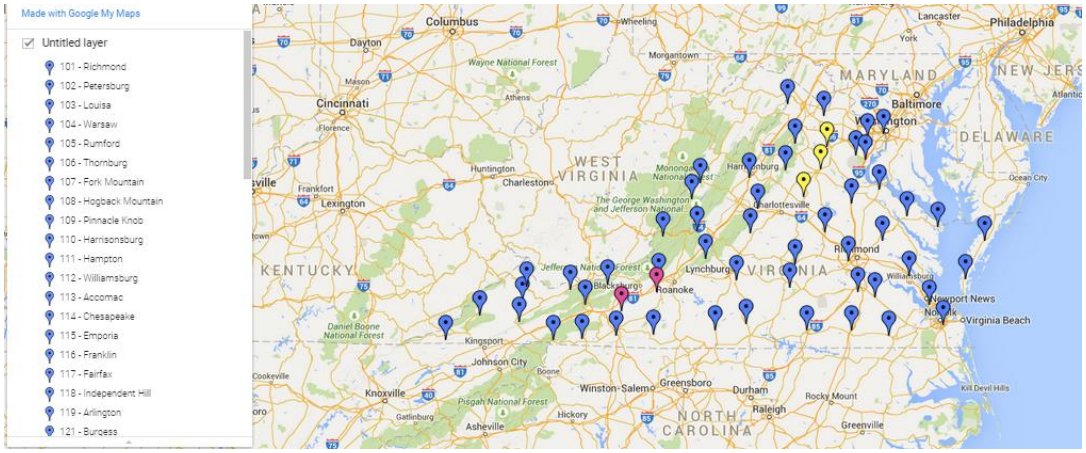
"The portion of the MTS[9] network terminated at Zone 1 Master Site in Richmond will contain a total of 55 tower sites, 20 of which will be land mobile radio (LMR) co-locations. The portion of the MTS network terminated as Zone 2 Master Site in Salem will contain a total of 66 tower sites, 25 of which will be LMR co-locations. State Police Headquarters (SPHQ) in Richmond and the VSP [Virginia State Police] 6th Division Headquarters in Salem will be connected together by a 'partitioned' section of the MTS network routed through the 1st, 3rd, and 6th Divisions. The MTS network will consist of ten OC-3 Synchronous Optical Network (SONET)10 loops arranged in nine distinct and separate rings identified as R-1 [Ring-1] through R-9. R-1 through R-4 and R-6 through R-8 will contain parallel OC-3 radio links on a combined six microwave paths sharing different rings. One path shared by R-7 and R-8 serving the VSP 6th Division Headquarters will contain three parallel OC-3 radio links on one common path. All other parallel paths will contain two optical carrier 3 (OC-3)[11] radio links. All paths in ring R-8 will be dual OC-3s except the aforementioned individual path, which will contain three OC-3s" (EIA, 2015a).

[8] An Optical Carrier (OC) is a measure of Optical level capacity also expressed as OCx. OC-3 capacity is 155.52 Megabits per Second (Mbps)
[9] Motorola TETRA base station.
[10] Synchronous Optical Network (SONET) is a standardized digital optical protocol supporting synchronous data transmission. SONET is defined around a base rate of 51.84 bps and multiples thereof known as Optical Carrier levels (OCx)
[11] Optical carrier transmission rates are a standardized set of specifications of transmission bandwidth for digital signals that can be carried on Synchronous Optical Networking (SONET) fiber optic networks.



Source: (Radio Reference.com, 2015a)

Figure 15.1.1-3: STARS County/City Coverage and Divisional Structure



Source: (Google Tower Location Mashup, 2015)

Figure 15.1.1-4: STARS Tower Locations

City and County Public Safety Networks

Virginia's city and county public safety networks serving police, fire, and EMS users are diverse with a large number of older VHF and UHF systems reflecting a mix of analog and digital systems such as P-25 (Radio Reference.com, 2015b). There are, however, a number of cities and counties in Virginia which have elected to upgrade to P-25. The majority of these P-25 adoptions are for the Phase 1 version of P-25 which utilizes Frequency Division Multiplexing (FDMA)[12] (Radio Reference.com, 2015c). As of mid-2015, there were a total of 37 P-25

[12] Frequency Division Multiple Access (FDMA) is a multiplexing channel access method used by Project-25 Phase 1 systems which provides users with a unique allocation of frequency band space or channels.

systems deployed in Virginia of which 18 were city or county deployments; 17 of the 18 deployments were in the 800 MHz band and with one deployment in Suffolk County in the 700 MHz band (Project25.org, 2015a). Four counties in Virginia (as of mid-2015) have implemented time division multiple access 14 (TDMA13) Phase 2 P-25 systems (Loudoun, Pittsylvania, Prince William, and Suffolk) with the first three electing 800 MHz and Suffolk choosing 700 MHz (Project25.org, 2015b).

As indicated above, local city/ town and county police public safety agencies use a combination of VHF and 700/800 MHz systems for communications in Virginia. For example, users of older VHF systems include Virginia State Police lo-band SIRS radios, city/town fire dispatch and incident VHF communications, and EMS VHF communications.

Public Safety Answering Points (PSAPs)

According to the Federal Communication Commission's (FCC) Master PSAP registry, there are 173 PSAPs serving Virginia's 95 counties and 38 independent cities (FCC, 2015b).

Commercial Telecommunications Infrastructure

Virginia'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 Virginia'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

Virginia'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 as well as cable submarine systems for international connectivity (BLS, 2016). Table 15.1.1-7 presents the number of providers of switched access[14] lines, Internet access,[15] and mobile wireless services including coverage.

[13] Time Division Multiple Access is the multiplexing regime used in P-25 Phase 2 systems.
[14] "A service connection between an end user and the local telephone company's switch; the basis of plain old telephone services (POTS)" (FCC 2014).
[15] Internet access includes DSL, cable modem, fiber, satellite, and fixed wireless providers.

Table 15.1.1-7: Telecommunications Access Providers and Coverage in Virginia as of December 31, 2013

Commercial Telecommunications Access Providers	Number of Service Providers	Coverage
Switched access lines	165	98% of households
Internet access	78	66% of households
Mobile wireless	14	96% of population

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

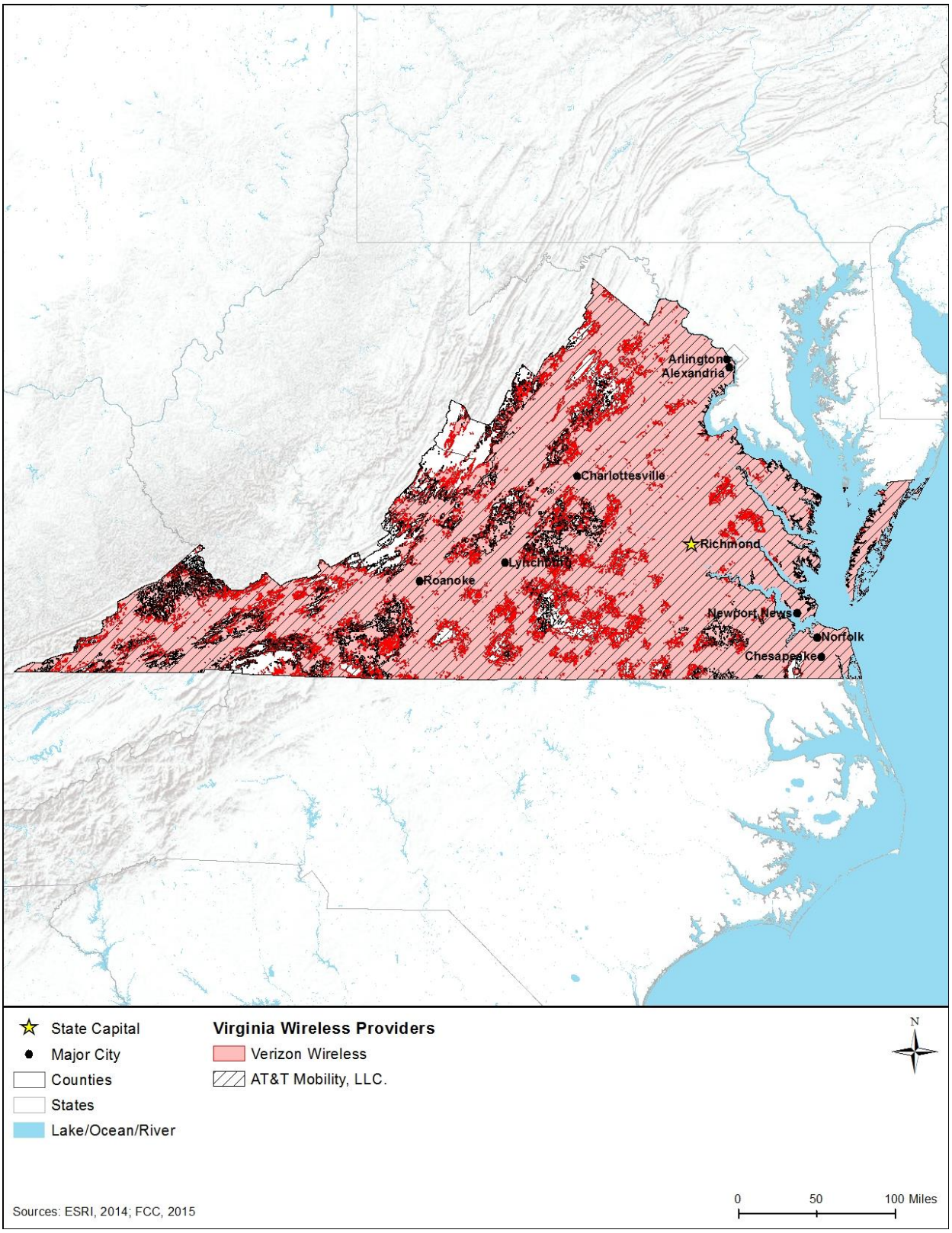
Table 15.1.1-8 shows the wireless providers in Virginia along with their geographic coverage. The following four maps, Figure 15.1.1-5, Figure 15.1.1-6, Figure 15.1.1-7 and Figure 15.1.1-8, show the combined coverage for the top two providers AT&T and Verizon Wireless; Sprint's, T-Mobile's, and Ntelos's coverage; Bit Communication's, U.S. Cellular's, B2X Online's, and Virginia Broadband LLC's coverage; and the coverage of all other providers with less than 5% coverage area, respectively.

Table 15.1.1-8: Wireless Telecommunications Coverage by Providers in Virginia

Wireless Telecommunications Providers	Coverage
AT&T Mobility	89.5%
Verizon Wireless	84.4%
Sprint Nextel	34.1%
Ntelos	27.0%
T-Mobile	14.9%
Bit Communications	13.8%
U.S. Cellular	11.7%
B2X Online, Inc.	5.5%
Virginia Broadband, LLC	5.4%
Other[a]	18.26%

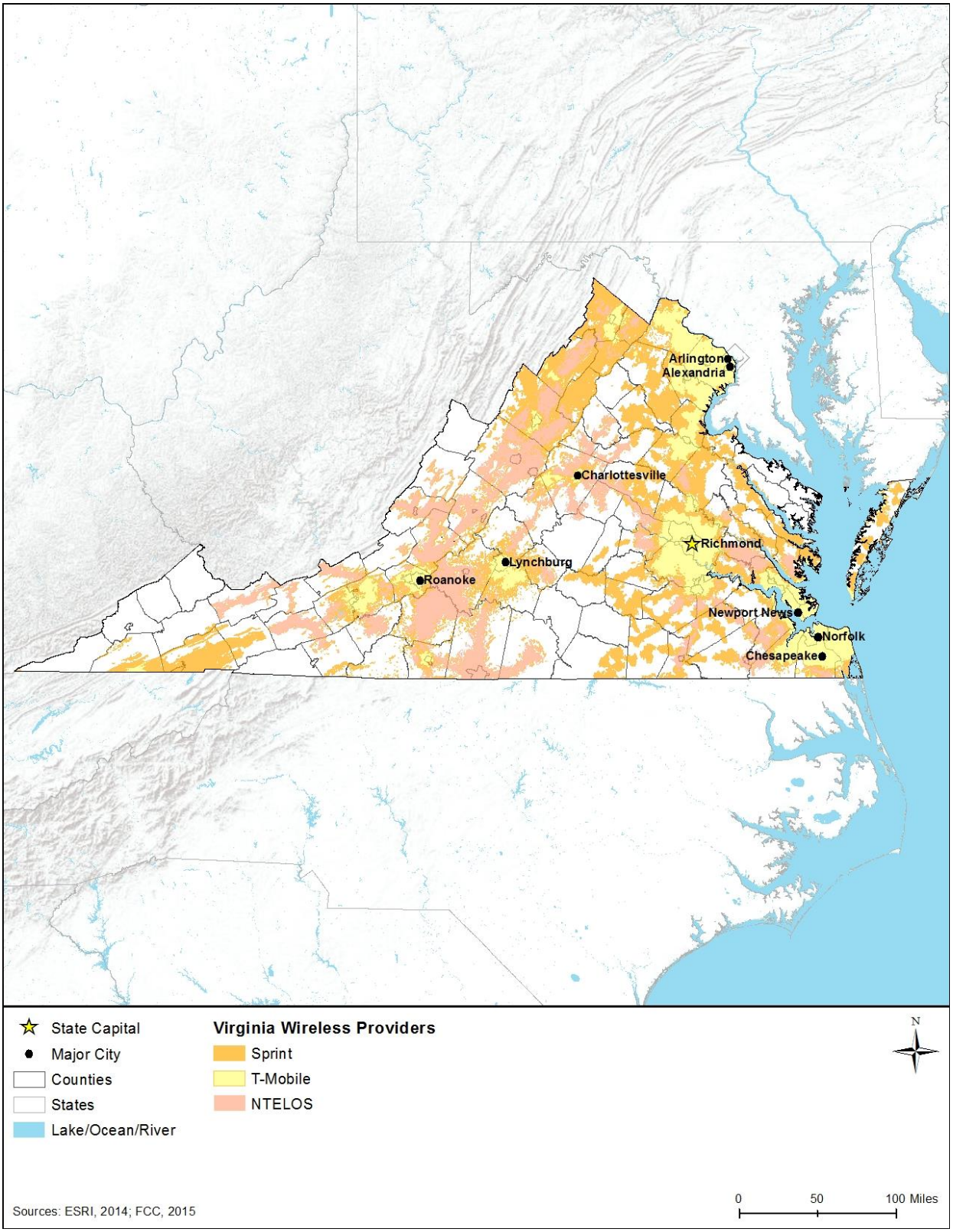
Source: (NTIA, 2014)

[a] Other: Provider with less than 5% coverage area. Providers include: Northern Neck Wireless Internet Services, LLC; Cricket Wireless; HighSpeedLink; Wvva.net Inc.; Gamewood Technology Group, Inc.; Stewart Computer Services; Eastern Shore Communications; NRV Unwired; IGO Technology; Roadstar Internet Inc.; CVALink Broadband



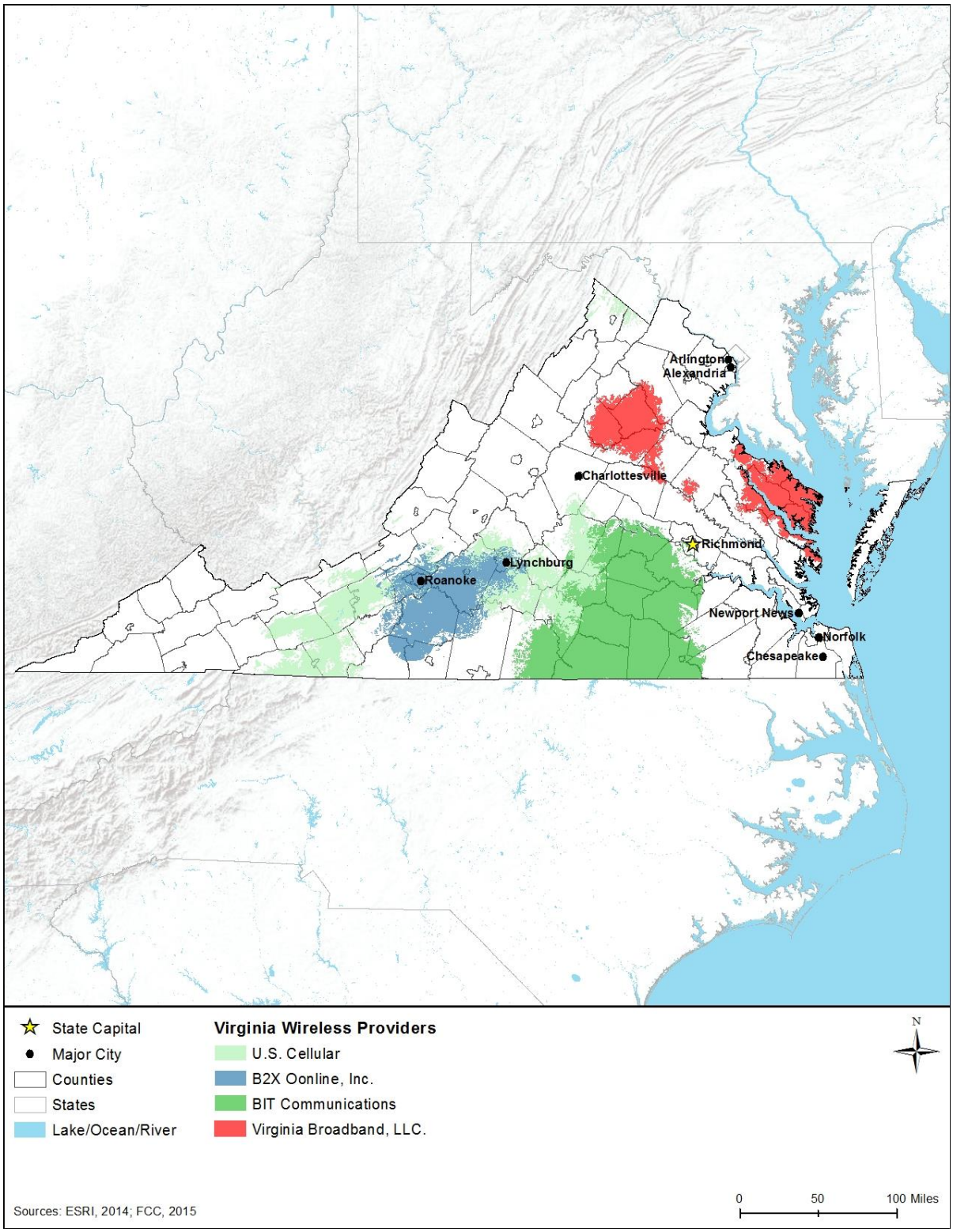
Source: (NTIA, 2014)

Figure 15.1.1-5: AT&T and Verizon Wireless Availability in Virginia



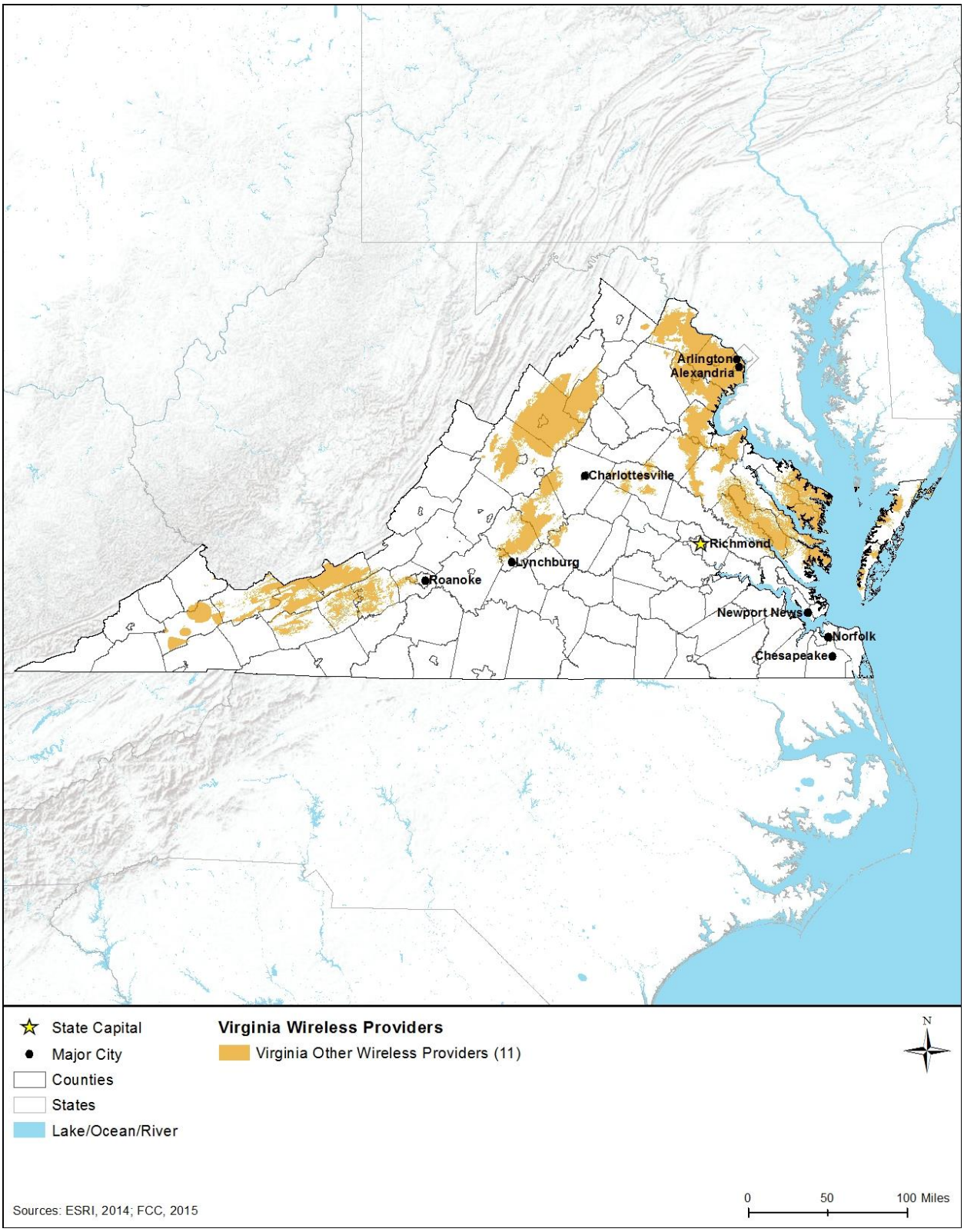
Source: (NTIA, 2014)

Figure 15.1.1-6: Sprint Nextel, T-Mobile, and Ntelos Wireless Availability in Virginia



Source: (NTIA, 2014)

Figure 15.1.1-7: U.S. Cellular, Bit Communications, B2X Online, and Virginia Broadband, LLC Wireless Availability in Virginia



Source: (NTIA, 2014)

Figure 15.1.1-8: Wireless Availability in Virginia for Other Coverage Providers

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 15.1.1-9 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 15.1.1-9: Types of Towers

Telecommunications tower infrastructure can be found throughout Virginia, although tower infrastructure is concentrated in the higher and more densely populated area. Owners of towers and some types of antennas are required to register those infrastructure assets with the FCC [16] (FCC, 2016b). Table 15.1.1-9 shows the number of towers (including broadcast towers) registered with the FCC in the state of Virginia. Figure 15.1.1-10 shows the location of those 2,057 structures, as of June 2015.

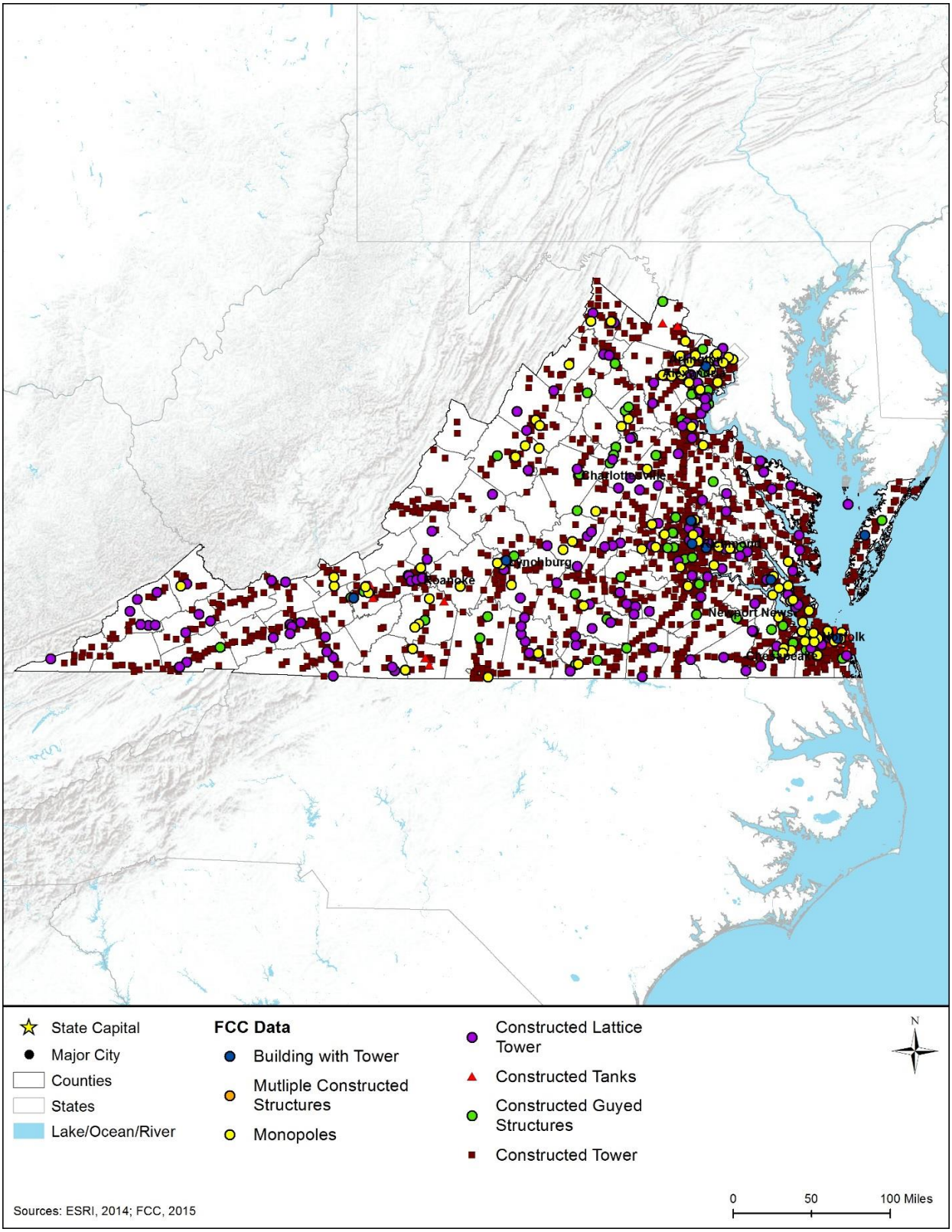
[16] An antenna structure must be registered with the FCC if the antenna structure is taller than 200 feet above ground level or may interfere with the flight path of a nearby airport.

Table 15.1.1-9: Number of Commercial Towers in Virginia by Type

Constructed[a] Towers[b]		**Constructed Monopole Towers**	
100ft and over	224	100ft and over	0
75ft – 100ft	539	75ft – 100ft	0
50ft – 75ft	569	50ft – 75ft	46
25ft – 50ft	357	25ft – 50ft	44
25ft and below	43	25ft and below	3
Subtotal	**1,732**	**Subtotal**	**93**
Constructed Guyed Towers		**Buildings with Constructed Towers**	
100ft and over	31	100ft and over	0
75ft – 100ft	11	75ft – 100ft	2
50ft – 75ft	15	50ft – 75ft	2
25ft – 50ft	6	25ft – 50ft	2
25ft and below	0	25ft and below	3
Subtotal	**63**	**Subtotal**	**9**
Constructed Lattice Towers		**Multiple Constructed Structures[c]**	
100ft and over	11	100ft and over	0
75ft – 100ft	56	75ft – 100ft	0
50ft – 75ft	39	50ft – 75ft	0
25ft – 50ft	16	25ft – 50ft	0
25ft and below	23	25ft and below	0
Subtotal	**145**	**Subtotal**	**0**
Constructed Tanks[d]			
Tanks	15		
Subtotal	**15**		
Total All Tower Structures		**2,057**	

Source: (FCC, 2015c)

[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, 2015c)
[b] Free standing or guyed 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)



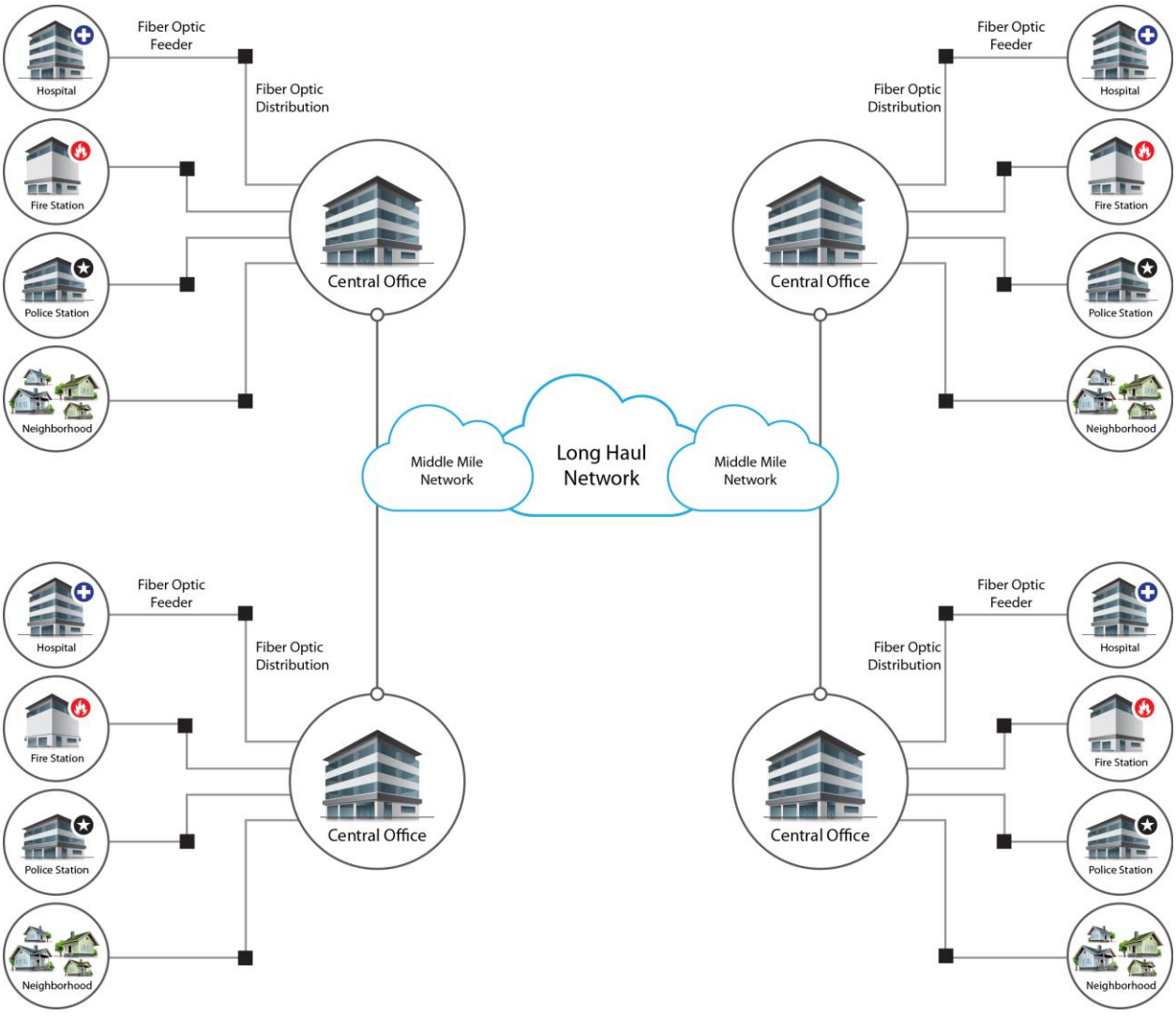
Source: (FCC, 2015c)

Figure 15.1.1-10: FCC Tower Structure Locations in Virginia

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. 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 15.1.1-11.

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 15.1.1-11: Typical Fiber Optic Network in Virginia

Last Mile Fiber Assets

In Virginia, fiber access networks are concentrated in the highest population centers as shown in the figures below. In Virginia, there are 8 fiber providers that offer service in the state, as listed in Table 15.1.1-10. Figure 15.1.1-12 shows coverage provided by Verizon; Figure 15.1.1-13 presents coverage by Comcast, CenturyLink, and Megapath; and Figure 15.1.1-14 presents coverage by other providers.

Table 15.1.1-10: Fiber Provider Coverage

Fiber Provider	Coverage
Verizon Virginia	26.19%
Comcast	13.11%
CenturyLink	11.73%
Megapath Corporation	5.22%
Other[a]	21.92%

Source: (NTIA, 2014)

[a] Other: Provider with less than 5% coverage area. Providers include: Bit Communications; Blue Ridge Internetworks; Charter Communications, Inc.; Citizens; Cogent; Cox Communications; Fairpoint Communications; Highland Telephone Cooperative; Inter Mountain Cable, Inc.; Level 3 Communications; Lumos Network, Inc.; Mediacom; Metrocast Communications; MGW Networks LLC; Nelson Cable, Inc.; New Hope Telephone Company; Nextlink Wireless, Inc.; Optinet; Pemtel; RCN Telecom Services, LLC; SCTC; Shentel; Skyline Telephone Membership Corporation; Suddenlink Communications; Sunset Digital Communications, Inc.; TDS Telecom; Time Warner Cable; XO Communications Services, Inc.

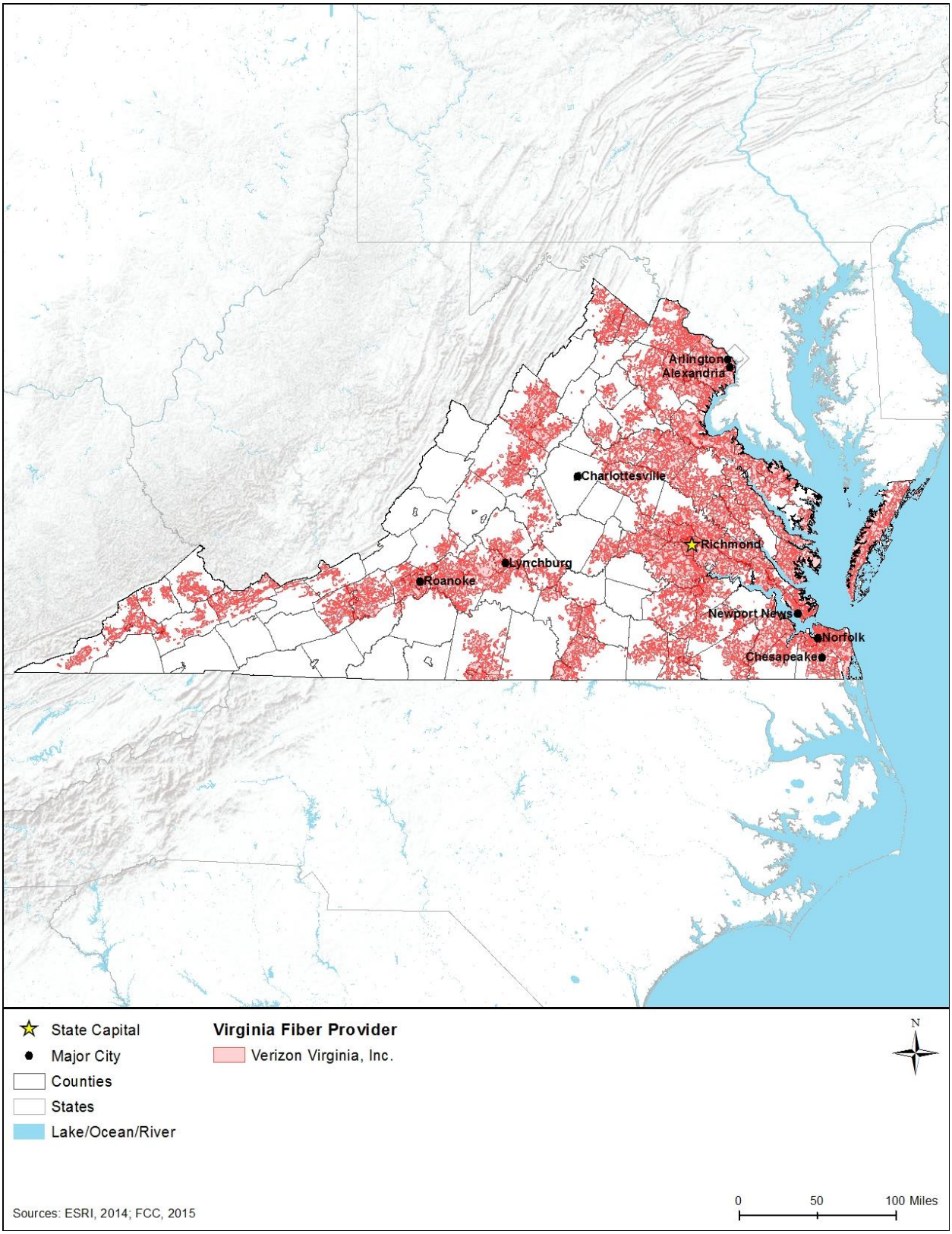


Figure 15.1.1-12: Verizon Fiber Availability in Virginia

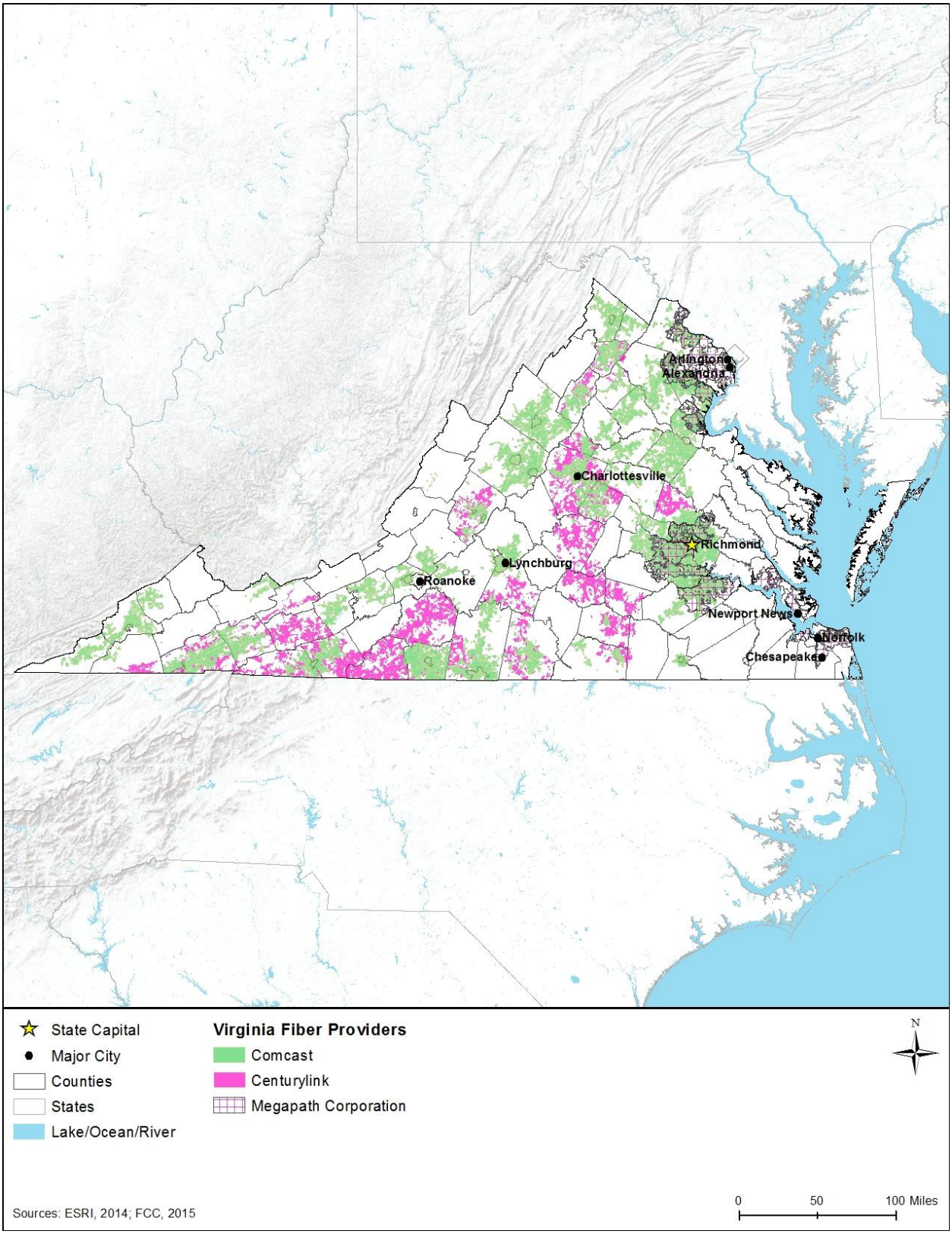


Figure 15.1.1-13: Comcast, CenturyLink, and Megapath Fiber Availability in Virginia

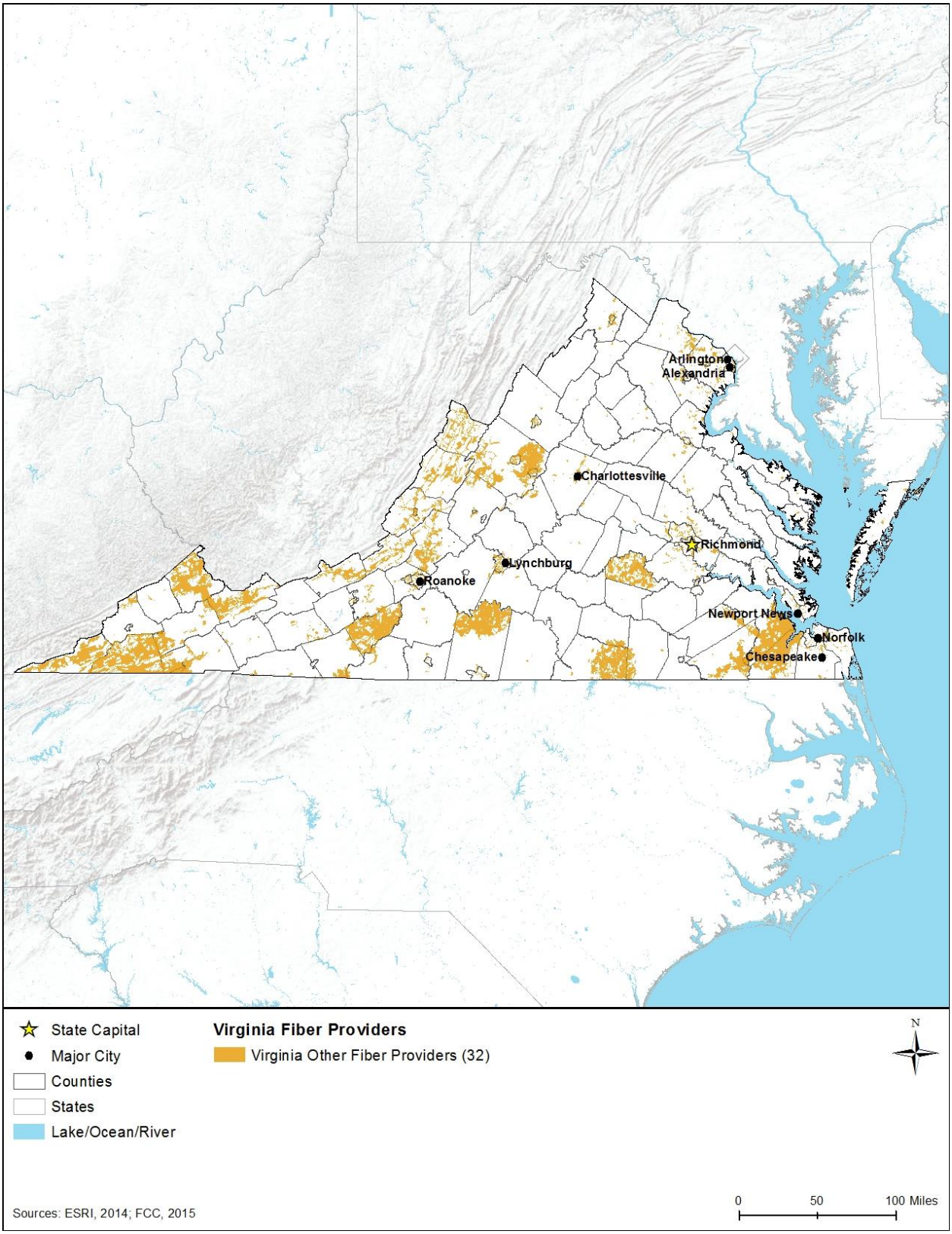


Figure 15.1.1-14: Fiber Availability in Virginia for All Other Coverage Providers

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 and 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).

15.1.1.6. Utilities

Utilities are the systems that are essential to support daily operations in a community and cover a broad array of public services, such as electricity, wastewater, and sewage. Section 15.1.4, Water Resources, describes the potable water sources in the state.

Electricity

It is the responsibility of the Virginia State Corporation Commission (SCC) to regulate the rates of investor or member-owned electric utilities. Among other duties, they monitor construction for projects concerning the transmission lines or generating equipment used to make and transmit electricity (SCC, 2015a). Three investor-owned electric companies provide power to large sections of the state: The Appalachian Power Company (APCo), Dominion Virginia Power, and Kentucky Utilities (known in Virginia as Old Dominion Power). These are regulated by the SCC, as are the thirteen member-owned electric cooperatives that operate in Virginia (SSC, 2015). In addition, there are 12 utility entities (mostly municipal systems) that are not regulated by the SCC. APCo, Dominion Virginia Power, and the cooperative of Rappahannock occupy the majority of the service territories in the state. Dominion Virginia Power mostly operates in the eastern areas of the state, in coastal territories, and APCo operates in the western portion of Virginia. The Rappahannock collective operates mostly in northeastern Virginia (SCC, 2015b).

Over the last several years, nearly all of Virginia's electricity has been produced by nuclear power, coal, and natural gas. Nuclear power has historically been the largest of these three sources. In 2016, 92,439 thousand megawatt-hours of electricity was produced with natural gas accounting for 44 percent and nuclear power accounting for 39percent[17] (EIA, 2017a). It should be noted that the state's nuclear power was produced by only two nuclear facilities. In 2015, the state received an offshore wind energy research lease, allowing them to begin work on renewable wind energy facilities. This may eventually supplement Virginia's current renewable energy programs, as currently most electricity from renewable sources is produced from biomass (EIA, 2015b).

[17] One megawatt-hour can be defined as "One thousand kilowatt-hours or 1million 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, 2015c).

Water

The Commonwealth of Virginia is home to 5,364 water systems, owned by the state, federal, or local government, or by a public or private owner. These systems are categorized as being either a community system, a non-community system (such as a campground or golf club) or a non-transient non-community system (such as a school). The quality of the water produced by these systems is the concern of the Virginia Department of Health (VDH). Along with monitoring the quality of drinking water, they also enforce regulations and provide engineering and technical assistance to system operators (VDH, 2015).

The protection of Virginia's bodies of water and other water resources falls to the DEQ. It utilizes the Water Permitting Division and Water Planning Division to carry out directives of the State Water Control Law and Federal Clean Water Act (VDEQ, 2015a). Virginia's lakes, rivers, and other waters are tested yearly for over 130 possible pollutants. This information, along with suspected sources of the pollutants, is used to compose an overall Virginia Water Quality Assessment Report, which is made available for the state's residents (VDEQ, 2015b).

The Virginia DEQ is also part of the Chesapeake Bay Program, a "multi-governmental cooperative partnership between Delaware; the District of Columbia; Maryland, Pennsylvania; New York; Virginia; West Virginia; the Chesapeake Bay Commission, a tristate legislative body; and the U.S. Environmental Protection Agency" that seeks to restore the water quality of the Chesapeake (VDEQ, 2015c). The DEQ does work in the areas of toxic substance reduction and nutrient point source reduction, in addition to numerous others (VDEQ, 2015c). Monitoring programs are in place to analyze current conditions and long trends pertaining to the health of the bay. There are also programs in place to monitor the health of the Bay's plankton, as plankton are very reactive in regard to changes in the Bay's quality and composition. Other programs monitor the health of shellfish and worms living in the bay, as a means of monitoring water quality (VDEQ, 2015d).

Wastewater

Virginia's Wastewater programs fall under the jurisdiction of the DEQ. Not only does the Department offer training to treatment facility staff, but it also evaluates the performance of treatment systems and facilities (VDEQ, 2015e). The DEQ's Wastewater Engineering Program is used to review construction permits and plans, offer technical assistance to treatment facilities, and evaluate permits for facility operation (VDEQ, 2015f). Although training is completed by the DEQ, facility operators are licensed by the Board for Waterworks and Wastewater Works Operators and Onsite Sewage System Professionals (DPOR, 2015). Issues dealing with onsite sewage management systems, such as septic tanks, are handled by the Division of Onsite Sewage, Water Services, Environmental Engineering and Marina Programs, part of the DEQ (VDEQ, 2015g). Applications for septic systems can be obtained from the division (VDEQ, 2015h).

Solid Waste Management

The DEQ uses its Solid Waste Program to regulate "the storage, treatment and disposal of solid waste." (VDEQ, 2015i). Waste Management approaches in Virginia seek to deal with waste first by reducing it at the source, then by reusing and recycling waste. What cannot be reused or recycled is sent to resource recovery centers where it can be used to produce energy. Any other wastes are incinerated or landfilled (VDEQ, 2015i).

In 2014, 20,160,344 tons of waste was received by Virginia facilities; 12,188,388 tons was landfilled, 795,983was recycled onsite and 2,169,120 was incinerated. The state is home to 55 municipal solid waste (MSW) landfills that were used in 2014. A total of 9,748,776 tons of waste was landfilled in these facilities in relation to the 265,428,065 tons of space left in the landfills at the end of 2014. A further 35,689,919 tons of capacity was available in landfills designated for construction materials. Regarding recycling, in 2014 1,139,178 tons of waste was recycled or diverted (out of a total of 13,998,379 tons). Most of this was done offsite, though some composting and recycling did take place on the facilities grounds. Between 2008 and 2014, the total amount of solid waste received from sources in Virginia fell from 15,402,762 to 14,975,574 tons (VDEQ, 2015i).

15.1.2. Soils

15.1.2.1. 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.

- 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.

15.1.2.2. Specific Regulatory Considerations

The Proposed Action must meet the requirements of 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. A list of applicable state laws and regulations is included in Table 15.1.2-1 below.

Table 15.1.2-1: Relevant Virginia Soil Statutes and Regulations

State Law/Regulation	Agency	Applicability
State Water Control Law (§62.1-44.2 et seq.)[a]	Virginia Department of Environmental Quality	Land disturbing activities equal to or exceeding 10,000 square feet are subject to these regulations including preparation of an Erosion and Sediment Control Plan (in addition to any local requirements).

Sources: (Virginia Law, 2017a)
[a] (VDOT, 2015b)

15.1.2.3. Environmental Setting

Virginia is composed of four Land Resource Regions (LRR),[18] 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;
- Northern Atlantic Slope Diversified Farming Region; and
- South Atlantic and Gulf Slope Cash Crops, Forest, and Livestock Region.

Within and among Virginia's four LRRs are 13 Major Land Resource Areas (MLRA),[19] which are characterized by patterns of soils, climate, water resources, land uses, and type of farming (NRCS, 2006). The locations and characteristics of Virginia's MLRAs are presented in Figure 15.1.2-1 and Table 15.1.2-2, respectively.

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[20] such as bacteria, fungi, biological crusts, vegetation, animals, and climatic variables such as precipitation and temperature. For example, expansive soils[21] with wet and dry seasons alternately swell and shrink, which presents integrity risks to structural foundations

[18] Land Resource Region: "A geographical area made up of an aggregation of Major Land Resource Areas (MLRA) with similar characteristics" (NRCS, 2006).
[19] 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).
[20] The flora and fauna of a region
[21] Expansive soils are characterized by "the presence of swelling clay materials" that absorb water molecules when wet and expand in size or shrink when dry leaving "voids in the soil" (Rogers, Olshansky, & Rogers, 2004).

(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[22] (discussed further in the subsections below).

15.1.2.4. 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 12 soil orders in the world and they are characterized by both observed and inferred[23] 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). FirstNet used the STATSGO2 database to obtain soils information at the programmatic level to ensure consistency across all the states and territories. This regional information provides a sufficient level of detail for a programmatic analysis. The best available soils data and information, including the use of the more detailed SSURGO database, will be used, as appropriate, during subsequent site-specific assessments. The STATSGO2[24] soil database identifies ten different soil suborders in Vermont (NRCS, 2015c). Figure 15.1.2-2 depicts the distribution of the soil suborders, and Table 15.1.2-3 provides a summary of the major physical-chemical characteristics of the various soil suborders found. The STATSGO2[25] soil database identifies eleven different soil suborders in Virginia (NRCS, 2015a). Figure 15.1.2-2 depicts the distribution of the soil suborders, and Table 15.1.2-3 provides a summary of the major physical-chemical characteristics of the various soil suborders found.

[22] Rutting is indentations in soil from operating equipment in moist conditions or soils with lower bearing strength (USFS, 2009b).
[23] "Soil properties inferred from the combined data of soil science and other disciplines (e.g., soil temperature and moisture regimes inferred from soil science and meteorology)" (NRCS, 2015g)
[24] STATS2GO is the Digital General Soil Map of the United States developed by the National Cooperative Soil Survey and supersedes the State Soil Geographic (STATSGO) dataset; the U.S. General Soil Map is comprised of general soil association units and is maintained and distributed as a spatial and tabular dataset. (NRCS, 2015a)
[25] STATS2GO is the Digital General Soil Map of the United States developed by the National Cooperative Soil Survey and supersedes the State Soil Geographic (STATSGO) dataset; the U.S. General Soil Map is comprised of general soil association units and is maintained and distributed as a spatial and tabular dataset.

15.1.2.5. Runoff Potential

The NRCS uses four Hydrologic Soil Groups (A, B, C, and D) that are based on a soil's runoff potential. Group A generally has the smaller runoff potential, whereas Group D generally has the greatest (Purdue University, 2015). Table 15.1.2-3 (below) provides a summary of the runoff potential for each soil suborder in Virginia.

Group A. Sand, loamy sand or sandy loam soils. This group of soils has "low runoff potential and high infiltration rates[26] 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). Psamments and Udepts fall into this category in Virginia.

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, Aquults, Udalfs, Udepts, and Udults fall into this category in Virginia.

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. Aquepts, Udalfs, Udepts, and Udults fall into this category in Virginia.

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). Aquents, Aquepts, Aquults, Saprists, Udalfs, Udepts, and Udults fall into this category in Virginia.

[26] 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)

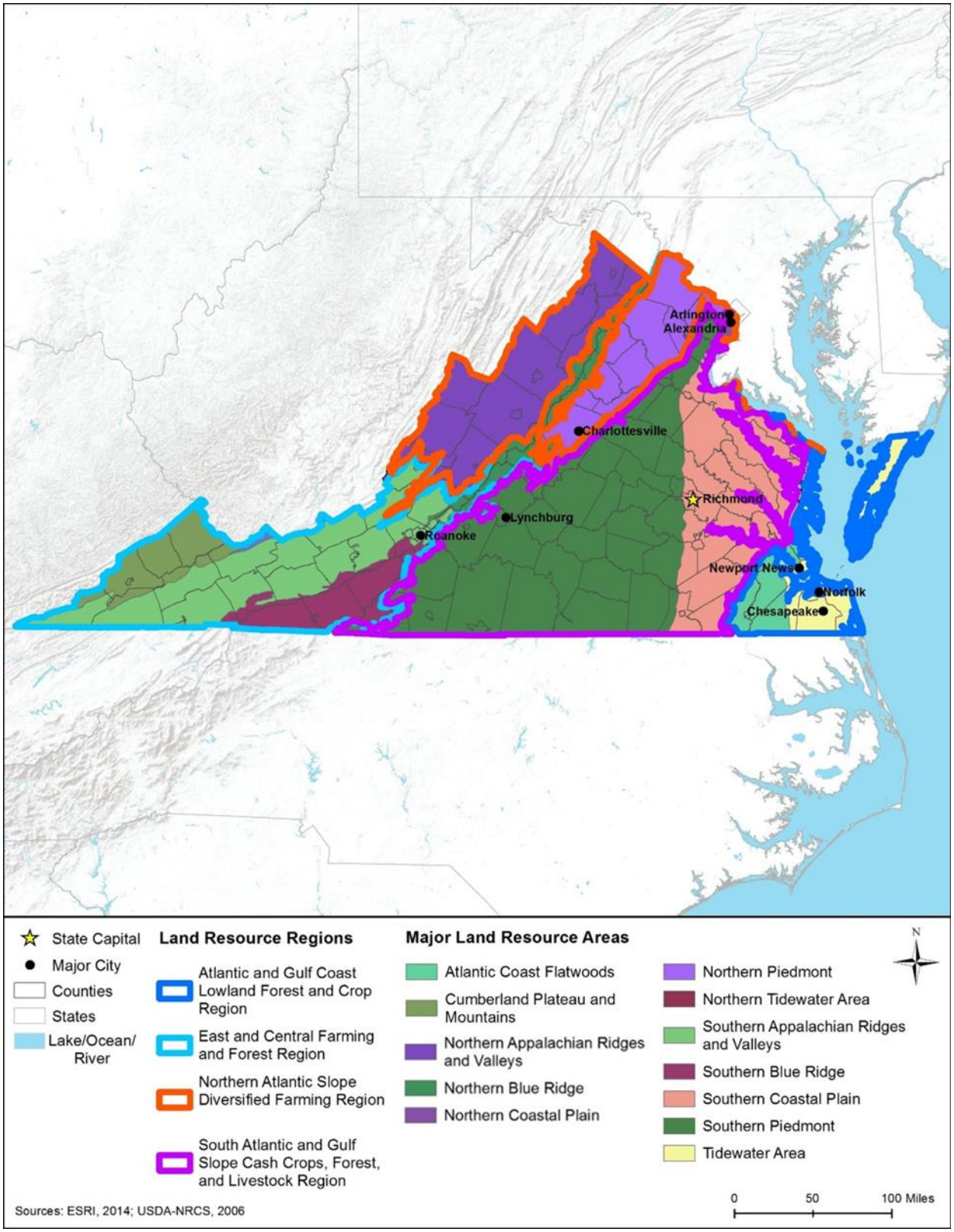


Figure 15.1.2-1: Locations of Major Land Resource Areas in Virginia

Table 15.1.2-2: Characteristics of Major Land Resource Areas in Virginia

MLRA Name	Region of State	Soil Characteristics
Atlantic Coast Flatwoods	Southeastern Virginia	Spodosols[a] and Ultisols[b] are the dominant soils in this area. They are deep, well drained to very poorly drained, and loamy or clayey.
Cumberland Plateau and Mountains	Western Virginia	Ultisols and Inceptisols[c] are the most common soil orders in this MLRA. Depth of soils and drainage conditions vary widely with the topography, which ranges from undulating to rolling areas to steep slopes.
Northern Appalachian Ridges and Valleys	Northwestern Virginia	Inceptisols, Ultisols, and Alfisols[d] are the dominant soil orders. These loamy or clayey soils range from shallow to very deep, and are generally excessively drained to moderately well drained.
Northern Blue Ridge	Northern central Virginia	Inceptisols, Ultisols, and Alfisols are the dominant soil orders. They are moderately deep to very deep and are also loamy-skeletal and sandy-skeletal to clayey.
Northern Coastal Plain	Northeastern Virginia	Ultisols is the dominant soil order in this area. They are very deep, excessively drained to very poorly drained, and loamy or sandy.
Northern Piedmont	Northern Virginia	Alfisols, Inceptisols, and Ultisols are the dominant soil orders in this area. They are moderately deep to very deep, moderately well drained to somewhat excessively drained, and loamy or loamy-skeletal.
Southern Appalachian Ridges and Valleys	Western Virginia	The dominant soil orders areUdults and to a lesser extent, Udepts. These soils vary from shallow to very deep, and are generally well drained.
Southern Blue Ridge	Southwestern central Virginia	Inceptisols and Ultisols are the dominant soil orders in this area. These soils are shallow to very deep and are loamy or clayey.
Southern Coastal Plain	Eastern Virginia	Ultisols, Entisols[e], and Inceptisols are the dominant soil orders in this area. They are very deep, somewhat excessively drained to poorly drained, and loamy.
Southern Piedmont	Central and Southern Virginia	Ultisols, Inceptisols, and Alfisols are the dominant soil orders in this area. These soils are shallow to very deep, generally well drained, and loamy or clayey.
Tidewater Area	Southeastern and Eastern Virginia	Alfisols and Entisols are the dominant soil orders in this area with Histosols to a lesser extent. Soils are generally very deep and poorly drained, and mostly loamy to clayey.

Source: (NRCS, 2006)

[a] Spodosols: "Soils formed from weathering processes that strip organic matter combined with aluminum from the surface layer and deposit them in subsoil. They commonly occur in areas of coarse-textured deposits under forests of humid regions, tend to be acid and infertile, and make up nearly 4% of the world's ice-free land surface." (NRCS, 2015d)

[b] Ultisols: "Soils in humid areas. They formed from fairly intense weathering and leaching processes that result in clay-enriched subsoil dominated by minerals, such as quartz, kaolinite, and iron oxides. Ultisols are typically acid soils in which most nutrients are concentrated in the upper few inches. They have a moderately low capacity to retain additions of lime and fertilizer." (NRCS, 2015d)

[c] 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)

[d] Alfisols: "Soils [that] result from weathering processes that leach clay minerals and other constituents out of the surface layer and into the subsoil, where they can hold and supply moisture and nutrients to plants. They formed primarily under forest or mixed vegetative cover and are productive for most crops." (NRCS, 2015d)

[e] 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)

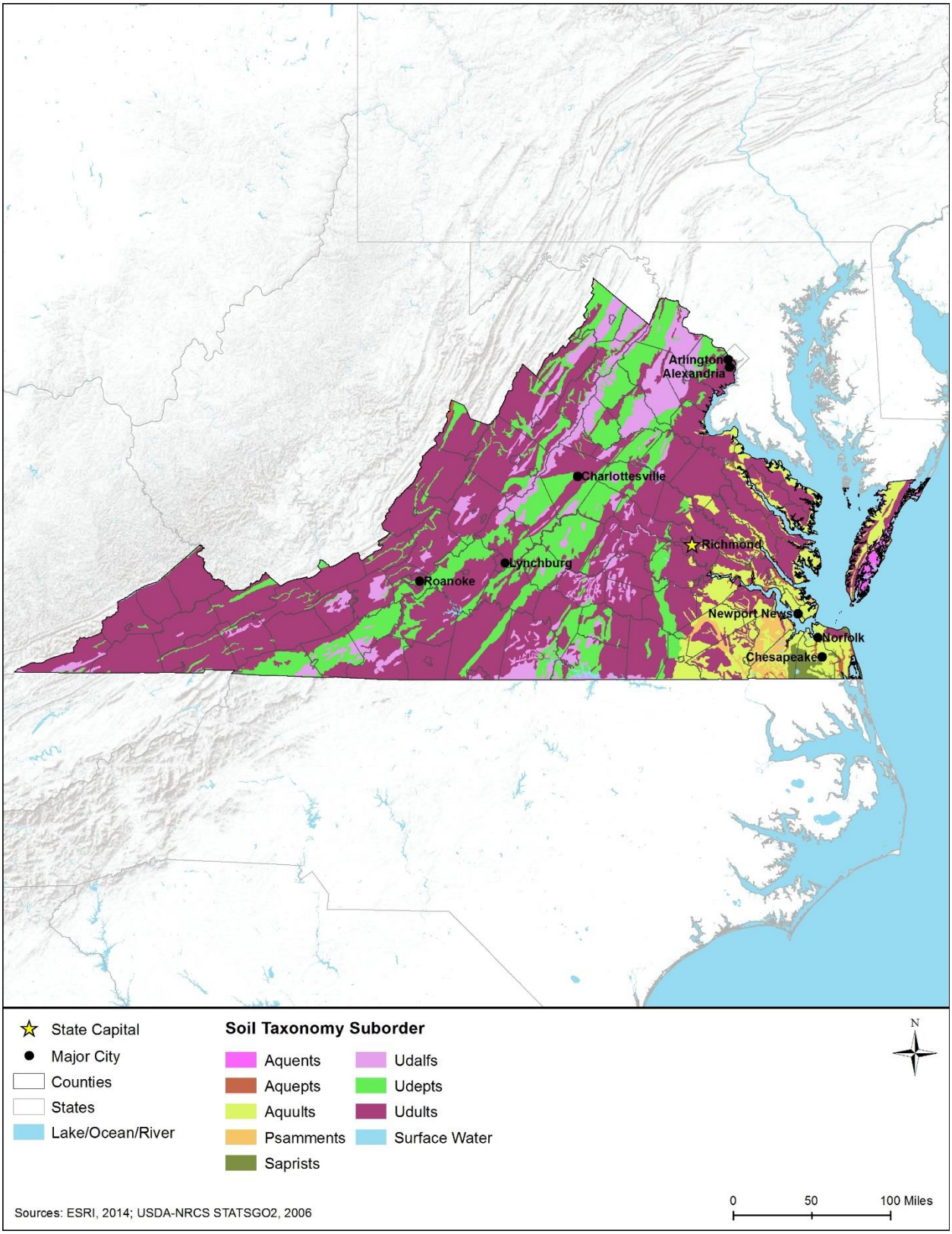


Figure 15.1.2-2: Virginia Soil Taxonomy Suborders

Table 15.1.2-3: Major Characteristics of Soil Suborders Found in Virginia, as depicted in Figure 15.1.2-2

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
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.	Silty clay loam	0-1	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.	Silt loam, very channery[c] loam	0-15	Poorly drained	Yes	B, C, D	Medium to High	Moderate to Very Low	Medium to High, depending on slope	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.	Fine sandy loam, sandy clay, sandy clay loam	0-2	Poorly drained	Yes	B, D	Medium to High	Moderate to Very Low	Medium to High, depending on slope	High, due to hydric soil and poor drainage conditions
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 sandy, loamy sand, sand	2-35	Excessively drained to well 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.	Fine sandy loam, muck, sand	0-2	Very poorly drained	Yes	D	High	Very Low	High	High, due to hydric soil and poor drainage conditions
Alfisols	Udalfs	Udalfs have a udic (humid or subhumid climate) moisture regime, and are believed to have supported forest vegetation at some time during development.	Channery silt loam, clay, gravelly clay loam, loam, silt loam, silty clay loam, very gravelly silt loam, weathered bedrock	0-35	Moderately well drained to well drained	No	B, C, D	Medium to High	Moderate to Very Low	Medium to High, depending on slope	Low
Inceptisols	Udepts	Udepts have a 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 loam, channery sandy loam, channery silt loam, cobbly[d] fine sandy loam, extremely channery loam, fine sandy loam, silt loam, unweathered bedrock, very channery sandy	0-80	Moderately well drained to excessively drained	No	A, B, C, D	Low to High	High to Very Low	Low to High, depending on slope	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
			loam, very channery silt loam, weathered bedrock								
Ultisols	Udults	Udults are more or less freely drained, relatively humus poor, and have a 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).	Channery loam, channery sandy clay loam, clay, clay loam, cobbly fine sandy loam, extremely cobbly clay, fine sandy loam, gravelly loam, loam, sandy clay, sandy clay loam, sandy loam, silt loam, silty clay loam, unweathered bedrock, variable, very cobbly clay loam, very flaggy[c] loam, very gravelly fine sandy loam, very gravelly silt loam, weathered bedrock	0-70	Moderately well drained to somewhat excessively drained	No	B, C, D	Medium to High	Moderate to Very Low	Medium to High, depending on slope	Low

Source: (NRCS, 2015a) (NRCS, 1999)

[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, 2015h).
[b] Based on Runoff Potential, described in Section 3.5.3.2
[c] Channery: thin, flat, coarse fragments of sandstone, limestone, or schist.
[d] Cobbly: refers to soil texture; coarse or rocky.
[e] Flaggy: pieces of flagstone are mixed in the soil.

15.1.2.6. 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 15.1.2-3 (above) provides a summary of the erosion potential for each soil suborder in Virginia. Soils with the highest erosion potential in Virginia include those in the Aquents, Aquepts, Aquults, Saprists, Udalfs, Udepts, and Udults suborders, which are found throughout most of the state (Figure 15.1.2-2).

15.1.2.7. 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 (USFWS, 2009). 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 10 tons can cause soil compaction of greater than 12 inches in 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 15.1.2-3 provides a summary of the compaction and rutting potential for each soil suborder in Virginia. Soils with the highest potential for compaction and rutting in Virginia include those in the Aquents, Aquepts, Aquults, and Saprists suborders, which are found throughout the state, but particularly in northeastern and southeastern area of Virginia (Figure 15.1.2-2)

15.1.3. Geology

15.1.3.1. 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 groundwater (Section 15.1.4.7), human health (Section 15.1.15), and climate change (Section 15.1.14).

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

- Section 15.1.3.3, Major Physiographic Regions and Provinces;[27,28]
- Section 15.1.3.4, Surface Geology;
- Section 15.1.3.5, Bedrock Geology;[29]
- Section 15.1.3.6, Paleontological Resources;[30]
- Section 15.1.3.7, Fossil Fuel and Mineral Resources; and
- Section 15.1.3.8, Potential Geologic Hazards.[31]

15.1.3.2. Specific Regulatory Considerations

The Proposed Action must meet the requirements of NEPA and other applicable laws and regulations. Applicable federal laws and regulations that apply to Geology, such as the National Historic Preservation Act and the Clean Water Act, are detailed in Appendix C. A list of applicable state laws and regulations is included in Table 15.1.3-1 below.

Table 15.1.3-1: Relevant Virginia Geology Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
2012 Virginia Construction Code	Virginia Department of Housing and Community Development	Provisions for earthquake-resistant design
Manual of the Structure and Bridge Division[a]	Virginia Department of Transportation	Bridges must be designed with consideration of seismic motion

Sources: (VDHCD, 2017) (VDOT, 2017)

[a] (VDGIF, 2015a)

15.1.3.3. Environmental Setting: Physiographic Regions and Provinces

The concept of physiographic regions was created in 1916 by geologist Nevin Fenneman as a way to describe areas of the United States based on common landforms (i.e., not climate or vegetation). Physiographic regions are areas of distinctive topography, geography, and geology. "Important physiographic differences between adjacent areas are, in a large proportion of cases, 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-

[27] Physiographic regions: Areas of the United States that share commonalities based on topography, geography, and geology. (Fenneman, 1916)
[28] Physiographic provinces: Subsets within physiographic regions. (Fenneman, 1916)
[29] Bedrock: Solid rock beneath the soil and superficial rock. (USGS, 2015b)
[30] Paleontology: "Study of life in past geologic time based on fossil plants and animals." (USGS, 2015b)
[31] 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)

divided into physiographic provinces based on differences observed on a more local scale. (Fenneman, 1916)

Virginia contains two physiographic regions: Atlantic Plain and the Appalachian Highlands (Figure 15.1.3-1) (USGS, 2013a). The general characteristics of these regions are summarized in the following subsections.

Atlantic Plain Region

The Atlantic Plain Region includes the Continental Shelf and the Gulf and Atlantic Coast plains stretching from New York 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 nearby 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. (NPS, 2015aa)

Within Virginia, the Atlantic Plain Region (locally referred to as the Coastal Plain Province) composes the eastern portion of the state. The western edge of the Coastal Plain abuts the Piedmont Province at the Fall Zone; the Fall Zone is a transitional area "between the older, resistant, metamorphic rocks[32] of the Piedmont Province and younger, softer, mostly unconsolidated sediments of the Coastal Plain" (VDCR, 2013). Moving eastward, Coastal Plain sediments "increase in thickness from a featheredge near the Fall Zone to more than 4,000 meters under the continental shelf" (William and Mary, 2017a). Soils are dominated by sand-sized sediments, but are interspersed with gravels, marine clays, and shells (VDCR, 2013).

The Coastal Plain is characterized by a series of terraces that "stair-step" down to the east. The western edge of the Coastal Plain is approximately 250 feet above sea level (ASL) and elevation falls to sea level at the Atlantic Ocean (VDCR, 2013). Throughout the province, scarps[33] reflect the locations of previous shorelines; landforms are higher and older in the western portion of the Coastal Plain Province and have been more impacted by stream erosion (William and Mary, 2017a). The Virginia Eastern Shore, on the southern end of the Delmarva Peninsula, is a typical barrier island with sand dunes on the coastline and marshes on the bay side. The coastline regularly shifts positions, as it is impacted by wind and waves (VDCR, 2013).

[32] Metamorphic Rocks: "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, 2015b)
[33] Scarp: "A relatively steep face or slope of considerable linear extent, irrespective of origin." (USGS, 2015b)

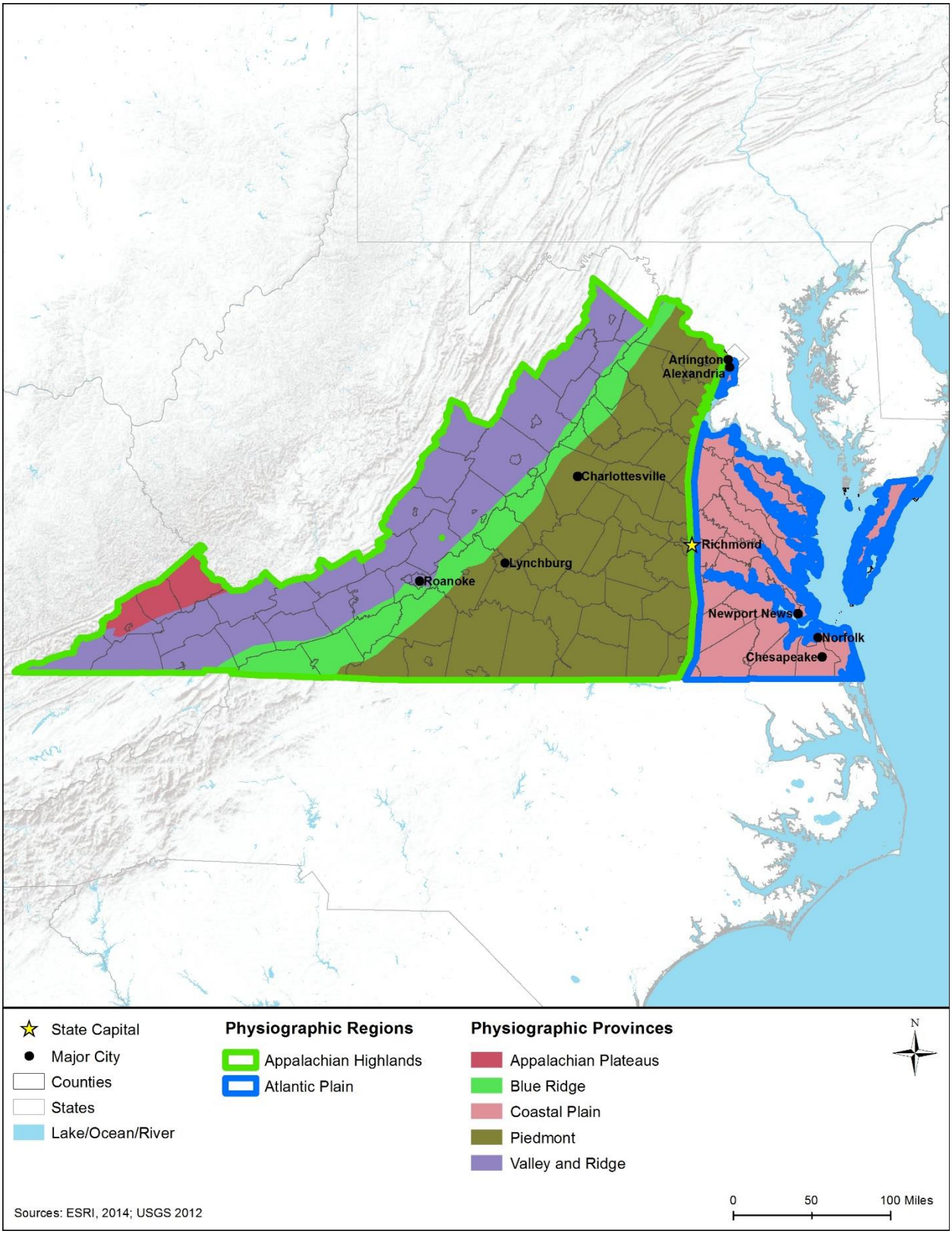


Figure 15.1.3-1: Physiographic Regions and Provinces of Virginia

Appalachian Highlands Region

The Appalachian Highlands Region extends from Canada to Alabama. This region is composed of layers of folded sedimentary rock,[34] created when the North American plates collided with the Eurasian and African plates more than 500 million years ago (MYA). Once similar in height to the present-day Rocky Mountains,[35] 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. (QAB, 1968)

As reported above, the Appalachian Highlands Region within Virginia is made up of several physiographic provinces, most notably the Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau (USGS, 2003b).

Piedmont Province – The Piedmont Province is the largest physiographic province in Virginia. The Piedmont Province spans the entire length of the state from north to south, and is nearly 190 miles wide in southern Virginia, and about 45 miles wide in northern Virginia. The Piedmont Province's rolling hills begin at the Fall Zone at about 160 feet ASL, and become more rugged near the Blue Ridge Mountains in the west, where elevations reach 1,000 feet ASL. The Piedmont's bedrock geology contains resistant metamorphic and igneous rocks[36] (VDCR, 2013). Bedrock is usually buried under layers of saprolite,[37] except where it has been removed by erosion (William and Mary, 2017b).

Figure 15.1.3-2: Image of Northern Blue Ridge Shenandoah National Park (VA)

Source: (William and Mary Department of Geology 2015c)

[34] 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, 2015b)
[35] The Rocky Mountains exceed 14,000 feet above sea level (USGS, 2015b).
[36] Igneous Rock: "Rock formed when molten rock (magma) that has cooled and solidified (crystallized). See intrusive (plutonic) and extrusive (volcanic) igneous rock." (USGS, 2015b)
[37] Saprolite: "Clay-rich, residual material derived from in-place weathering of bedrock." (USGS, 2015b)

Blue Ridge Province – The Blue Ridge Province consists of the eastern section of Virginia's mountains. Precambrian Era (older than 542 MYA) rocks were compressed to form the Appalachian Mountains during three mountain building events. The northern Blue Ridge Mountains are underlain by resistant igneous rocks (e.g., granite[38] and basalt[39]); the high point of the northern Blue Ridge is Apple Orchard Mountain (4,225 feet ASL). South of Roanoke Gap, the Blue Ridge widens to 50 miles across; the peak elevation in the southern Blue Ridge is Mount Rogers (5,729 feet ASL) (VDCR, 2013).

Valley and Ridge Province – The Valley and Ridge Province consists of parallel ridges and valleys that are underlain by folded Paleozoic (542 MYA to 251 MYA) sedimentary rocks (VDCR, 2013). The ridges, which lie between 4,000 and 4,600 feet ASL, "are largely underlain by more resistant sandstones,[40] quartzites,[41] and shales,[42] whereas valleys are largely underlain by softer carbonates (e.g., limestone[43] and dolomite[44]) and shales" (VDCR, 2013). Karst[45] landforms are common in Virginia's Great Valley (William and Mary, 2017c).

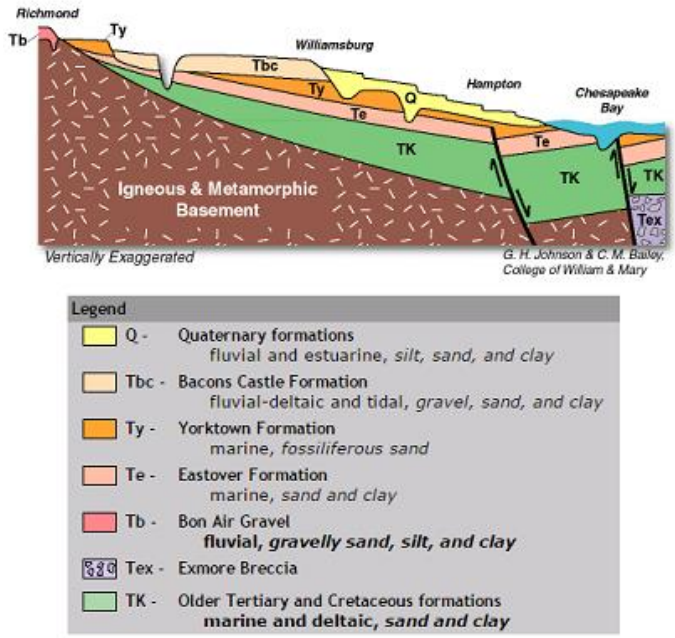
Appalachian Plateaus Province – The Appalachian Plateaus Province lies in southwestern Virginia and is characterized by “high elevation, low relief”, and downcut stream channels. The upper layers of the Province are laden with coal, natural gas, and petroleum. (William and Mary, 2017d)

15.1.3.4. Surface Geology

Surficial geology is characterized by materials such as till,[46] sand and gravel, or clays that overlie bedrock. The surface terrain, which can include bedrock outcrops, provides information on the 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,[47] subsidence,[48] and erosion. (Thompson, 2015)

[38] Granite: "A coarse-grained intrusive igneous rock with at least 65% silica." (USGS, 2015b)
[39] Basalt: "A dark, fine-grained, extrusive (volcanic) igneous rock with a low silica content (40% to 50%), but rich in iron, magnesium, and calcium." (USGS, 2015b)
[40] Sandstone: "Sedimentary rock made mostly of sand-sized grains." (USGS, 2015b)
[41] Quartzite: "Hard, somewhat glassy-looking rock made up almost entirely of quartz. Metamorphosed quartz sandstone and chert are quartzites." (USGS, 2015b)
[42] Shale: "Sedimentary rock derived from mud. Commonly finely laminated (bedded). Particles in shale are commonly clay minerals mixed with tiny grains of quartz eroded from pre-existing rocks." (USGS, 2015b)
[43] Limestone: "A sedimentary rock made mostly of the mineral calcite (calcium carbonate)." (USGS, 2015b)
[44] Dolomite: "A magnesium-rich carbonate sedimentary rock." (USGS, 2015b)
[45] Karst: "A distinctive landscape (topography) that can develop where the underlying bedrock, often limestone or marble, is partially dissolved by surface or groundwater." (USGS, 2015b)
[46] 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, 2015b)
[47] Slope failure, also referred to as mass wasting, is the downslope movement of rock debris and soil in response to gravitational stresses.
[48] Subsidence: "Gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials." (USGS, 2000)

Most of the surficial materials in Virginia are marine deposits that are on the present day Coastal Plain physiographic province. These sediments were deposited during the Tertiary (66 MYA to 2.6 MYA) and Quaternary (2.6 MYA to present) Periods during interglacial periods when sea level was higher than present-day levels. Modern surface deposits emanate from existing streams and rivers. There is no evidence of recent glacier deposits in Virginia. A cross-sectional representation of Coastal Plain sediment deposits in Virginia is included in Figure 15.1.3-3. (William and Mary, 2017a). Figure 15.1.3-4 depicts the generalized surface geology for all of Virginia.



Source: (Radford University, 2014)

Figure 15.1.3-3: Terrace Stratigraphy of the Virginia Coastal Plain

15.1.3.5. Bedrock Geology

Bedrock geology analysis, and "the study of distribution, position, shape, and internal structure of rocks" (USGS, 2015c) reveals important information about a region's surface and subsurface characteristics (i.e., 3-dimensional geometry), including dip (slope of the formation),[49] rock composition, and regional tectonism.[50] 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 (NHDES, 2017).

[49] 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." (USGS, 2015b)
[50] Tectonicisms: "Structure forces affecting the deformation, uplift, and movement of the earth's crust." (USGS, 2015d)

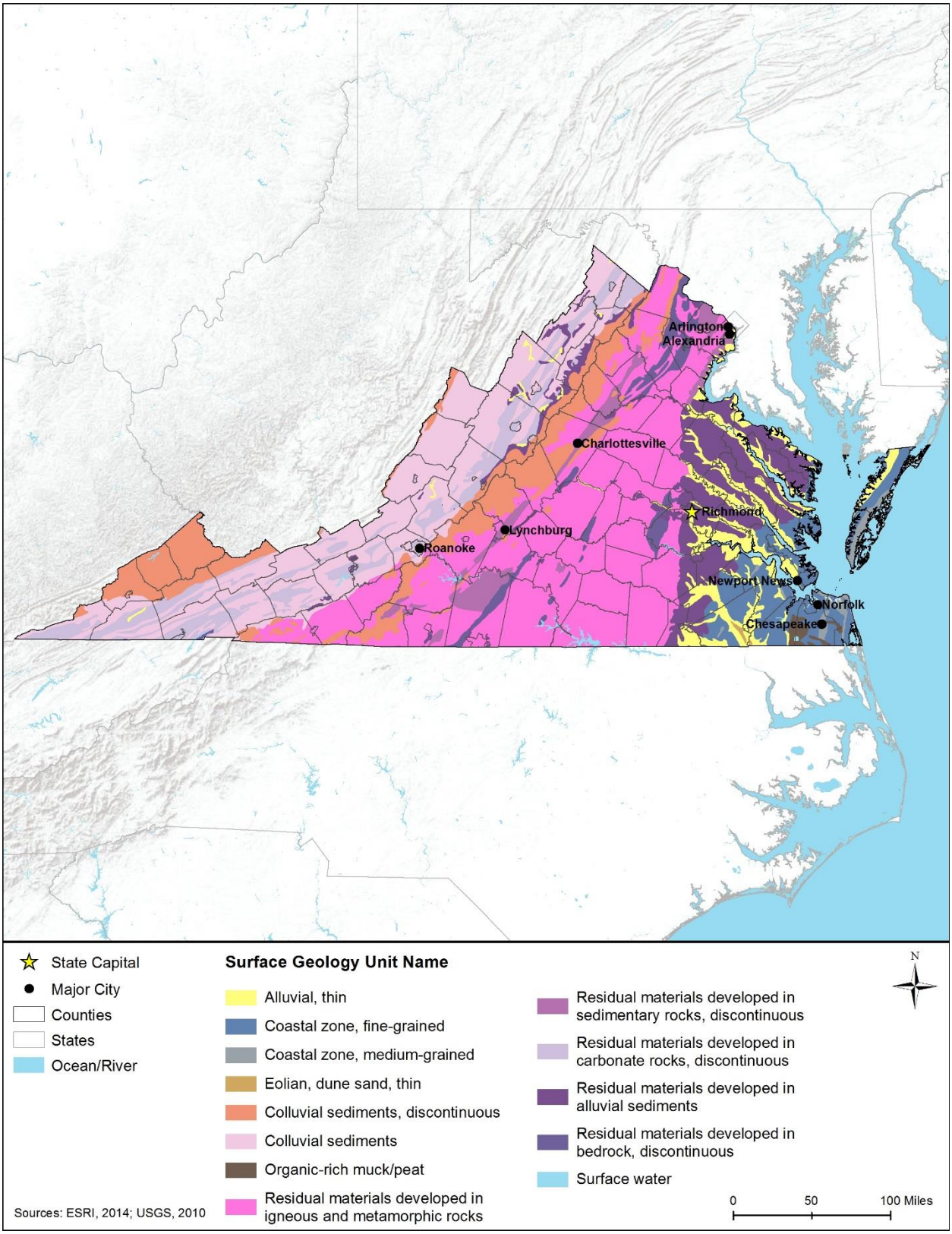


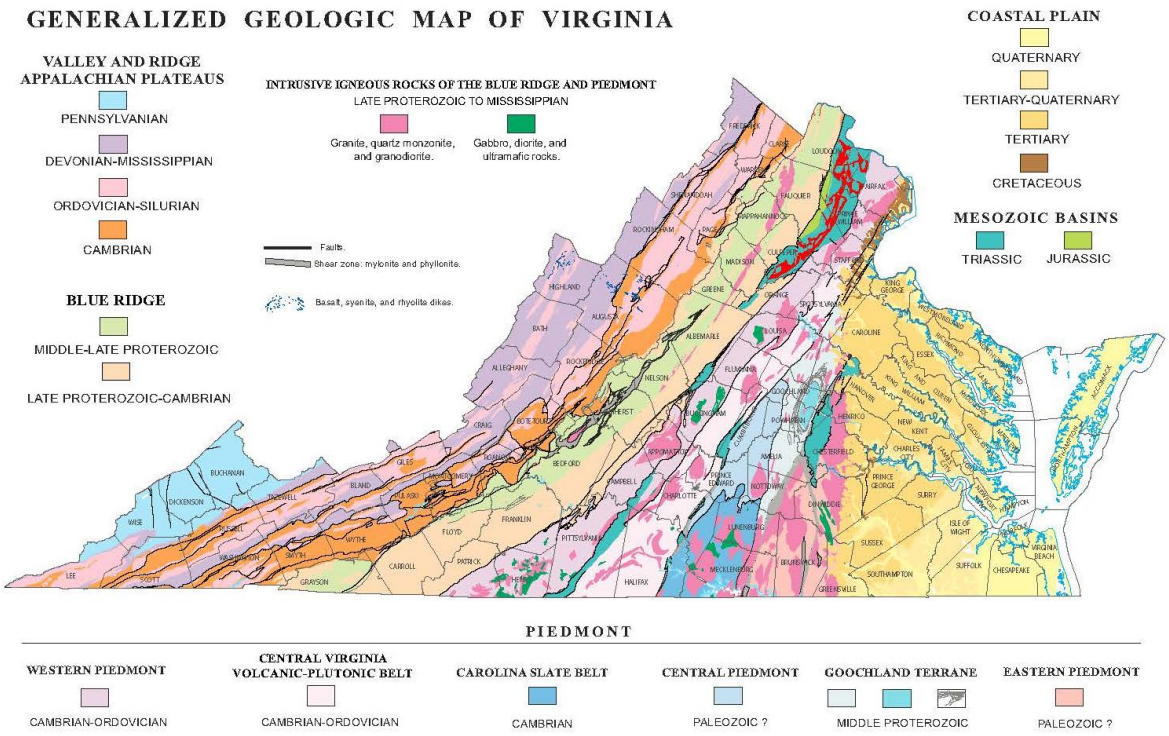
Figure 15.1.3-4: Generalized Surface Geology for Virginia

The bedrock geology of Virginia varies significantly by physiographic designation. A brief overview of the bedrock geology of each physiographic province is included below. For a more detailed description of each physiographic province, refer to Section 15.1.3.3.

- Virginia's Coastal Plain is composed of marine deposited sediments that dip slightly to the southeast; this landscape is not generally susceptible to seismic hazards (as discussed in Section 15.1.3.8). (William and Mary, 2017a)
- Igneous and metamorphic rocks from the late-Precambrian (2,500 MYA to 542 MYA) and Paleozoic (542 MYA to 251 MYA) Eras compose the Piedmont Province's bedrock. Many exposed rocks have been significantly weathered and likely originated from rock masses outside of North America. (William and Mary, 2017b)
- The Blue Ridge Province contains older metamorphic and igneous rocks that have been compressed (during the Paleozoic Era) against the mountains of the Valley and Ridge province to the west. The oldest rocks in the Blue Ridge are granites that date to more than 1.2 Billion Years Ago (BYA). (William and Mary, 2017e)
- The Valley and Ridge Province's bedrock contains folded Paleozoic sedimentary rock. The ridges contain relatively strong sedimentary rocks, while the valleys are composed of carbonate sedimentary rocks that are conducive to the formation of karst topography. (William and Mary, 2017c)
- The Appalachian Plateau is made up of similar rocks as the neighboring Valley and Ridge; the primary difference is that the Appalachian Plateau is characterized by smaller folds and flatter lying rocks. (William and Mary, 2017d)

Despite no active tectonic plate boundaries[51] in Virginia, there are existing vulnerabilities in certain areas where fault[52] lines occur (see Section 15.1.3.8, Geologic Hazards). Figure 15.1.3-5 displays the general bedrock geology for Virginia. For more site-specific bedrock geology information, other sources such as regulated mine information from the Virginia Department of Mines Minerals and Energy,[53] county soil surveys, and USGS topographical maps[54] should be consulted. Additionally, more detailed studies may be available for specific areas from the USGS, county soil and water conservation districts, and local academic institutions.

[51] Tectonic Plate: "A slab of rigid lithosphere (crust and uppermost mantle) that moves over the asthenosphere." (USGS, 2015d)
[52] Fault: "A fracture in the Earth along which one side has moved in relative to the other." (USGS, 2015d)
[53] https://www.dmme.virginia.gov/
[54] http://www.usgs.gov/pubprod/



Source: (Virginia Department of Mines Minerals and Energy, 2015)

Figure 15.1.3-5: Generalized Bedrock Geology for Virginia

15.1.3.6. Paleontological Resources

Paleozoic Era (542 to 241 MYA) marine fossils in Virginia can be found in sedimentary rocks from the Cambrian (542 to 488 MYA), Ordovician (488 to 444 MYA), Silurian (444 to 416 MYA), and Devonian (416 to 359 MYA) Periods, in the Valley and Ridge and Appalachian Plateau provinces (see Section 15.1.3.3 for more information on Virginia's physiography). Approximately 350 MYA, during the Carboniferous Period, the western part of Virginia was above sea level and covered with lush, dense forests and swamps. The organic material that accumulated in these large areas eventually produced Virginia's coal seams. By the Mesozoic Era (251 to 66 MYA), the eastern part of the state was still under a shallow sea; marine fossils have been recovered from some Cretaceous Period (146 to 66 MYA) outcrops. Deposits from the Triassic Period (251 to 200 MYA) have yielded dinosaur footprints in the Piedmont Province. During the Cenozoic Era (66 MYA to present), sea levels varied dramatically, as evidenced by the abundance of marine fossils in Coastal Plain sediments, as well as land-based animal fossils along rivers and lakes. (William and Mary, 2017f)

Skolithos trace fossils in Paleozoic Era deposits along the western flank of the Blue Ridge Mountains, are the oldest common fossils recorded in Virginia. Additionally, individual and colonial corals, fern impressions, trilobites, and gastropod fossils have been recorded in

Paleozoic rocks in the Valley and Ridge (Virginia Department of Mines Minerals and Energy, 2012b). Mesozoic Era marine fossils, including oysters and belemnites, have been recorded in the eastern part of the state. Fossils of dinosaur footprints, freshwater fish, and insects have been found in the Piedmont province (William and Mary, 2017b). Many fossils from the Cenozoic Era have also been recorded in Virginia. Pelecypods, which are bivalve mollusks, are typically found in sedimentary deposits along the Coastal Plain. One type of pelecypod, the *Chesapecten jeffersonius*, is the state fossil of Virginia (Virginia Department of Mines Minerals and Energy, 2012b). Marine rocks in the Coastal Plain also yield high numbers of clam, snail, and sand dollar fossils, as well as fossilized whalebones, shark teeth, and colonial corals. Additionally, sediments deposited along rivers and lakes have yielded mastodon and mammoth fossils (Strauss, 2017). Some potential fossil-bearing locations in Virginia are depicted in Figure 15.1.3-6.

Source: (Virginia Department of Mines Minerals and Energy, 2012b)

Virginia State Fossil
Chesapecten jeffersonius

15.1.3.7. Fossil Fuel and Mineral Resources

Oil and Gas

In 2016, Virginia produced 11 thousand barrels of crude oil. All of the Virginia's oil came from one rig in the southwestern part of the state; exploration in other parts of the state have been unsuccessful. (EIA, 2017b)

As of 2015, Virginia ranked 17th nationwide for production of natural gas, with total production exceeding 127,584M cubic feet (roughly 0.4 percent of total nationwide production) (EIA, 2013a). Between 1991 and 2011, natural gas production increased by more than ten-fold. As of 2015, there were 8,111 natural gas producing wells in Virginia (Figure 15.1.3-7), most of which extract coalbed methane from coal-rich formations (EIA, 2014a), such as the Pennsylvanian Period (318 MYA to 299 MYA) Norton, Lee, and Pocahontas Formations. Conventional gas is extracted from Devonian Period (416 MYA to 359 MYA) shales and Mississippian Period (359 MYA to 318 MYA) limestone and sandstone of the Appalachian Basin (VDMME, 2015a).

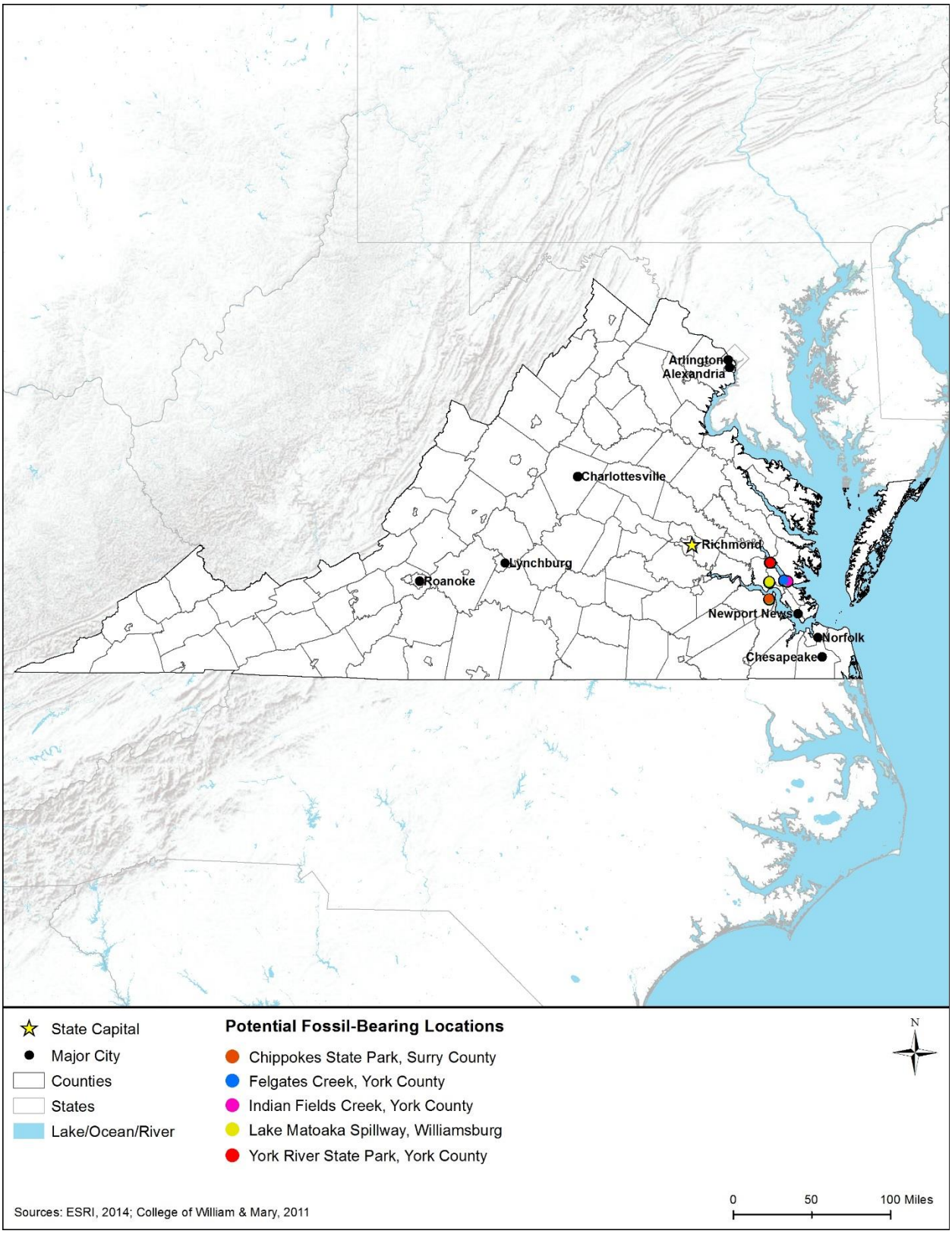


Figure 15.1.3-6: Virginia Potential Fossil-Bearing Locations

Minerals

As of 2016, Virginia's nonfuel mineral production was valued at over $1.2B. Crushed stone was the state's leading nonfuel mineral commodity, followed by portland cement, construction sand and gravel, lime, and fuller's earth (USGS, 2017a). As of 2012, there were 130 active crushed stone mines, which produced an estimated value of $654M (VDMME, 2015b). Crushed stone was the state's leading nonfuel mineral commodity in 2013; as of that time, Virginia also the only state to produce kyanite. (USGS, 2017b). Common clays and shale (VDMME, 2015c), dimension stone, feldspar, gemstones, gypsum, salt, titanium minerlas, zircon, kyanite, sulfur (oil), talc, iron oxide pigments, and vermiculite have also been produced and mined in Virginia (USGS, 2017b).

Coal is primarily mined in three areas of Virginia: Southwest Virginia coalfield, Valley Coalfields, and Eastern Coalfields (Figure 15.1.3-7). The Southwest Virginia coalfield has deposits of low-medium volatile bituminous coal from Pennsylvanian Period sedimentary rocks. The Valley Coalfields are in the Valley and Ridge Province and contain medium volatile bituminous to semi-anthracite coals, while the Eastern Coalfields have high-volatile bituminous coal from the Triassic Period (VDMME, 2015d). With 70 active coal mines, Virginia contributes to just under 2 percent of the nation's total coal production (EIA, 2014a).

15.1.3.8. Geologic Hazards

The three major geologic hazards of concern in Virginia are earthquakes, landslides, and subsidence. Volcanoes do not occur in Virginia and therefore do not present a hazard to the state (USGS, 2015e). The subsections below summarize current geologic hazards in Virginia.

Earthquakes

Between 1973 and March 2012, there were 15 earthquakes of a magnitude 3.5 on the Richter scale[55] or greater in Virginia (although considerably more that were felt in Virginia but originated outside of the state) (Earthquake Tracker, 2017). 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 natural and manmade structures on the surface (USGS, 2012b).

[55] A base-10 logarithmic scale that defines magnitude as the logarithm of the ratio of the amplitude of the seismic waves to an arbitrary, minor amplitude; used to measures earthquakes.

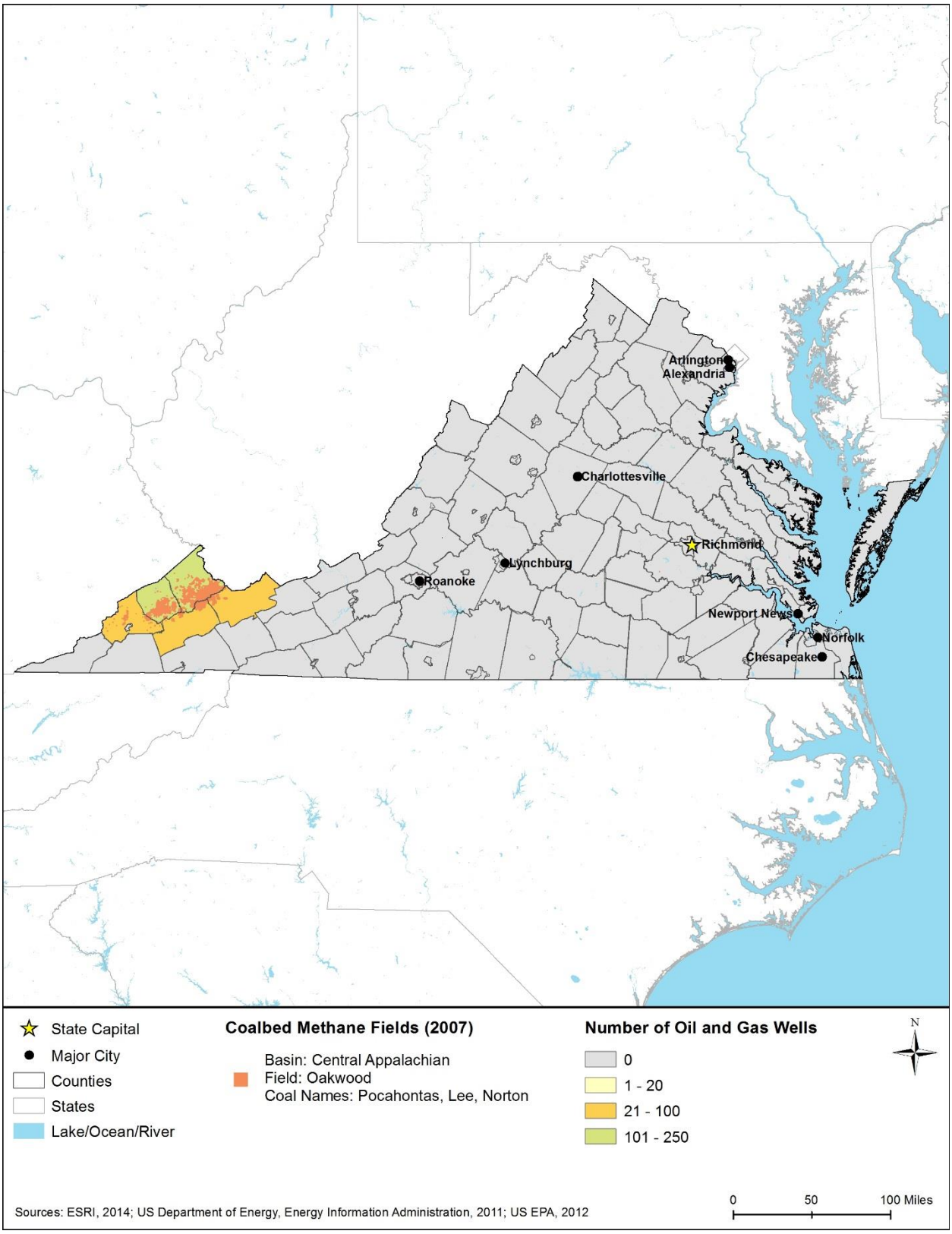


Figure 15.1.3-7: Coalbed Methane Fields and Oil/Gas Wells in Virginia

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. Subduction zone earthquakes happen where tectonic plates converge. "When these plates collide, one plate slides (subducts) 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)

2011 Mineral, VA Earthquake

In August 2011, a magnitude-5.8 earthquake centered in Mineral, VA, impacted much of the East Coast of the United States (USGS, 2017c). The earthquake occurred in the Central Virginia Seismic Zone, which "extends east-west about 120km from the Fall Line to Blue Ridge and is about 100km wide in the north-south direction." The August 2011 earthquake may have emanated from a relatively new fault. Rock falls attributed to the earthquake were located more than 150 miles away (by comparison, earthquakes of a similar magnitude in the western United States are typically felt just 40 miles away) (USGS, 2017c).

Figure 15.1.3-8 depicts the seismic risk throughout Virginia. The map indicates levels of horizontal shaking (measured in Peak Ground Acceleration (PGA)) 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% g.[56] (USGS, 2010)

Areas of greatest seismicity in Virginia are concentrated in the central portion of the state (just west of the Richmond area) and in the extreme southwestern portion of the state in the Appalachian Plateau Province. The largest earthquake ever recorded in Virginia was a magnitude-5.9 quake that occurred in 1897 in Giles County (just west of the City of Blacksburg) in the southwestern portion of the state (VT, 2017).

Landslides

On average, significant storms that produce widespread landslides occur in Virginia every 10 to 15 years. More than 150 people died following landslides attributed to Hurricane Camille in August 1969. In June 1995, an intense thunderstorm produced more than 500 localized landslides in Madison County. In August 2004, Tropical Depression Gaston triggered an 11-acre landslide in downtown Richmond and hundreds of smaller landslides in the city's suburbs. (VDMME, 2015e)

"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, 2003a). 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, 2003a)

[56] Post-1985 buildings (in California) have experienced only minor damage with shaking of 60% g. (USGS, 2010)

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, 2003a)

Steep slopes and highly fractured bedrock contribute to landslides in Virginia's Ridge and Valley and Blue Ridge Provinces; landslides are often precipitated by heavy rainfall. Landslides also may occur in the Piedmont and Coastal Plain Provinces, but they are "often smaller and generated by human disturbance, such as [constructing steep] road cuts." Areas that are most landslide-prone contain slopes greater than 30 degrees. Figure 15.1.3-9 displays the landslide incidence and susceptibility map for Virginia. (VDMME, 2015e)

Subsidence

Land subsidence is a "gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials" (USGS, 2000). The main triggers of land subsidence can be aquifer compaction, drainage of organic soils, mining, sinkholes, and thawing permafrost (although permafrost does not occur in Virginia). More than 80 percent of subsidence in the United States is due to 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 (USGS, 2013b). If an aquifer is confined by layers of silt or clay, which do not transport groundwater, the lowered water pressure in the sand and gravel can cause ground layers collapse on one another. Compression permanently lowers 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. Changes in ground-surface elevation not only affect the integrity and operation of existing infrastructure, but also complicate vegetation and best management of land use. (USGS, 2013b)

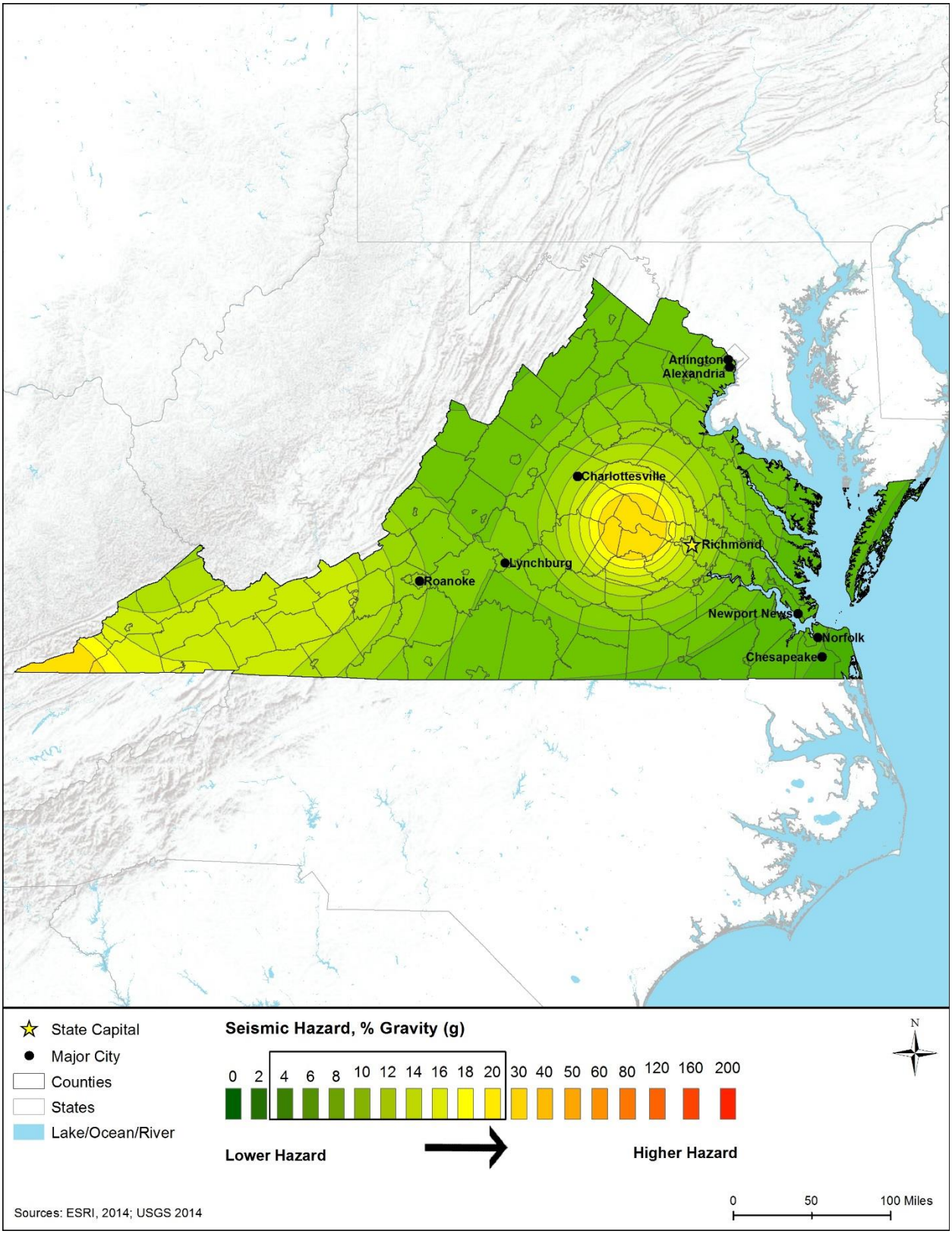


Figure 15.1.3-8: Virginia 2014 Seismic Hazard Map

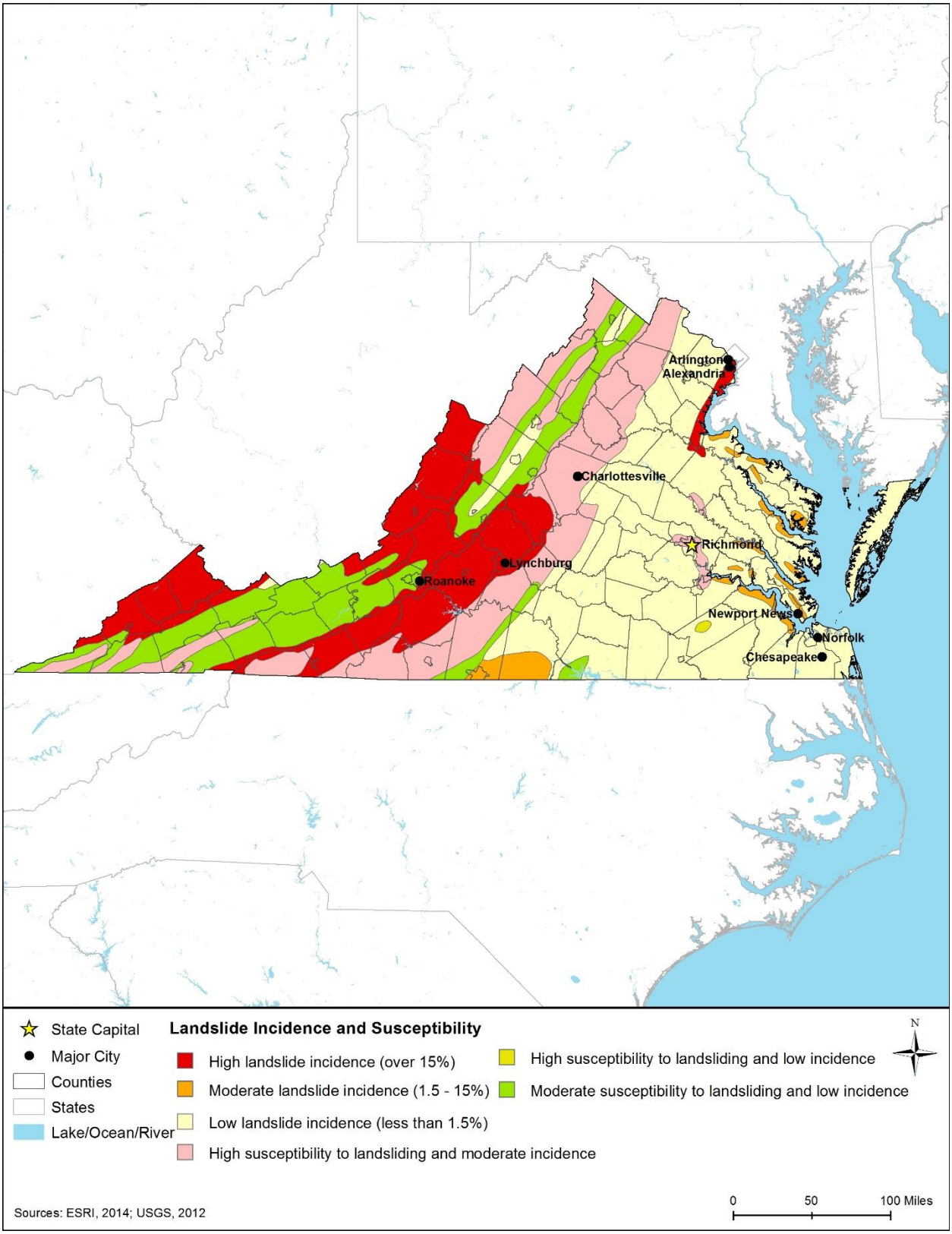


Figure 15.1.3-9: Virginia Landslide Incidence and Susceptibility Hazard Map[57]

In Virginia, a significant cause of land subsidence is the collapse of karst. "Karst is a terrain with distinctive landforms and hydrology created from the dissolution of soluble rocks, principally limestone and dolomite" (USGS, 2012c). Karst sinkholes are usually brought on by sinking soils resulting from caves below. Karst topography in Virginia is predominantly in a band that includes the counties of the Valley and Ridge Physiographic Province. Figure 15.1.3-10 displays the locations of all karst topography in Virginia, which regularly causes sinkhole problems along roads and highways. Between 1910 and 2011, the Virginia Department of Emergency Management recorded 12 significant "historical land subsidence events." There are 2,651 state facilities that are at risk to impacts due to karst subsidence, including the Virginia Polytechnic Institute and State University, which has 328 buildings that are considered to be at risk (VHMP, 2015).

[57] Susceptibility hazards not indicated in Figure 15.1.3-10 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 the incidence of landslides. Some generalization was necessary at this scale, and several small areas of high incidence and susceptibility were slightly exaggerated. (USGS, 2014a)

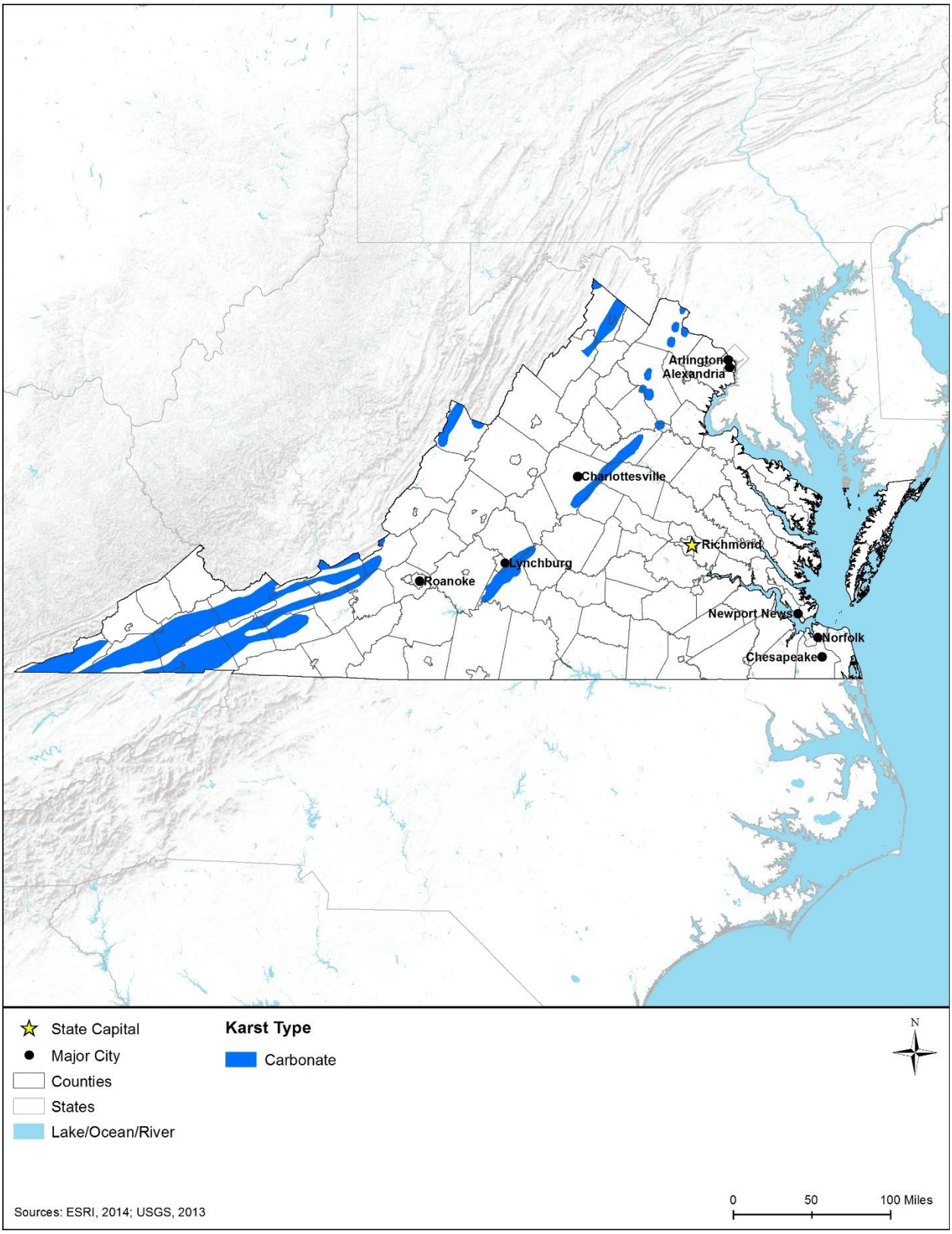


Figure 15.1.3-10: Virginia Karst Topography

15.1.4. Water Resources

15.1.4.1. 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 15.1.5). 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 health, economic wellbeing, and ecological health. (USGS, 2014b)

15.1.4.2. Specific Regulatory Considerations

Federal laws relevant to protecting the quality and use of water resources are summarized in Appendix C. Table 15.1.4-1 summarizes the major Virginia laws and permitting requirements relevant to the state's water resources.

Table 15.1.4-1: Relevant Virginia Water Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Virginia Pollution Discharge Elimination System Permit Program	Virginia Department of Environmental Quality (VDEQ)	Permits are required for discharges of pollutants to surface waters from point sources including municipal and industrial stormwater dischargers.
Virginia Stormwater Management Program Regulations	VDEQ	Activities that disturb one acre of land or greater, or that are part of a larger "common plan of development or sale that ultimately disturbs one or more acres. Permit holders must develop stormwater pollution prevention plans.
Virginia Stormwater Management Program Regulations	VDEQ	MS4 operators must put in place a number of programs to reduce the discharge of polluted stormwater to surface waters.
Virginia Pollution Abatement Permit Program	VDEQ	Handling or discharging of waste or wastewater to anywhere other than a surface water or wastewater treatment plant. These materials can include sewage sludge, industrial wastes, municipal wastewater, and animal wastes.
Groundwater Withdrawal Permitting Program	VDEQ	Person or entity withdrawing 300,000 gallons of groundwater or more in any month from a Groundwater Management Area must obtain a permit.

Sources: (VDEQ, 2015j) (VDEQ, 2015k) (VDEQ, 2015k) (VDEQ, 2015l) (VDEQ, 2015m)

15.1.4.3. Environmental Setting: Surface Water

Surface water resources are lakes, ponds, rivers, and streams, as well as estuarine[58] and coastal waters. According to the Virginia Department of Environmental Quality (VDEQ), Virginia has over 100,000 miles of rivers and streams, over 117,00 acres of lakes and reservoirs, 120 miles of Atlantic Ocean coastline, and over 3,300 miles of Chesapeake Bay estuarine coastline (VDEQ, 2014). These surface waters supply drinking water; provide flood control and aquatic habitat; and support recreation, tourism, agriculture, fishing, power generation, and manufacturing across the state (VDEQ, 2014).

Watersheds

Watersheds, or drainage areas, consist of surface water and all underlying groundwater, and encompass an area of land that drains all the streams and rainfall to a common outlet (e.g., reservoir, bay). Virginia's waters (lakes, rivers, and streams) are divided into 14 major watersheds, or drainage basins (Figure 15.1.4-1). VA Appendix A, Table A-1: Characteristics of Virginia's Watersheds, provides detailed information on the state's major watersheds, as defined by VDCR. The James Watershed and all watersheds north of it flow into the Chesapeake Bay. The Albemarle, Chowan, and Roanoke Watersheds drain south and east into the Albemarle-Pamlico Estuary. The New Watershed and all watersheds to the west of it drain into the Mississippi River basin and ultimately into the Gulf of Mexico. Visit http://www.dcr.virginia .gov/soil_and_water/wsheds.shtml for additional information on Virginia's watersheds. (VDCR, 2014a)

[58] 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, 2015a)

Freshwater

As shown in Figure 15.1.4-2, there are nine major rivers in Virginia: Chowan, James, New, Potomac, Rappahannock, Roanoke, Shenandoah, Tennessee, Big Sandy, and York River (VDEQ, 2014). The Potomac River forms much of Virginia's northeastern border with Maryland and Washington, DC, before flowing into the Chesapeake Bay. The Rappahannock, York, and James rivers also flow into the Chesapeake Bay on the bay's western shoreline. The Shenandoah River is located in the northern part of the state where it's north branch and south branch flow north, converge into the Shenandoah main stem, then flow into the Potomac River. The New River, which originates in North Carolina, flows north through the southwest corner of Virginia and then into West Virginia, ultimately draining into the Mississippi River Basin. The Chowan River originates in the southeastern part of the state and flows south into the Albemarle Sound, which is located in North Carolina and extends north into Virginia. The Roanoke River also flows south into the Albemarle Sound (DCR, 2017). Virginia also has 248 publically owned lakes with a combined area of approximately 117,158 acres. Of these, 123 are considered "significant lakes" for water quality monitoring and total approximately 113,545 acres. In addition to those owned publically, there are many hundreds of other smaller, privately owned lakes, reservoirs, and ponds throughout the state. The state's lakes and reservoirs are used for flood control, recreation, cooling water for power generation, hydropower, and as public water supply (VADEQ, 2014) (VDGIF, 2017a).

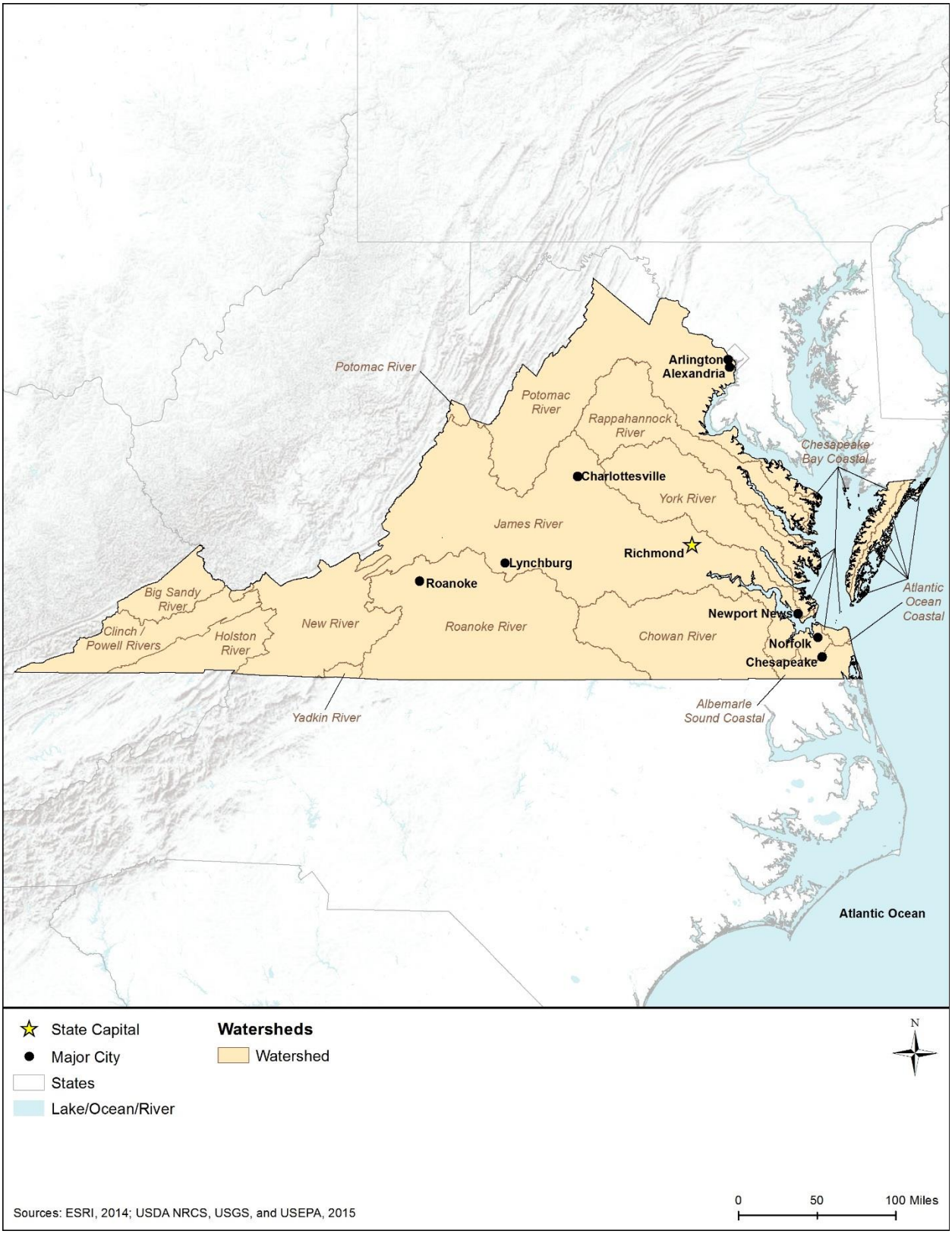


Figure 15.1.4-1: Virginia's Watersheds, Defined by VDCR

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 Virginia, from ocean waves and storms. Virginia's estuarine environments support a variety of habitats, including tidal wetlands, 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)

Virginia has two distinct coastal water environments: the estuarine shoreline of the Chesapeake Bay and the Atlantic Ocean coastline on the Delmarva Peninsula and in the southeastern corner of the state. Virginia has over 3,300 miles of Chesapeake Bay and Atlantic Ocean coastline (VDEQ, 2014). The VDEQ, National Oceanic and Atmospheric Administration (NOAA), and other state agencies and local governments implement policies that "protect… coastlines and foster sustainable development" (VDEQ, 2015n). Information on Virginia's coastal resources is available on the VDEQ Coastal Zone Management site at www.deq.state.va.us/Programs/CoastalZoneManagement.aspx.

Virginia has two major estuaries located in the southeastern corner of the state (Figure 15.1.4-3).

- The Chesapeake Bay Estuary lies in the eastern portion of Virginia, stretching 200 miles from the mouth of the Susquehanna River to the bay's outlet to the Atlantic Ocean (Chesapeake Bay Program, 2015a). The Chesapeake Bay and its tidal tributaries have a "combined surface area of 4,480 square miles," making it the largest estuary in the United States (Chesapeake Bay Program, 2015a). The Chesapeake Bay's watershed of about 64,000 square miles encompasses "parts of Maryland, Pennsylvania, Delaware, New York, West Virginia, Virginia, and all of the District of Columbia" (Chesapeake Bay Program, 2015a).
- The Chesapeake Bay was the first estuary in the United States to receive special protection under federal law when the Chesapeake Bay Program was established in 1983 (Chesapeake Bay Program, 2015b). The Bay has a variety of water quality problems including excess nitrogen and phosphorous which results in depleted dissolved oxygen levels, harming aquatic life. Despite federal and state efforts over the past 25 years, the Bay's water quality has failed to sufficiently improve, and as a result, the EPA established a Total Maximum Daily Load (TMDL) for the bay in 2010 (USEPA, 2015f). The TMDL establishes limits for the total amounts of nitrogen, phosphorous, and sediment that can enter the bay, and is being implemented by the six states within the Bay watershed and the District of Columbia (USEPA, 2015f). For more information on the Chesapeake Bay, visit EPA's Chesapeake Bay Program Office website at http://www2.epa.gov/aboutepa/about-chesapeake-bay-program-office. The Chesapeake Bay is also an EPA-designated Large Aquatic Ecosystem (USEPA, 2012b). The bay ecosystem is home to about 350 species of fish, more than 170 species of shellfish, about 30 species of waterfowl, and about 80,000 acres of aquatic grasses that provide habitat for blue crabs (Chesapeake Bay Program, 2015a).
- The Ablemarle-Pamlico Estuary consists of eight individual sounds and bays on the coasts of Virginia and North Carolina: Back Bay, Currituck Sound, Albemarle Sound, Roanoke Sound, Groatan Sound, Pamlico Sound, Core Sound, and Bogue Sound. Of these, only Back

Bay extends into Virginia. The estuary's waters have a total surface area of about 2 million acres and include about half of the juvenile fish habitat on the east coast. (Albemarle-Pamlica National Estuary Partnership, 2012) (Albemarle-Pamlico National Estuary Partnership, 2015) The estuary was designated as an estuary of national significance in 1987 and a Comprehensive Conservation and Management Plan (CCMP) was written in 1994. The CCMP sets forth actions to identify knowledge gaps, protect the ecosystem, restore the ecosystem, engage the public, and monitor progress. (Albemarle-Pamlica National Estuary Partnership, 2012) For more information on the Albemarle-Pamlico Estuary, visit Albemarle-Pamlico National Estuary Partnership's National Estuary Program website at http://www.apnep.org/web/apnep/.

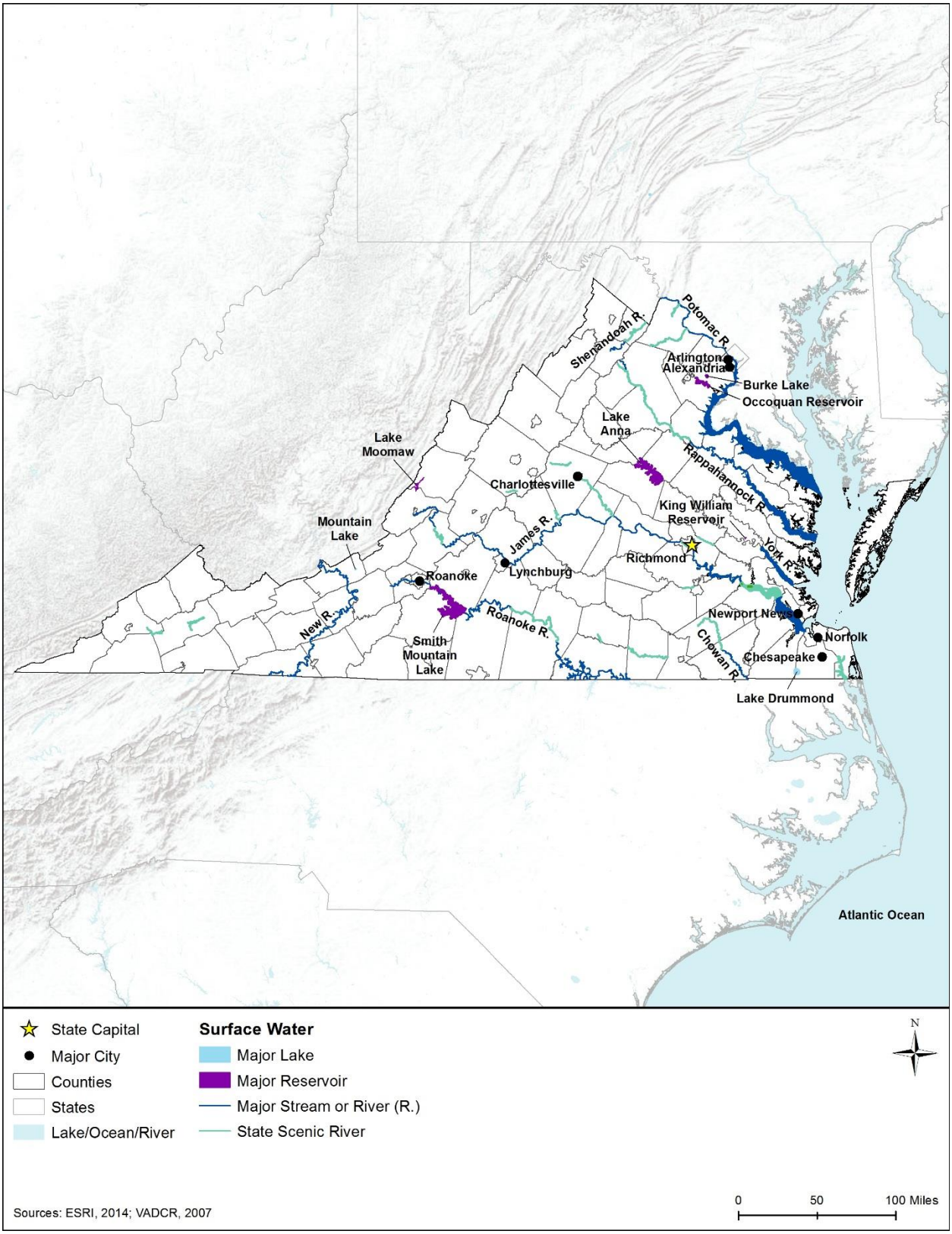


Figure 15.1.4-2: Virginia Surface Waterbodies

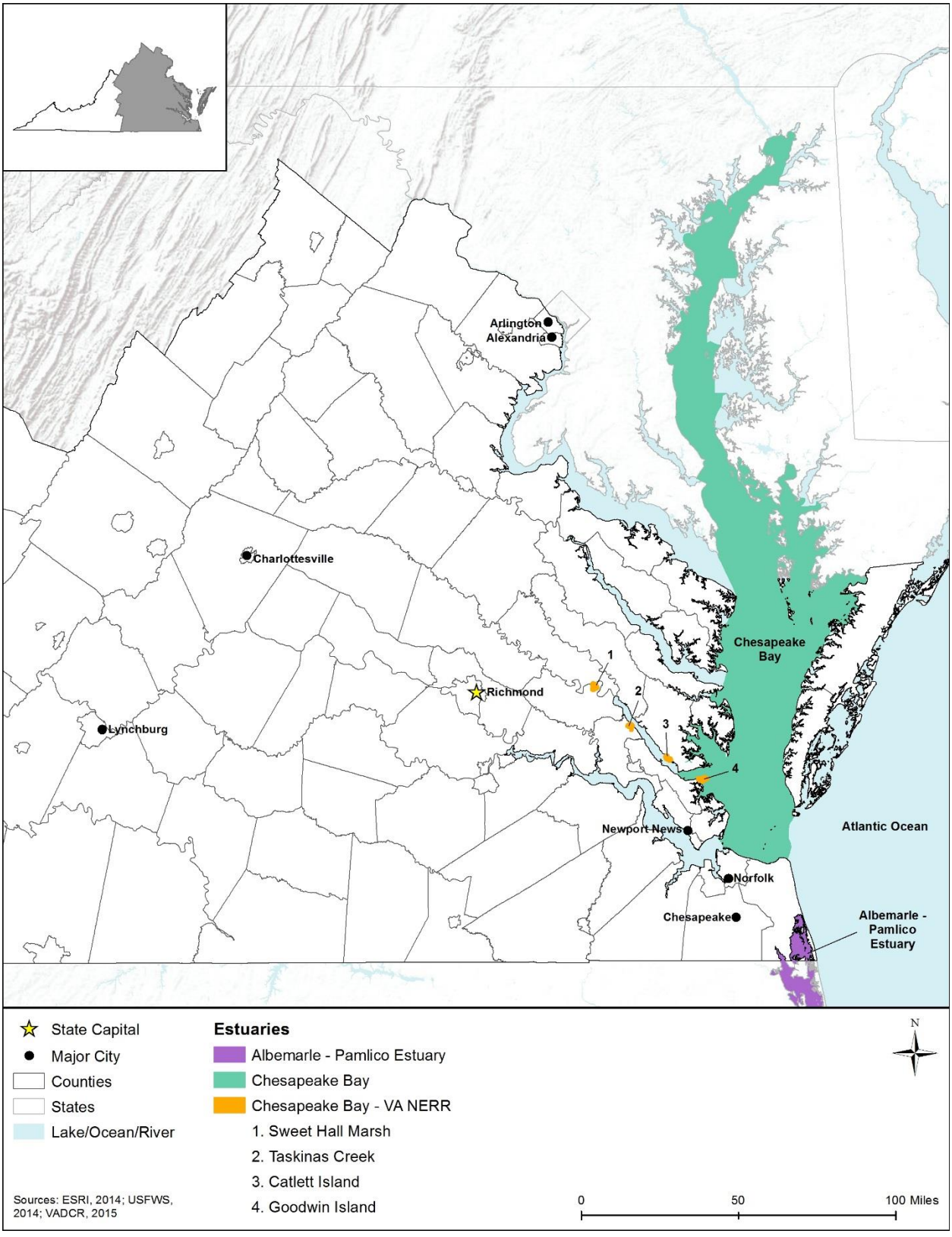


Figure 15.1.4-3: Virginia's Estuaries

15.1.4.4. Sensitive or Protected Waterbodies

Wild and Scenic Rivers

Virginia has no federally designated National Wild and Scenic Rivers, but the state has designated 33 river segments totaling 815 miles in length as "scenic" under state law, as listed in VA Appendix A, Table A-2: Virginia Scenic Rivers. The purpose of Virginia's Scenic River Program is to "identify, designate and help protect rivers and streams that possess outstanding scenic, recreational, historic and natural characteristics of statewide significance for future generations." (VDCR, 2015b)

State Designated Critical Resource Waters

The Chesapeake Bay National Estuarine Research Reserve (NERR) is located within the Chesapeake Bay Estuary. Administered by NOAA, the Chesapeake Bay NERR is part of a network of 28 NERRs across the country whose mission is to "practice and promote stewardship of coasts and estuaries through innovative research, education, and training using a place-based system of protected areas" (NERRS, 2011). The Chesapeake Bay NERR's waters are designated Critical Resource Waters[59] (USACE, 2015). The Chesapeake Bay NERR consists of seven components, three in Maryland and four in Virginia. The Virginia components, Sweet Hall Marsh, Taskinas Creek, the Catlett Islands, and Goodwin Islands, protect more than 3,070 acres (Chesapeake Bay NERR, 2015a). Sweet Hall Marsh is located on the Pamunkey River, a tributary of the York River. Taskinas Creek, Catlett Islands, and Good Islands are located directly on the York River, south of Sweet Hall Marsh (Chesapeake Bay NERR, 2015b). These reserve components are all located within the York River estuary, which is the fifth largest supplier of freshwater to the Chesapeake Bay and is bordered by agricultural, undeveloped land (Virginia Institute of Marine Science, 2008).

15.1.4.5. 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,[60] the causes of impairment, and probable sources. Table 15.1.4-2 summarizes the water quality of Virginia's assessed major waterbodies by category, percent impaired, designated use,[61] cause, and probable sources. Figure 15.1.4-4 shows the Section 303(d) waters in Virginia as of 2014.

As shown in Table 15.1.4-2, various sources affect Virginia's waterbodies, causing impairments. For example, pathogens have impaired the Occoquan River, Lake Accotink is impaired for

[59] Critical Resource Waters: include designated marine sanctuaries, National Estuarine Research Reserves, National Wild and Scenic Rivers, critical habitat for Federally listed threatened and endangered species, coral reefs, State natural heritage sites, and outstanding national resource waters or other waters officially designated by a State as having particular environmental or ecological significance and identified by the District Engineer after notice and opportunity for public comment. (USGS, 2015b)
[60] 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, 2015a)
[61] 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, 2015a)

mercury in fish tissue, and the Chesapeake Bay is impaired for PCBs in fish tissue (VDEQ, 2014). Virginia has issued fish consumption advisories for a number of different fish species, largely because of the presence of PCBs and mercury in these species (VDH, 2013). Designated uses of impaired waterbodies include recreation, fish consumption, aquatic life, and shellfish (VDEQ, 2014).

Table 15.1.4-2: Section 303(d) Impaired Waters of Virginia, 2008

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	66%	66%	Recreation, fish consumption, aquatic life, and wildlife	Pathogens[c], low dissolved oxygen, mercury in fish tissue, acidity	Wildlife other than waterfowl, livestock, domestic waste, septic systems
Lakes, Reservoirs, and Ponds	75%	84%	Aquatic life, fish consumption, recreation, wildlife	PCBs in fish tissue, low dissolved oxygen, mercury in fish tissue, acidity	Flow alteration, wildlife other than waterfowl, domestic waste, atmospheric deposition[d]
Estuaries and Bays	92%	95%	Aquatic life, fish consumption, shellfish, recreation	PCBs in fish tissue, noxious aquatic plants, low dissolved oxygen, algal growth	Municipal sewage, industrial wastewater, agriculture, atmospheric deposition[d]

Source: (USEPA, 2015l)

[a] Some waters may be considered for more than one water type
[b] Virginia has not assessed all waterbodies within the state.
[c] Pathogen: a bacterium, virus, or other microorganism that can cause disease (USEPA, 2015a).
[d] Atmospheric deposition: the process by which airborne pollutants settle onto to the earth's surface and pollutants travel from the air into the water through rain and snow ("wet deposition"), falling particles ("dry deposition"), and absorption of the gas form of the pollutants into the water. (USEPA, 2015a)

According to Virginia's 2012 Water Quality Assessment, only 0.1% of rivers, less than 0.1% of lakes and reservoirs, and estuarine waters fully support all designated uses. Recreation is the mostly commonly impaired designated use for rivers, whereas fish consumption and aquatic life and fish consumption are the most commonly impaired designated uses for lakes and estuaries respectively. Low dissolved oxygen concentrations are a major cause of aquatic life impairment in Virginia. Nitrogen and phosphorous are carried to waterbodies via stormwater runoff and lead to the growth of excessive amounts of algae, which in turn leads to depletion of dissolved oxygen in the water column, suffocating fish and other aquatic life. Stormwater runoff can also carry pathogens into surface waters that originate in waste from livestock and pets. Shellfish that are exposed to these pathogens can be harmful if consumed by humans which is a major cause of shellfish designated use impairments. PCBs and mercury are a major cause of fish consumption impairment. PCBs were once used in industrial processes and are now present as legacy pollutants in the soil. Mercury often enters waterbodies through atmospheric deposition and originates in industrial processes such as coal burning, waste incineration, and metal processing. Mercury and PCBs accumulate in fish tissue. (VDEQ, 2014)

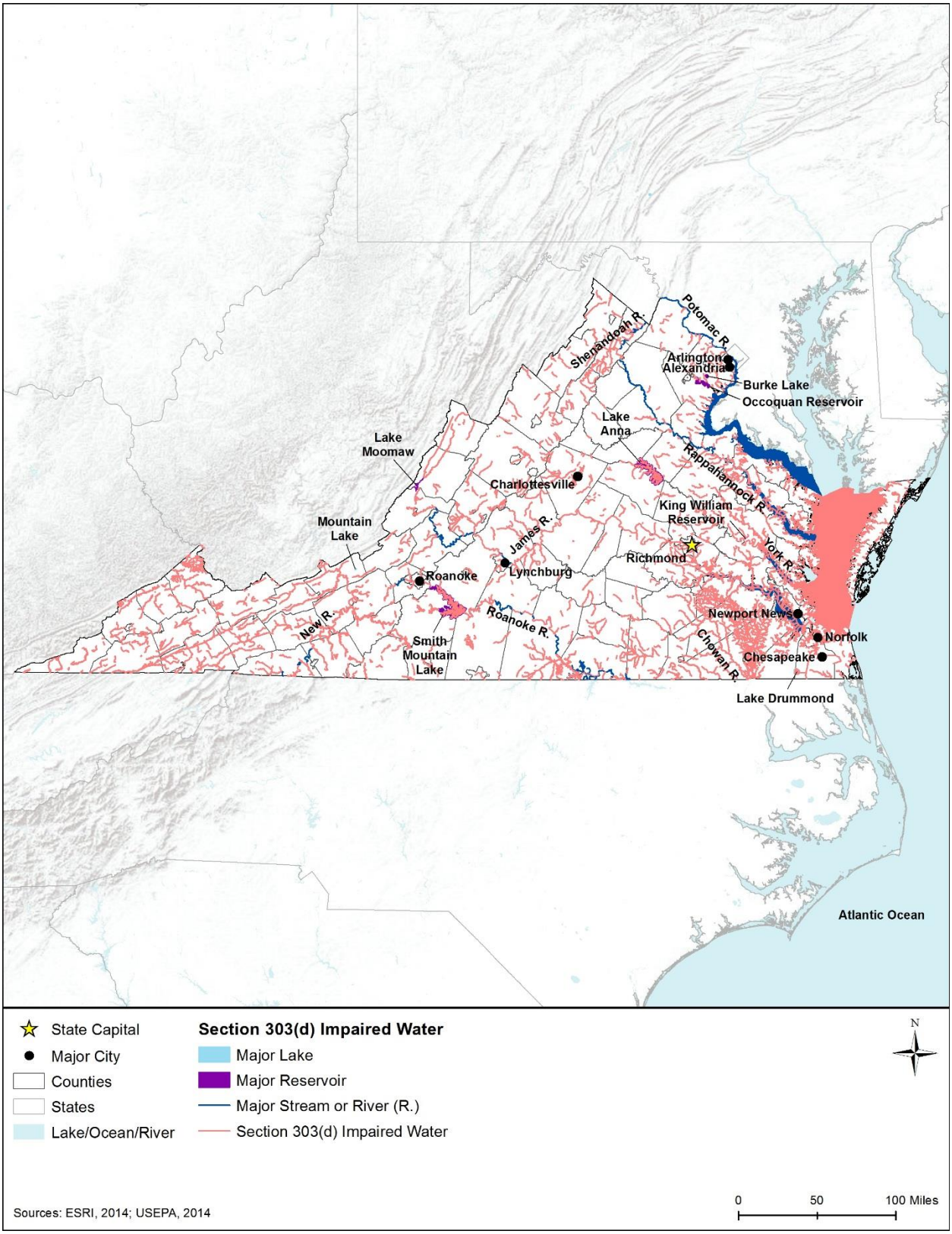


Figure 15.1.4-4: Section 303(d) Impaired Waters of Virginia, 2014

15.1.4.6. Floodplains

Floodplains are lowlands along inland or coastal waters, including flood-prone areas of offshore islands. 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 CFR 59.1) (FEMA, 2000). 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 Virginia:

- **Riverine and lake floodplains** occur along rivers, streams, or lakes where overbank flooding may occur, inundating adjacent land areas. In mountainous areas, such as the Appalachian Mountains and Blue Ridge Mountains, floodwaters can build and recede quickly, with fast moving and deep water (USGS, 2015f). 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)
- **Coastal floodplains** in Virginia border the Atlantic Ocean coastline on the Delaware-Maryland-Virginia (Delmarva) Peninsula and the shores of the Chesapeake Bay (VDEQ, 2015o). 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 (FEMA, 2013).

Flooding is the leading cause for disaster declaration by the President in the U.S. and results in significant damage throughout the state annually. Flooding in Virginia can result in loss of life and damage to property, infrastructure, agriculture, and the environment. Causes include severe

rain events, rapid snowmelt, hurricanes, impervious[62] surfaces, climate change, and dam failure. (VDEM, 2013)

Floodplains, low-lands, and coastal areas are more prone to flooding than other areas in Virginia. Based on historical flooding, population vulnerability, injuries and deaths, crop and property damage, and geographic extent, the greatest flood risk exists in the watersheds along the shoreline of Chesapeake Bay and its tributaries, and in the Potomac-Shenandoah Watershed (see Figure 15.1.4-1). Of the 47 Presidentially Declared Disasters that occurred in Virginia between 1957 and 2013, 37 were flood events. (VDEM, 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 290 communities in Virginia through the National Flood Insurance Program (NFIP) (FEMA, 2014c). Established to reduce the economic and social cost of flood damage, 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, Virginia had 22 communities participating in the CRS (FEMA, 2014d).[63]

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

[62] Impervious: a hardened surface or area that does not allow water to pass through. For example, roads, rooftops, driveways, sidewalks, pools, patios, and parking lots are all impervious surfaces (USEPA, 2015a).
[63] A list of the 22 CRS communities can be found in the most recent FEMA CRS report dated May 1, 2014 (http://www.fema.gov/media-library-data/1398878892102-5cbcaa727a635327277d834491210fec/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)

Virginia's principal aquifers consist of carbonate-rock,[64] crystalline rock,[65] sandstone,[66] and unconsolidated sedimentary deposits.[67] Approximately 2 million Virginia residents get their drinking water exclusively from wells. Generally, the water quality of Virginia's aquifers is suitable for drinking and daily water needs. Threats to groundwater quality include agriculture, municipal waste and toxic materials, leaking underground storage tanks, leaking septic systems, road salt, and agriculture (Virginia Places, 2017). Table 15.1.4-3 provides details on aquifer characteristics in the state; Figure 15.1.4-5 shows Virginia's principal and sole source aquifers.

Table 15.1.4-3: Description of Virginia's Principal Aquifers

Aquifer Type and Name	Location in State	Groundwater Quality
Northern Atlantic Coastal Plain aquifer system Semi-consolidated to unconsolidated sedimentary deposits. The system include the surficial, Chesapeake, Castle-Hayne-Aquia, Severn-Magothy, and Potomac aquifers.	Occurs in the eastern portion of the state and on the Delmarva Peninsula	The deeper parts of the aquifer to the southeast contain slightly saline or salt water. Dissolved solids in the western portion are calcium and magnesium bicarbonate; sodium bicarbonate in the central part of the aquifer; and sodium chloride in the eastern part of the aquifer.
Piedmont and Blue Ridge crystalline-rock aquifers Crystalline metamorphic and igneous rocks including coarse-grain gneisses and schists, phyllite and metamorphosed volcanic rocks.	Occurs in a wide band running from south to north in the central part of the state	Water quality is generally sufficient for drinking and other uses. Dissolved solids average about 120 milligrams per liter (mg/L). The water is soft and slightly acidic.
Early Mesozoic basin aquifers Igneous rocks including diabase dikes and sills and basalt flows.	Occurs in patches in the central part of the state	Water quality is generally sufficient for drinking and other uses. Dissolved solid concentrations average 230 mg/L. The water is hard and slightly basic. Iron concentrations can be as high as 5.3 mg/L in some locations, which may require treatment before use.
Valley and Ridge aquifers Carbonate rocks, shale, and sandstone, and some coal-bearing beds.	Occurs in bands running south to north in the western part of the state	Water quality is generally sufficient for drinking and other uses. Dissolved solid concentrations average about 150 mg/L. Water contains calcium bicarbonate. Water is moderately hard and slightly basic.
Valley and Ridge carbonate-rock aquifers Composed mostly of limestone.	Occurs in bands running south to north in the western part of the state	Water quality is generally sufficient for drinking and other uses. Water contains calcium and magnesium carbonate and dissolved solid concentrations average about 330 mg/L. The water is very hard and slightly basic.

[64] Carbonate-rock aquifers typically consist of limestone with highly variable water-yielding properties (some yield almost no water and others are highly productive aquifers) (USGS, 2015b).
[65] Crystalline-rock aquifers are composed of igneous and metamorphic rock, and spaces between the crystals are extremely small. This type of aquifer generally yields little water, and is only permeable when the rock is fractured. (USGS, 2010)
[66] Sandstone aquifers are composed of sedimentary rock made of sand. Because the pores between rock particles are very small, most water is carried in fractures in the rock (USGS, 2015b).
[67] Unconsolidated sedimentary deposits: "loosely bound sediments such as sand, gravel, and silt, which tend to accumulate in low areas or valleys" (USGS, 2015b).

Aquifer Type and Name	Location in State	Groundwater Quality
Mississippian Aquifers Shale, siltstone, sandstone, and some conglomerate and limestone.	Occurs in bands running south to north in the western part of the state	Water quality is generally sufficient for drinking and other uses.
Pennsylvanian Aquifers Sandstone, grey and black shale and claystone, limestone, and coal.	Occurs in the western portion of the state bordering both Tennessee and West Virginia	Water quality is generally sufficient for drinking and other uses. Concentrations of dissolved solids average about 230 mg/L. The water is soft and slightly basic.

Source: (USGS, 1995a) (USGS, 1995b) (USGS, 1995c) (USGS, 1995d)

Sole Source Aquifers

The USEPA defines sole source aquifers (SSAs) as "an aquifer that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer" and are areas with no other drinking water sources (USEPA, 2015i). Virginia has three designated SSAs within the state (as shown in Figure 15.1.4-5). The Poolesville SSA is located in the northern portion of the state and underlies the Potomac River and crosses into Maryland. The Prospect Hill SSA also lies in the northern portion of the state and is entirely within Virginia. The Columbia and Yorktown-Eastover SSA underlies the portion of the state on the Delmarva Peninsula (USEPA, 2007).

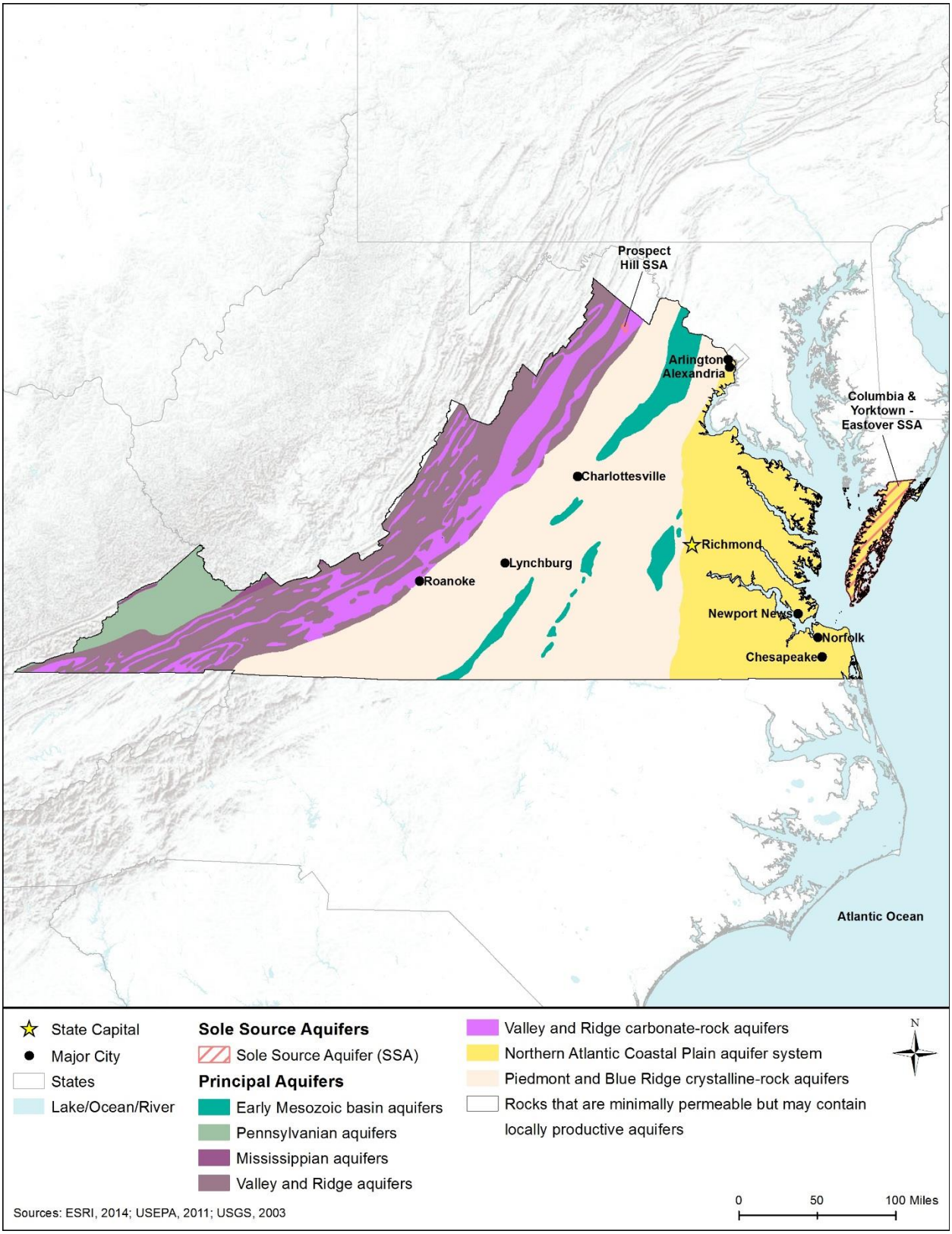


Figure 15.1.4-5: Principal and Sole Source Aquifers of Virginia

15.1.5. Wetlands

15.1.5.1. 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 U.S. Environmental Protection Agency (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).

15.1.5.2. Environmental Laws and Regulations

Table 15.1.5-1 summarizes the major Virginia state laws and permitting requirements relevant to the state's wetlands.

Table 15.1.5-1: Relevant Virginia Wetland Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Virginia Water Protection (VWP) Program 9 VAC 25-210	Virginia Department of Environmental Quality (DEQ)	Permit is required to temporarily or permanently impact less than ½ acre of non-tidal wetlands or open water and up to 300 linear feet of non-tidal stream bed.
		Facilities and Utility and Public Service Companies activities Regulated by the Federal Energy Commission or the State Corporation Commission and Other Utility Line Activities are allowed to temporarily or permanently impact up to 1 acre of non-tidal wetlands or open water and up to 1,500 linear feet of non-tidal stream bed.
		Permit is required for activities that significantly alter or degrade existing wetland function or acreage, including draining, filling, dumping, permanent flooding or impounding.
		Permit is required for most commercial and noncommercial projects involving tidal waters, tidal wetlands, and/or dunes and beaches in Virginia (a standard JPA must be submitted for dredging and filling activities).
		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 DEQ indicating that the proposed activity will not violate water quality standards.

Sources: (VDEQ, 2015p) (VDEQ, 2015q)

15.1.5.3. Environmental Setting: Wetland Types and Functions

The U.S. Fish and Wildlife Service's (USFWS's) 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 in (Cowardin, Carter, Golet, & LaRoe, 1979). The Wetlands Classification System includes five major wetland Systems: Marine, Estuarine, Riverine, Lacustrine, and Palustrine. The District includes three of these Systems, as detailed in Table 15.1.5-2. The first four of these include both wetlands and deepwater habitats but the Palustrine includes only wetland habitats. (USFWS, 2015a)

- The Marine System consists of open ocean, continental shelf, including beaches, rocky shores, lagoons, and shallow coral reefs. Normal marine salinity (saltiness) to hypersaline (more than 35 percent salty) water chemistry; minimal influence from rivers or estuaries. Where wave energy is low, mangroves, or mudflats may be present.
- The Estuarine System consists of deepwater tidal habitats and adjacent tidal habitats that 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 of 0.5 ppt or greater.
- 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 at least 20 acres. Includes lakes, larger ponds, sloughs, lochs, bayous, etc.
- Palustrine includes all nontidal wetlands dominated by trees, shrubs, persistent emergent plants, or emergent mosses or lichens, and all wetlands that occur in tidal areas where the salinity is below 5 percent. The system is characterized based on the type and duration of flooding, water chemistry, vegetation, or substrate characteristics (soil types) (Cowardin, Carter, Golet, & LaRoe, 1979) (FGDC, 2013).

In Virginia, the two main types of wetlands are palustrine (freshwater) wetlands found on river and lake floodplains across the state, and estuarine/marine (tidal) wetlands around Chesapeake Bay and the Atlantic Ocean coastline. Table 15.1.5-2 uses 2014 NWI data to characterize and map Virginia 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 required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. As shown in Figure 15.1.5-1 and Figure 15.1.5-2 western Virginia has relatively few wetlands, while eastern Virginia has abundant palustrine and estuarine/marine wetlands. The map codes and colorings in Table 15.1.5-2 correspond to the wetland types in the figures.

Table 15.1.5-2: Virginia 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	910,894
Palustrine scrub-shrub wetland	PSS	Woody vegetation less than 20 feet tall dominates PSS wetlands. Thickets and shrub swamps are examples of PSS wetlands.	Throughout the state, often on river and lake floodplains	
Palustrine emergent wetlands	PEM	Palustrine emergent 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	112,253
Palustrine unconsolidated bottom	PUB	PUB and PAB 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	85,073
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	1,832
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	2,871

Wetland Type	Map Code and Color	Description[a]	Occurrence	Amount (acres)[b]
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, including any areas with abundant submerged or floating-leaved aquatic vegetation. These wetlands are generally less than 8.2 feet deep.	Primarily in southeastern Virginia	5,346
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.	Chesapeake Bay and the Atlantic Ocean coastline	189,681

Sources: (Cowardin, Carter, Golet, & LaRoe, 1979), (USFWS, 2015a), (FGDC, 2013)

[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, Carter, Golet, & LaRoe, 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. Saline soils and salt tolerant plants characterize these wetland types. (USEPA, 2015c)

Palustrine Wetlands

In Virginia, palustrine wetlands are the most abundant wetland type. They are located throughout the state, and typically found in floodplains along stream channels and in bottomlands. Palustrine wetlands found in Virginia include non-tidal forested wetlands, such as non-tidal flood-plain forests, cypress tupelo swamps, red maple swamps, and Atlantic white cedar swamps that contain flood-tolerant trees and seasonal standing water. Interdunal swales are found along the Atlantic coast, in topographic hollows within the sand dunes, and include palustrine emergent and scrub-shrub wetlands. Pocosins are scrub-shrub wetlands located slightly higher than the surrounding topography, with poor natural drainage, and are also found in coastal Virginia. Bogs, fens,[68] and wet meadows can also be found in Virginia. (VDEQ, 2012)

[68] Fens are low lands covered wholly or partly with water.

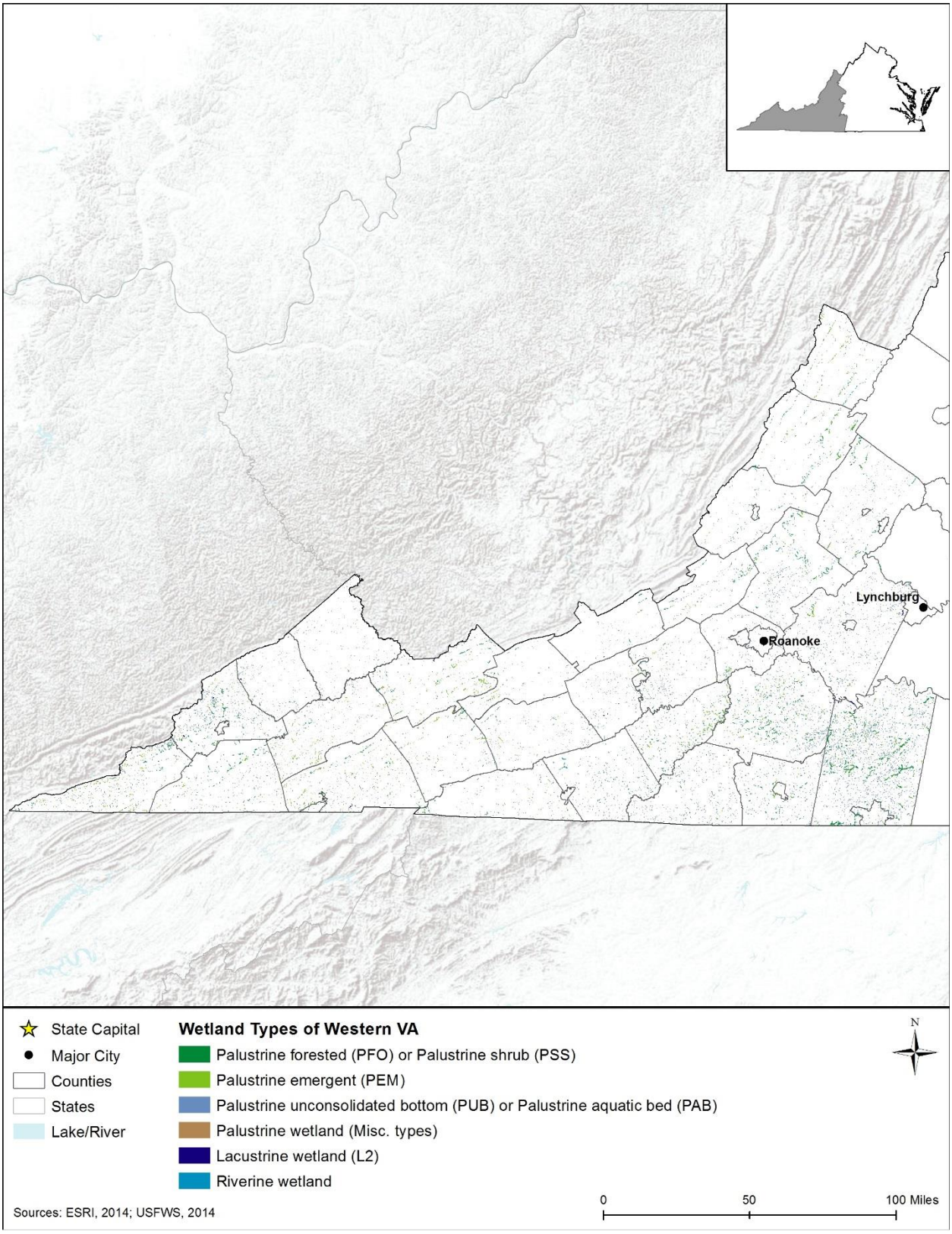


Figure 15.1.5-1: Wetlands by Type, in Western Virginia, 2014

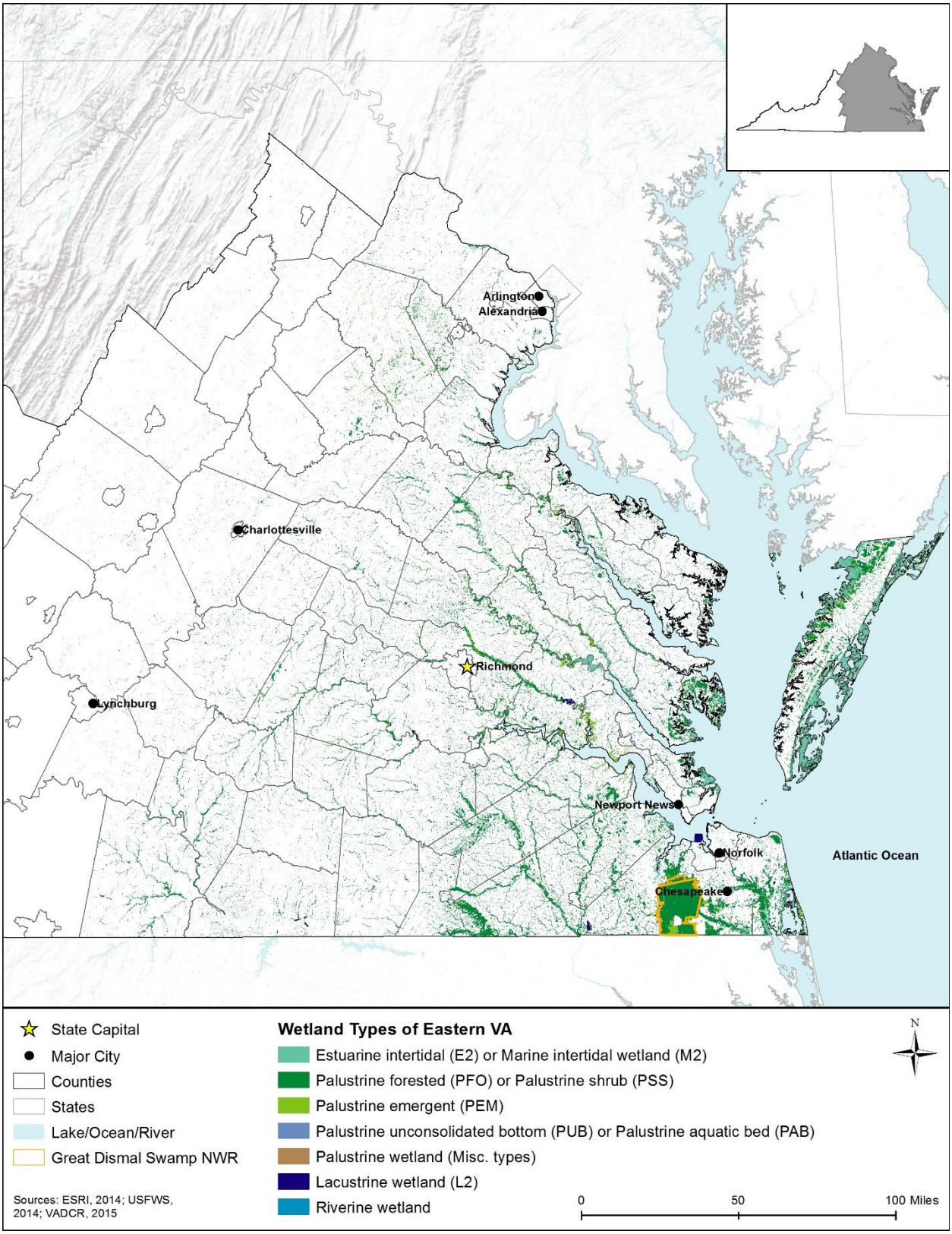


Figure 15.1.5-2: Wetlands by Type, Eastern Virginia, 2014

Estuarine and Marine Wetlands

Extensive estuarine wetlands are found around the Chesapeake Bay, and are characterized by mostly herbaceous vegetation that can withstand the brackish or salty water. Estuarine wetlands are also found along the freshwater portions of tidal rivers (VDEQ, 2012). These tidal wetlands provide important habitat for shellfish and fishes (brackish and marine), as well as migratory shorebirds and various waterfowl. Game and commercial fish, including striped bass, bluefish, and sea trout utilize tidal marshes and estuaries for nursery and spawning, and shellfish such as the blue crab, oysters, clams, and shrimp are also dependent on tidal wetlands. Tidal brackish marshes are typically found along river systems between freshwater and salt marsh. They have varying salinity levels, and provide habitat for numerous aquatic waterfowl and animals. Tidal salt marshes have the highest salinity of tidal marshes. Areas regularly flooded during high tide are nearly completely dominated by saltmarsh cordgrass, while areas not flooded on a regular basis have more diverse vegetation, including salt meadow hay, salt grass, and black needle rush. Tidal swamps are found between swamp forests or uplands, and emergent tidal wetlands, and can also be found along tidal rivers, on the depositional islands created in large meanders. Vegetation in these swamps is usually very diverse with both tidal marsh and freshwater swamp species. Tidal swamp types found in Virginia include tidal hardwood swamps, tidal bald cypress-tupelo swamps, shrub swamps, and estuarine fringe swamps, which are only located in southeast Virginia. (Moulds, Milliken, Sidleck, & Winn, 2005)

Riverine and Lacustrine Wetlands

Riverine and Lacustrine wetlands are not common in the state, and thus are not discussed.

Approximately one-half of the original (pre-colonial) wetlands acreage in Virginia have been lost due to industrial and urban development, recreation, forestry, and agricultural activity and development including dredging and filling, draining, ditching, and damming (VDEQ, 2011) (VDEQ, 2012). Land cover conversion is the greatest threat to wetlands in Virginia; non-tidal wetlands are typically converted to uplands via development, while tidal wetlands have been converted via development (typically with shoreline hardening) as well as conversion to open water due to sea level rise (VDEQ, 2011).

15.1.5.4. Environmental Setting: Wetlands of Special Concern or Value

Chesapeake Bay, the largest estuary in the country, has a variety of diverse estuarine habitats. The Chesapeake Bay-Virginia National Estuarine Research Reserve (NERR) is comprised of multiple sites (over 3,000 acres total) in Virginia, including the York River Basin, and parts of Sweet Hall Marsh, Taskinas Creek, Catlett Island, and Goodwin Islands. The Chesapeake Bay-Virginia NERR includes a wide range of wetland habitats, including tidal wetlands, mudflats, sandy shoals, seagrass beds, and oyster reefs. (NOAA, 2015a)

Other important wetland sites in Virginia include:

- The Great Dismal Swamp National Wildlife Refuge contains over 112,000 acres of important wildlife and bird habitat, along with many acres of marshland, in southwest Virginia

(USFWS, 2015c). To learn more about the refuge, see www.fws.gov/refuge/Great_Dismal_Swamp/.

- The Virginia Natural Area Preserve System was established to protect and conserve natural heritage resources in the state. These areas include places containing habitats of rare plants and animals, exemplary natural communities, or other rare natural features, including wetlands. These preserves are administered by the Virginia Department of Conservation and Recreation, and managed by the Division of Natural Heritage (VDCR, 2010). To learn more about Natural Heritage Preserves, visit http://www.dcr.virginia.gov/natural-heritage/natural-area-preserves/.
- Wildlife Management Areas are designated for outdoor recreation; these public lands include more than 203,000 acres, some of which include wetland areas (VDGIF, 2015a). To learn more about state Wildlife Management Areas, visit http://www.dgif.virginia.goc/wmas/.
- National Natural Landmarks range in size from 19 acres to over 45,000 acres, and are owned by U.S. Fish and Wildlife Service, U.S. Forest Service, Virginia Department of Conservation and Recreation, and other conservation organizations and individuals (NPS, 2015a). Visit www.nature.nps.gov/nnl/state.cfm?State=VA to learn more about Virginia's National Natural Landmarks.
- Other wetlands protected under easements or agreements through voluntary government programs and resource conservation groups are found across the state, including the Virginia Outdoor Foundation, The Nature Conservancy, Virginia Department of Historic Resources, Virginia Department of Forestry, Fauquier County, Albemarle County, and Land Trust of Virginia. 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 3,700 acres in conservation easements in Virginia (NCED, 2015).

For more information on Virginia's wildlife management areas, National Natural Landmarks, conservation programs, and easements, see Section 15.1.8, Visual Resources, and Section 15.1.7, Land Use, Recreation, and Airspace.

15.1.6. Biological Resources

15.1.6.1. Definition of the Resource

This section describes the biological resources of Virginia, officially known as the Commonwealth of Virginia. Biological resources include terrestrial[69] vegetation, wildlife, fisheries and aquatic habitats,[70] and threatened[71] and endangered[72] species, and communities and species of conservation concern. Wildlife habitat and associated biological ecosystems are also important components of biological resources. Because of the significant topographic variation

[69] Terrestrial: "Pertaining to the land" (USEPA, 2015c)
[70] Habitat: "The place where a population lives, including its living and non-living surroundings" (USEPA, 2015c)
[71] Threatened: "A species that is likely to become endangered if not protected" (USEPA, 2015c)
[72] Endangered: "Animals, birds, fish, plants, or other living organisms threatened with extinction by anthropogenic (man-caused) or other natural changes in their environment. Requirements for declaring a species endangered are contained in the Endangered Species Act" (USEPA, 2015c)

within the state, the results of glaciation, and its location along the Atlantic coast, Virginia supports a wide diversity of biological resources. Such resources range from marine[73] settings along the Atlantic Ocean and influenced by Chesapeake Bay along the eastern boundary of the state, to tidal waters associated with the Potomac, Rappahannock, York, and James Rivers, convergence of piedmont and plains habitats along the Falls Line, and Oak-Hickory-Pine forests in the montane regions of the Blue Ridge and Central Appalachians in the state's western region.

15.1.6.2. Specific Regulatory Considerations

The proposed project must meet the requirements of NEPA and other applicable laws and regulations. The pertinent federal laws relevant to the protection and management of biological resources in Virginia are summarized in Section 1.8 and Appendix C. Table 15.1.6-1 summarizes the major state of Virginia laws relevant to the state's biological resources and the project.

Table 15.1.6-1: Relevant Virginia Biological Resource Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Code of Virginia § 10.1	Virginia Department of Conservation and Recreation (VDCR)	Administers the Natural Heritage Conservation Program protecting state wildlife, native plants and their ecosystems.
1984 Fisheries Management Policy Act Code of Virginia, Title 29.1	Virginia Department of Game and Inland Fisheries (VDGIF)	Management and oversight of Virginia's wildlife and inland fish. Oversees recreational, fishing, and hunting opportunities.
1875 Virginia Fish Commission Act; 1972 Virginia Wetlands Act; 1984 Fisheries Management Policy Act	Virginia Marine Resources Commission (VMRC)	Management and regulation of marine resources and fisheries management (shared with DGIF).
Executive Order 35 (2014) Continuation of the Coastal Zone Management Act	Virginia Department of Environmental Quality (VDEQ)	Administers and regulates point source water pollution management and nontidal wetlands management, nonpoint source pollution management, and the state's Coastal Zone Management Program.

Sources: (Virginia Law, 2017b) (Virginia Law, 2017c) (VAMRC, 2017) (VA Governor, 2017)

15.1.6.3. Terrestrial Vegetation

The distribution of flora[74] within the state is a function of the characteristic geology, soils, climate, and water of a given geographic area and correlate to distinct areas identified as ecoregions.[75] 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 depict a general area with

[73] Marine: "Any marine environment, from pond to ocean, in which plants and animals interact with the chemical and physical features of the environment" (USEPA, 2015c)
[74] The plants of a particular region, habitat, or geological period.
[75] Ecoregion: "A relatively homogeneous ecological area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables." (USEPA, 2015c)

similar ecosystem types, functions, and qualities. (National Wildlife Federation, 2015) (USDA, 2015) (World Wildlife Fund, 2015).

Ecoregion boundaries often coincide with physiographic[76] regions of a state. The ecoregions mapped by USEPA are the most commonly referenced, although individual states and organizations have defined ecoregions that may differ slightly from those designated by USEPA. The USAEPA Level I ecoregion is the coarsest level, dividing the U.S. into 15 ecological regions. Level II further divides the country into 50 regions. The continental U.S. contains 104 Level III ecoregions and the contiguous lower 48 states has 84 ecoregions. This section presents a discussion of biological resources for Virginia at USEPA Level III ecoregion (USEPA, 2015b).

As shown in Figure 15.1.6-1, the USEPA divides the Virginia into seven Level III ecoregions. These ecoregions support a variety of different plant communities, all predicated on their general location within the state. In the mountains of southwestern Virginia, mixed forests dominate in the Appalachians, Blue Ridge Mountains, and Shenandoah Valley. In the central portion of the state, hardwood forests dominate in the Piedmont. Coastal areas, including Chesapeake Bay and Hampton Roads, are adjacent to the Atlantic Ocean and communities are influenced by coastal climates and tide waters. Table 15.1.6-2 provides a summary of the general abiotic[77] characteristics, vegetative communities, and the typical vegetation found within each of the Virginia ecoregions.

[76] Physiographic: "The natural, physical form of the landscape." (USEPA, 2015c)
[77] Abiotic: "Nonliving characteristic of the environment; the physical and chemical components that relate to the state of ecological resources." (USEPA, 2015c)

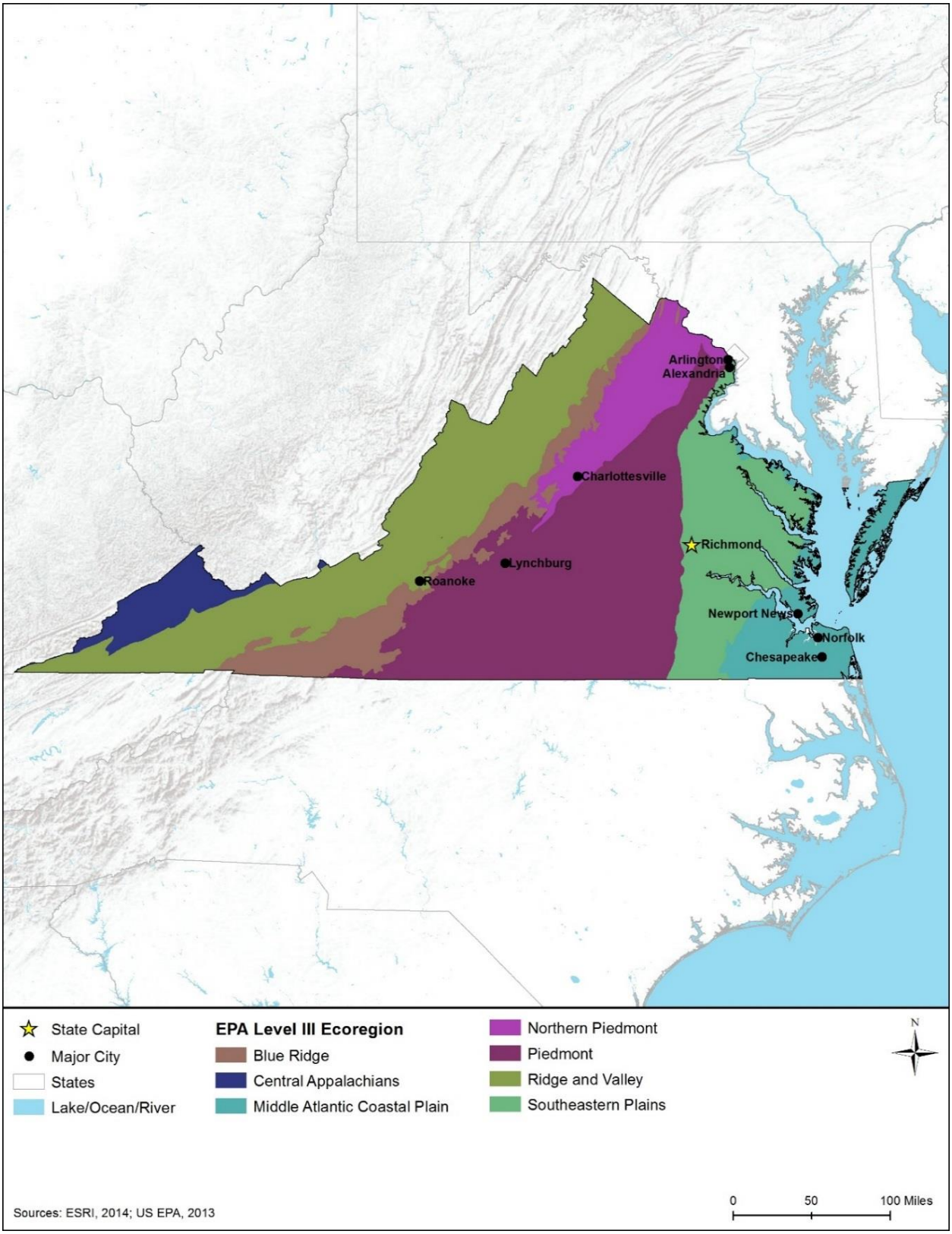


Figure 15.1.6-1. EPA Level III Ecoregions of Virginia

Table 15.1.6-2: EPA Level III Ecoregions of Virginia

Ecoregion Number	Description	Abiotic Characterization	General Vegetative Communities	Typical Vegetation
Geographical Region: Coastal Plain, including Chesapeake Bay, Eastern Shore, and Hampton Roads				
63	Middle Atlantic Coastal Plain	Composed of low elevation level plains, marshes, swamps, and estuaries[a] underlain by unconsolidated sediments and a blend of coarse and fine textured soils with poor drainage	Appalachian Oak Forest, Northern Cordgrass Prairie, Southern Floodplain[b] Forest, Delmarva Uplands, Live Oak-Sea Oats, Oak-Hickory-Pine Forest, Wetlands, Salt Estuarine Bay, and Marshes	**Hardwoods** – upland oak (*Quercus* spp.); water tupelo (*Nyssa aquatica*); swamp blackgum (*Nyssa biflora*); sweetgum (*Liquidambar styraciflua*) **Conifer Trees** – loblolly pine (*Pinus taeda*); pond pine (*Pinus serotine*)
65	Southeastern Plains	Irregular terrain including plains and hilly terrains with sand, silt, and clay soils and sandy lined low-terrain streams	Oak-Hickory-Pine Forest and Appalachian Forest in the northeast	**Hardwoods** – oaks; hickory (*Carya* spp.) **Conifer Trees** – longleaf pine (*Pinus palustris*); shortleaf pine (*Pinus echinata*); loblolly pine
Geographical Region: Piedmont, including Northern, Central and Southern Virginia				
45	Piedmont	Transitional area between mountainous Appalachians and the slight gradient[c] of the Coastal Plains composed mostly of irregular plains and some hills on fine grained soils	Oak-Hickory-Pine Forest converting to Pine and Hardwoods	**Hardwoods** – oaks; hickory; silver maple; sycamore; American elm; eastern boxelder **Conifer Trees** – shortleaf pine; loblolly pine
64	Northern Piedmont	Transitional region composed of low hills, irregular plains, and open valleys in contrast to the low mountains to the north and west and the flatter coastal plains to the east	Historically Appalachian Oak Forest transitioning to agricultural cropland	**Hardwoods** – oaks; sugar maple; black birch; tulip tree **Conifer Trees** – Virginia pine

Ecoregion Number	Description	Abiotic Characterization	General Vegetative Communities	Typical Vegetation
Geographical Region: Mountains, including Appalachians, Blue Ridge Mountains, and Shenandoah Valley				
66	Blue Ridge	Narrow forested mountainous ridges that are steeply sloped with well-defined drainages and cool and clear streams	Appalachian Oak Forest, Oak-Hickory-Pine Forest, Northern Hardwoods	**Hardwoods** – oaks; hickory; sugar maple; yellow birch; beech; hemlock **Conifer Trees** - longleaf pine; shortleaf pine; loblolly pine
67	Ridge and Valley	A diverse region composed of ridges and valleys with a variety of widths, heights, and geologic[d] composition, with numerous springs and caves	Mixed Oak-Sugar Maple-Northern Hardwood	**Hardwoods** – oaks; sugar maple; yellow birch; paper birch; American basswood
69	Central Appalachians	High elevation plateaus[e] dissected with scattered narrow ridges and streams providing a large amount of rainfall and dense forest coverage.	Appalachian Oak Forest, Mixed Mesophytic Forest	**Hardwoods** – oaks; maples; hickory **Shrubs** – eastern redbud

Sources: (USEPA, 2015b) (Petrides, 1986) (Elias, 1989) (VDCR, 2017a)

[a] Estuary: "An estuary is the area where a river or stream connects with the open sea or ocean, estuarine includes the estuary and its associated habitats such as seagrasses and shellfish beds." (USEPA, 2015c)
[b] Floodplain: "The flat or nearly flat land along a river or stream or in a tidal area that is covered by water during a flood." (USEPA, 2015c)
[c] Gradient: "The slope or incline measured by the change in elevation over a specified length. Measurement units may consist of either a dimensionless proportion (percentage) or an angle based on the 360-degree circumference of a circle." (USEPA, 2015c)
[d] Geologic: "Referring to the history and structure of the solid portion (rocks, soils, and minerals) of the earth" (USEPA, 2015c)
[e] Plateau: An area of relatively level high level ground surface. (USEPA, 2015c)

Communities of Concern

Virginia contains vegetative communities of concern that include rare natural plant communities, plant communities with 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[78] that could result from implementation of an action.

The Virginia Natural Heritage Program (VNHP) statewide inventory includes lists of all types of natural communities known to occur, or that have historically occurred, in the state. 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 VNHP ranking system assesses rarity using a state rank (S1, S2, S3, S4, S5) that indicates its rarity within Virginia. Communities ranked as an S1 by the VNHP are of the greatest concern. This rank is typically based on the range of the community, the number of occurrences, the viability of the 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 (VDCR, 2017a) (VDCR, 2014b).

In Virginia, the S1-ranked terrestrial communities occur throughout the state, from High-elevation Mountainous Communities in the western portion of the state to the Lower Elevation Mesic Forests of the Piedmont, Sandy Woodlands in the Coastal Plain and Outer Piedmont regions, and Maritime Zone communities within the state's eastern seaboard. VA Appendix B summarizes some of the rarest terrestrial plant communities found in Virginia, defined as those with a state rank of S1, distribution, abundance, and the associated USEPA Level III ecoregions. As of April, 2017, there were 114 communities that were Critically Imperiled (S1 classification) representing approximately 37% of the total number of natural communities found in Virginia (VDCR, 2017b).

Nuisance and Invasive Plants

Nuisance and invasive plants are a broad category that includes a large number of undesirable plant species. 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 U.S., 88 of which terrestrial, 19 aquatic, and 5 parasitic (USDA, 2014).

[78] 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, 2015c)

Invasive species threaten or potentially threaten natural areas, parks, and other state protected lands. The Virginia Department of Conservation identifies 90 invasive plant species that pose such threat. Invasive plants displace native plants and alter wildlife habitats and other natural resources (VDCR, 2017c). Noxious weeds are a threat to Virginia's cropland, pastureland[79], forests, wildlands, wetlands, and shorelines. Noxious weeds can have adverse ecological and economic impacts to these resources by displacing native species, degrading wildlife habitat, and increasing soil erosion[80] (Virginia Law, 2017d). The 2012 Virginia Invasive Species Management Plan (ISMP) was developed by the Invasive Species Working Group (ISWG) an interagency working group and advisory committee, enabled by the Code of Virginia (§ 2.2-220.2). The ISMP defines invasive species management plan goals and strategies for both terrestrial and aquatic species to minimize environmental, economic, and social harm (Landscope, 2017a). The state's Department of Game and Inland Fisheries is responsible to preserve and propagate game, fish, and other wildlife upon the lands and inlands waters of the state (§ 29.1-Article 3). The Code of Virginia as empowers the Department of Conservation and Recreation to preserve natural diversity of biological resources (§10.1-211) (Virginia Law, 2017b).

The Virginia Department of Conservation and Recreation have identified 40 species of invasive plants rated as "high" and representing "a significant threat to native species, natural communities or the economy". The full list of invasive species can be found at http://www.dcr.virginia.gov/natural-heritage/document/nh-invasive-plant-list-2014.pdf

Some examples of these species that represent a significant threat are:

- **Aquatic –**phragmites (Phragmites australis), purple loosestrife (Lythrum salicaria), alligator weed (Alternanthera philoxeroides), and water hyacinth (Eichhornia crassipes).
- **Shrubs** – tree-of-heaven (*Ailanthus altissima*).
- **Terrestrial Forbs and Grasses** –giant hogweed Japanese stilt-grass (*Microstegium vimineum*), Johnson grass (*Sorghum halepense*), kudzu (*Pueraria montana*), mile-a-minute (*Persicaria perfoliata)*, and Canada thistle (*Cirsium vulgar, C. arvense*) (VDCR, 2017d).

15.1.6.4. Terrestrial Wildlife

This section discusses the terrestrial wildlife[81] species in Virginia, including mammals, birds, reptiles and amphibians,[82] and invertebrates.[83] This analysis describes those species of animals, and their habitats, that live predominantly on land. Terrestrial wildlife include common big game species, small game animals and furbearers, nongame animals, and game birds and waterfowl and their habitats that may be found in Virginia. A discussion of non-native and/or invasive wildlife species is also included. Information regarding the types and location of native

[79] Pastureland: "Land used primarily for the production of domesticated forage plants for livestock." (USEPA, 2015c)
[80] Erosion: "The general process or the group of processes whereby the materials of Earth's crust are loosened, dissolved, or worn away and simultaneously moved from one place to another, by natural agencies, which include weathering, solution, corrosion, and transportation." (USEPA, 2015c)
[81] Wildlife: (USEPA, 2015c)
[82] 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, 2015c)
[83] Invertebrate: "Animals without backbones: e.g. Insects, spiders, crayfish, worms, snails, mussels, clams, etc." (USEPA, 2015c)

and non-native/invasive wildlife is useful for assessing the importance of any impacts to these resources or the habitats they occupy. Virginia is home to over 30,000 species including 737 vertebrate[84] species. (VDGIF, 2015b) (Landscope, 2017b).

Mammals

Common and widespread mammalian species in Virginia include the black bear, white-tailed deer, and squirrels. Most mammals are widely distributed in the state; however, there are some species, such as the black bear that can be found anywhere in the state except in the coastal areas. (Michelle, 2017). There aer five of threatened and endangered mammals located in Virginia. Section 15.1.6.6, Threatened and Endangered Species, identifies these protected species.

In Virginia, white-tailed deer, elk, and black bear are classified as big game species, whereas small game species include small mammals (e.g., squirrels and rabbits), and upland and migratory game birds. Species may be legally hunted or trapped in the Virginia include black bear, deer, elk, rabbit, squirrel, dove, quail,grouse, wild turkey, woodcock, and various waterfowl (VDGIF, 2015c).

Virginia has identified 33 mammals as Species of Greatest Conservation Need (SGCN[85]). The SGCN list consists of at-risk species that are rare or declining, and provides a Conservation Opportunity Ranking (Tiers A through C), where Tier A represents species and habitat management strategies expected to realize the most conservation benefits and Tier C represents those with the least opportunity for effective conservation. The SGCN list is updated every 10 years by the state to focus their conservation efforts and serve as a basis for implementing the Virginia Wildlife Action Plan (VWAP) (VDGIF, 2015b).

Birds

The number of native bird species documented in Virginia varies according to the timing of the data collection effort, changes in bird taxonomy,[86] and the reporting organization's method for categorizing occurrence and determining native versus non-native status. Further, the diverse ecological communities (i.e., mountains, large rivers, coastal plains, estuaries, etc.) found in Virginia support a large variety of bird species. As of 2014, 469 species of resident and migratory birds have been documented in Virginia (VSO, 2016). In 2015, the VWAP identified 80 bird species that are classified as SGCN (VDGIF, 2015b).

Virginia is located within the Atlantic Flyway, which spans more than 3,000 miles from the Arctic tundra to the Caribbean. It is the most densely human-populated of the four waterfowl migration flyways in North America (Atlantic, Mississippi, Central, and Pacific), and many waterfowl species are thus threatened by urban sprawl and development (Ducks Unlimited, 2017a) (Ducks Unlimited, 2017b). Nevertheless, large numbers of waterfowl and non-waterfowl birds utilize this flyway 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

[84] Vertibrate: (USEPA, 2015c)
[85] http://www.dgif.virginia.gov/wildlife/virginiatescspecies.pdf
[86] Taxonomy: "A formal representation of relationships between items in a hierarchical structure" (USEPA, 2015c)

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, 2015ci). 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, 2015ci).

Bald eagles (*Haliaeetus leucocephalus*) are protected under the Bald and Golden Eagle Protection Act. Bald eagles are generally found near large rivers and lakes throughout Virginia, in the coastal, piedmont, and mountain regions of the state (VDGIF, 2016a). Golden eagles are rarely seen and a migratory species in Virginia, sometimes wintering in the state from December to March and "distributed across suitable sites along the entire Ridge and Valley" (VDGIF, 2016b).

A number of Important Bird Areas (IBAs) have also been identified in Virginia, as shown in Figure 15.1.6-2. 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 are identified according to standardized, scientific criteria through a collaborative effort among state, national, and international conservation-oriented non-governmental organizations (NGOs), state and federal government agencies, local conservation groups, academics, grassroots environmentalists, and birders. These IBAs link global and continental bird conservation priorities to local sites that provide critical habitat[87] for native bird populations (BirdLife, 2017).

According to the National Audubon Society, a total of 21 IBAs have been identified in Virginia, including breeding,[88] migratory stop-over, feeding, and over-wintering areas, and a variety of habitats such as forests, scrub/shrub, grasslands, freshwater and saltwater wetlands, and coastal beach and dune. These IBAs are widely distributed throughout the state, although the larger concentrations are located along the lower reaches of major rivers and in the Coastal Plain region of the state (NAS, 2015).

A number of threatened and endangered birds are located in Virginia. Section 15.1.6.6, Threatened and Endangered Species, identifies these protected species.

Reptiles and Amphibians

A total of 153 reptile and amphibian species occur in Virginia, including 56salamanders (VHS, 2017a), 27 frogs and toads (iNaturalist, 2017), 25 turtles (VHS, 2017b), 11 lizards (VHS, 2017c), and 34 snakes (VHS, 2017d) (VDGIF, 2015d) (VDGIF, 2015e). These species occur in a wide variety of habitats from the arid plains in the east to moist coniferous forests in the west. Very few species are widespread throughout the state, and are instead more commonly found in either the plains region in the east or the mountainous region in the west. Virginia has identified 32 amphibian SGCN (VDGIF, 2015b).

[87] Critical habitat: "A designated area that is essential to the conservation of an endangered or threatened species that may require special management considerations or protection" (USEPA, 2015c)
[88] Breeding areas: "The area utilized by an organism during the reproductive phase of its lifecycle and during the time that young are reared" (USEPA, 2015c)

Virginia's reptile and amphibian species are not classified as game species. The VDGIF prohibits nongame species from being harvested for commercial purposes; however, up to 5 individuals of any non-listed species may be collected and possessed for private use (VDGIF, 2017b).

Invertebrates

Virginia is home to an estimated 30,000 species of invertebrates, including a wide variety of bees, hornets, wasps, butterflies, moths, beetles, flies, dragonflies, damselflies, spiders, mites, and nematodes (Landscope, 2017c). 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.[89] 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. "Bees play an important role in natural and agricultural systems as pollinators of flowering plants that provide food, fiber, animal forage, and ecological services like soil and water conservation" (Delphia, O'Neill, & Prajzner, 2011). "As a group, native pollinators are threatened by habitat loss, pesticides, disease, and parasites" (NRCS, 2009). VDGIF lists 57 species of the Order

Lepidoptera (butterflies, skippers, and moths) and 76 species of Order Odonata as SGCN. Most of these species and an additional 60 species are classified as Natural Heritage Elements[90] by the VDCR (VDCR, 2015c).

[89] Pollinators: "Animals or insects that transfer pollen from plant to plant." (USEPA, 2015c)
[90] Rare plant and animal species as defined by VDCR.

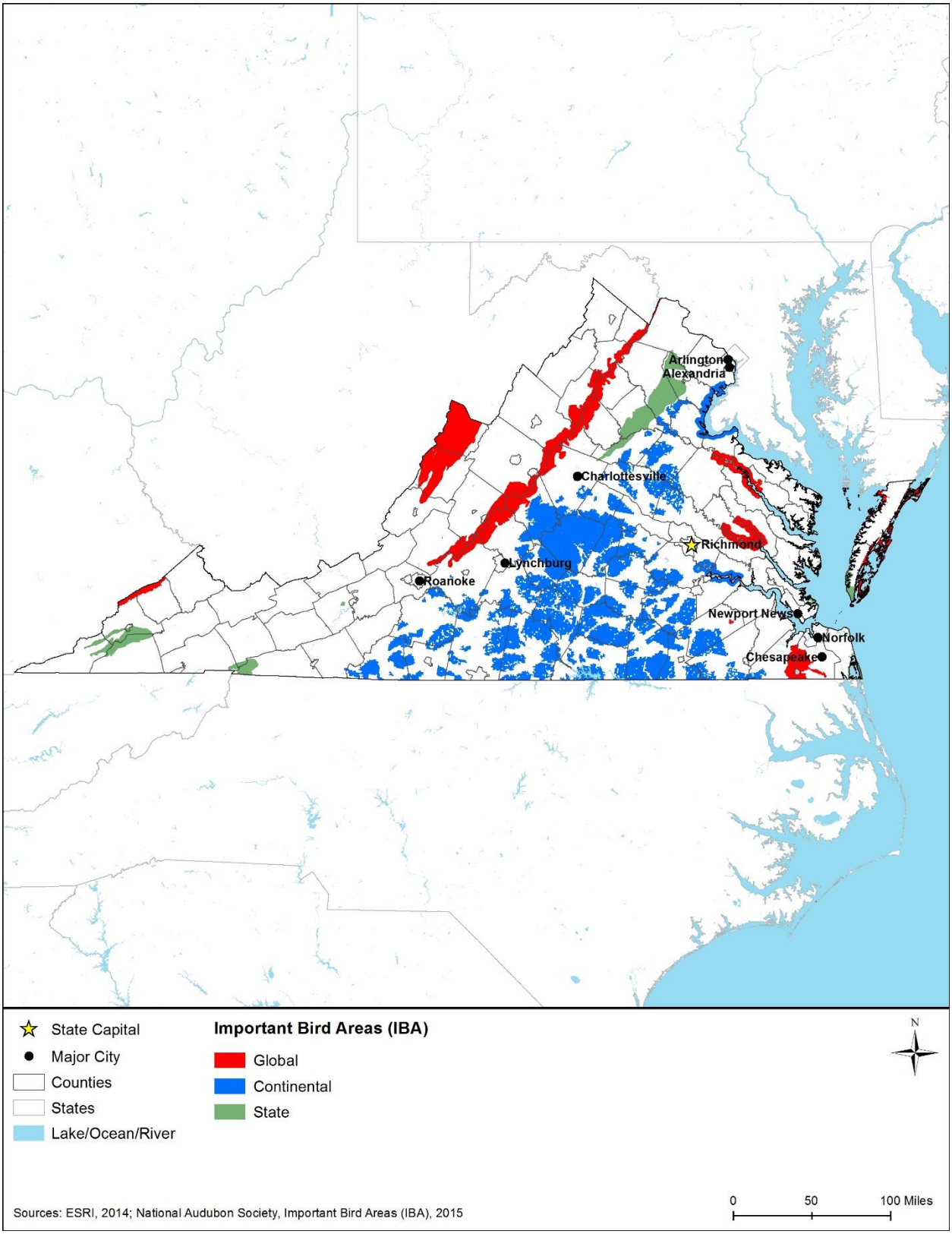


Figure 15.1.6-2: Important Bird Areas of Virginia

Invasive Wildlife Species

Virginia has adopted regulations that prohibit or regulate the possession, transport, importation, sale, purchase, and introduction of select terrestrial wildlife species,[91] except nuisance wildlife species (Virginia Administrative Code, 4 VAC 15-30-10 and §§29.1-521 and 29.1-553) (VAAC, 2016) (Virginia Law, 2017e). The nuisance species list includes two species of mammals and six species of birds (Virginia Law, 2017f). 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 (Environmental Science, 2017). If for example, a new tower was built in an area that was previously undisturbed and contained habitat for native species, the new site after being cleared, could potentially be better suited to invasive species.

15.1.6.5. Fisheries and Aquatic Habitat

This section discusses the aquatic wildlife species in Virginia, including freshwater fish, invertebrates, marine mammals, and sea turtles. A summary of non-native and/or invasive aquatic species is also presented. Fish are divided into freshwater and saltwater species, although many of Virginia's fish are diadromous (i.e., anadromous[92] and catadromous[93]), reflecting the state's location along the Atlantic coast and the variety of aquatic habitats it provides. A distinctive feature of Virginia's landscape with regard to aquatic wildlife is the coastal habitats along the lower reaches of its main rivers, the Chesapeake Bay, and offshore barrier islands. This area includes open ocean, estuaries, bays, inlets, and other coastal features that provide habitat for a multitude of wildlife.

Essential fish habitat identified by the Magnuson-Stevens Fishery Conservation and Management Act in Virginia is further discussed below. Critical habitat for threatened and endangered fish species, as defined by the ESA, exists within Virginia and is discussed in Section 15.1.6.6, Threatened and Endangered Species.

Freshwater Fish

With over 176,000 acres of public lakes and 27,300 miles of freshwater streams, Virginia is home to breeding populations of 39 known species of freshwater fish, ranging in size from rainbow trout to larger species such as striped bass and northern pike. These species are grouped into families that include bass, bowfin, carp, catfish, freshwater drum, freshwater eel, longnose gar, minnow, perch, pike, River herring, sunfish, and trout (VDGIF, 2015f). Many of these fish families include diadromous species, such as the anadromous American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris),* and striped bass (*Morone saxatilis*) and the

[91] Invasive species not native to Virginia.
[92] Anadromous: "Referring to the lifecycle of fishes, such as salmon, in which adults travel upriver from the sea to breed, usually returning to the area where they were born" (USEPA, 2015c)
[93] Catadromous: "An organism which lives in fresh water and goes to the sea to spawn, such as some eels" (USEPA, 2015c)

catadromous American eel (*Anguilla rostrata*) (Fairfax County, 2015a) (Fairfax County, 2015b) (VDGIF, 2015f).

Bass species in Virginia include the white perch (*Morone americana*), white bass (*Morone chrysops*), hybrid striped bass (*Morone hybrid*), and striped bass (*Morone saxatilis*) (discussed further under "Saltwater Fish"). The hybrid striped bass is an intermediate size (usually weighing less than 10 pounds) between the large-sized striped bass and smaller white bass. It is located only in the Claytor and Flannagan reservoirs,[94] as an introduced species (VDGIF, 2017c). Habitats for other species in this typically anadromous family include river and stream drainages as well as more open waters of large rivers and reservoirs with large connecting rivers.

Bowfin (*Amia calva*) also known as grindle or grinnel, are derived from primitive species estimated to occur more than 70 million years ago. Typically nocturnal, they feed on other fish, shellfish, mollusks, and frogs and often occur in dark, muddy bottom swamps, rivers, and lakes (VDGIF, 2017d).

Catfish in Virginia include blue catfish (*Ictalurus furcatus*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), and white catfish (*Ameiurus catus*). Catfish are known for their four pairs of barbels (commonly referred to as "whiskers") and scaleless skin. Blue catfish are the largest in size, with juvenile or medium-sized blue catfish often mistaken for the smaller channel catfish. Most species of catfish are abundant in tidal freshwater rivers and sometimes lakes, pools, and more brackish waters (VDGIF, 2017e).

Freshwater drum (*Aplodinotus grunniens*) also known as sheepshead, is a bottom feeder found in deep pools of the Clinch and Powell Rivers, Buggs Island lakes, and the Kerr Reservoir (VDGIF, 2017f).

American shad (*Alosa sapidissima*) feed on zooplankton, insect larvae, and as adults, worms and small fish. The species averages approximately three to five pounds, and is the largest fish of the river herring family. In Virginia, the American shad can be found in the James, Mattaponi, and Pamunkey Rivers (VDGIF, 2017g). Hickory shad (*Alosa mediocris)* also is a member of the river herring family, and weighs approximately one to two pounds. Adults in the ocean feed on squid, small fish, and fish eggs. The Hickory shad can be found in the Rappahannock, James, Appomattox, Chickahominy, Mattaponi, Pamunkey, and Nottoway Rivers (VDGIF, 2017h).

The American eel, a member of the freshwater eel family, is a catadromous fish that occurs in freshwater rivers and streams and breeds in the Sargossa Sea. The distribution in Virginia is limited to the Great Falls of the Potomac River and the dam of the Occoquan River (Fairfax County, 2015b).

Longnose gar (*Aplodinotus grunniens*), also known as billy gar, billfish, garfish, and garpike, is a species with prehistoric roots dating as far back as 245 million years. This species occurs in shallow waters of lakes and rivers and is poisonous (VDGIF, 2017i).

[94] Claytor Lake is near the New River in Pulaski County, VA. Flannagan Reservoir is located in the Cumberland Mountains of Dickenson County, VA.

The non-native Carp, a very large member of the minnow family, occurs in drainages throughout Virginia and prefers clean water but tolerates low quality waters. Minnows are an important food source for larger fish and other wildlife (VDGIF, 2017j).

Three perch species occur in Virginia, including the sauger (*Sander canadensis*), walleye (*Sander vitreum*), and yellow perch (*Perca flavescens*) (VDGIF, 2017k). Generally preferring cooler streams, they occur in larger rivers, drainages, and lakes. Yellow perch occur in mainly the tidal rivers and streams of the Piedmont and Coastal Plain regions (VDGIF, 2017l).

Three pike species occur in Virginia and include chain pickerel (*Esox niger*), muskellunge (*Esox masquinongy*), and northern pike (*Esox lucius*) (VDGIF, 2017k). The species are distinguished by their elongated form, pointed heads, and sharp predatory teeth. In the spring during spawning season, pikes are often found in more shallow waters; however, in summer they prefer deep waters (VDGIF, 2017m).

River herrings of Virginia include alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), and hickory shad (*Alosa mediocris*) (VDGIF, 2017k). Herring are relatively small anadromous fish, traveling along the coast for four to five years until they return to freshwater to spawn in the spring. Surviving American shad adults will return to the ocean after spawning; however, alewife and blueback herrings can inhabit freshwater throughout their lives, as in established impoundment facilities (VDGIF, 2017g).

The sunfish family includes 14 species, many are among the state's most widely recognized and popular sporting fishes. The most commonly encountered species are the bluegill, largemouth bass, and smallmouth bass (VDGIF, 2017k). These sunfish species live in a wide variety of habitats, including rocky, cool lakes and streams, and slow-moving streams (VDGIF, 2017n).

Trout species in Virginia include brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and rainbow trout, (*Oncorhynchus mykiss*). Brook trout are the only trout species native to Virginia waters. Trout live in a wide range of habitats including numerous rivers, streams, creeks, and pools. Rainbow trout, introduced to Virginia, is one of the state's most popular stock fish (VDGIF, 2015g).

Saltwater Fish

Virginia's nearshore marine waters are home to a large number of fish species, inhabiting the wide variety of marine habitats such as Chesapeake Bay, coastal inlets and estuaries, and offshore of the Atlantic Ocean.

Many saltwater fish species are well known by their recreational and commercial fishing value. Over 50 known saltwater fish species commonly occur within Virginia's offshore including Atlantic croaker, black drum, black sea bass, bluefish, grey triggerfish, northern kingfish, northern sea robin, oyster toadfish, pigfish, red drum, southern kingfish, scup, sheepshead, silver perch, spadefish, Spanish mackerel, spotted seatrout, smallmouth bass, striped bass, summer flounder, tautog, walleye, weakfish, white perch, winter flounder, and yellow perch (VMRC, 2006).

Table 15.1.6-3: Popular Saltwater Sportfish Species in Virginia

Common Name	General Habitat
American eel	Permanent freshwater streams (nonbreeding), open ocean (breeding)
Atlantic croaker	Chesapeake Bay, Coastal Bays, and open ocean
Black crappie	Chesapeake Bay
Black drum	Chesapeake Bay, Coastal Bays, and estuaries
Black sea bass	Coastal Bays and open ocean
Bluefish	Chesapeake Bay, Coastal Bays and open ocean
Chain pickerel	Chesapeake Bay
Channel catfish	Chesapeake Bay
Cobia	Coastal Bays and open ocean
Grey triggerfish	Coastal Bays and open ocean
Hickory shad	Large rivers (breeding), Chesapeake Bay, and open ocean (nonbreeding)
Largemouth bass	Chesapeake Bay
Northern kingfish	Chesapeake Bay, Coastal Bays and open ocean
Northern puffer	Chesapeake Bay
Northern sea robin	Chesapeake Bay and open ocean
Oyster toadfish	Chesapeake Bay
Pigfish	Chesapeake Bay, Coastal Bays, and open ocean
Red drum	Chesapeake Bay, Coastal Bays, and open ocean
Southern kingfish	Chesapeake Bay, Coastal Bays, and open ocean
Scup (Porgy)	Coastal Bays and open ocean
Sheepshead	Chesapeake Bay
Silver perch	Chesapeake Bay
Spadefish	Chesapeake Bay and open ocean
Spanish mackerel	Chesapeake Bay, Coastal Bays, and open ocean
Spotted seatrout	Chesapeake Bay, Coastal Bays, and open ocean
Smallmouth bass	Chesapeake Bay

Common Name	General Habitat
Spot	Chesapeake Bay and coastal bays
Striped bass	Coastal, within a few miles of shore except during migration; large rivers (breeding)
Summer flounder (fluke)	Chesapeake Bay, Coastal Bays, and open ocean
Tautog (Blackfish)	Coastal Bays and open ocean
Walleye	Chesapeake Bay
Weakfish	Chesapeake Bay, Coastal Bays, and open ocean
White perch	Chesapeake Bay, Coastal Bays and open ocean
Winter flounder	Deeper waters (summer), shallow estuaries, rivers, and bays (winter)
Yellow perch	Chesapeake Bay

Source: (Chesapeake Bay Program, 2012a) (VIMS, 2015) (VMRC, 2006)

Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act is the primary law governing marine fisheries management in U.S. federal waters. The Act calls for the identification and protection of fish habitats that are necessary for spawning, breeding, feeding, or growth to maturity. These habitats are termed "Essential Fish Habitat" or EFH. The NMFS provides an online mapping application and a website to provide the public a means to obtain illustrative representations of EFH. The online mapping tool is available at http://www.habitat.noaa.gov/protection/efh/efhmapper/index.html , and the EFH website is available at http://www.greateratlantic.fisheries.noaa.gov/hcd/list.htm . When assessing site-specific projects locations, this tool can be used to identify the potential for any conflicts between project activities and sensitive resources. presents a summary of EFH offshore of Virginia.

In addition to the species presented in Table 15.1.6-5, there are other EFH areas off the shore of Virginia about which limited information is known. These areas are for the Atlantic halibut, Atlantic wolfish, Barndoor skate, Ocean pout, Pollock, Red Hake, Redfish, Scup, Sea Scallop, Silver hake, Smooth Skate, Thorny Skate, Winter Flounder, Bluefin Tuna, Common thrasher shark, Sandbar shark, Scalloped hammerhead shark, and White shark (NMFS, 2006).

Table 15.1.6-4: Essential Fish Habitat Offshore of Virginia

Common and Scientific Name	Eggs	Larvae/ YOY[a]	Juveniles	Adults
American plaice (*Hippoglossoides platessoides*)	Various locations	Various locations	Various locations	Various locations
Atlantic butterfish (*Peprilus triacanthus*)	Various locations offshore and the Chesapeake Bay	Various locations offshore and the Chesapeake Bay	Various locations offshore and the Chesapeake Bay	Various locations offshore and the Chesapeake Bay
Atlantic cod (*Gadus morhuaI*)	Various locations	Various locations	Various locations	Various locations
Atlantic herring (*Clupea harengus*)	NA	NA	Scattered	Various locations
Atlantic mackerel (*Scomber scombrus*)	Few scattered southeastern shore	Few scattered southeastern shore	Offshore distant from the coastline	Offshore distant from the coastline
Atlantic surfclam (*Spisula solidissima*)	NA	NA	Various locations	Various locations
Black sea bass (*Centropristis striata*)	Lifestage data was not available	Scattered	Various locations	Various locations
Bluefish (*Pomatomus saltatrix*)	Scattered various locations offshore	Various locations offshore	Various locations offshore and the Chesapeake Bay	Various locations offshore and the Chesapeake Bay
Clearnose skate (*Raja eglanteria*)	Within the Chesapeake Bay	NA	Various locations offshore and the Chesapeake Bay	Various locations offshore and the Chesapeake Bay
Golden Tilefish (*Lopholatilus chamaeleonticeps*)	Along the eastern edge of Georges Bank; however, lifestage data was not available	Along the eastern edge of Georges Bank; however, lifestage data was not available	Along the eastern edge of Georges Bank; however, lifestage data was not available	Along the eastern edge of Georges Bank; however, lifestage data was not available
Haddock (*Melanogrammus aeglefinus*)	NA	Few scattered offshore distant from northeast coastline	Few scattered offshore distant from northeast coastline	NA
Little skate (*Leucoraja erinacea*)	Lifestage data was not available	Lifestage data was not available	Within the Chesapeake Bay and scattered offshore	Within the Chesapeake Bay
Longfin inshore squid (*Doryteuthis pealeii*)	Scattered offshore	NA	Various locations	Various locations
Monkfish (*Lophius*)	Lifestage data was not available	Lifestage data was not available	Various locations offshore	Scattered along the eastern edge of Georges Bank

Common and Scientific Name	Eggs	Larvae/ YOY[a]	Juveniles	Adults
Northern shortfin squid (*Illex illecebrosus*)	Along the eastern portion of Georges Bank	NA	Along the eastern portion of Georges Bank	Along the eastern portion of Georges Bank
Ocean Quahog (*Arctica islandica*)	Lifestage data was not available	Lifestage data was not available	Various locations	Various locations
Offshore hake (*Merluccius albidus*)	Scattered along the eastern edge of Georges Bank	Scattered along the eastern edge of Georges Bank	Scattered along the eastern edge of Georges Bank	Scattered along the eastern edge of Georges Bank
Red crab (*Gecarcoidea natalis*)	Scattered along the eastern edge of Georges Bank	Scattered along the eastern edge of Georges Bank	Scattered along the eastern edge of Georges Bank	Scattered along the eastern edge of Georges Bank
Rosette skate (*Leucoraja garmani*)	Lifestage data not available	Lifestage data not available	Scattered along the eastern edge of Georges Bank	NA
Spiny dogfish (*Squalus acanthias*)	Lifestage data was not available	Lifestage data was not available	Various locations	Various locations
Summer flounder (*Paralichthys dentatus*)	Lifestage data was not available	Within the Chesapeake Bay and scattered along the coast	Lifestage data was not available	Lifestage data was not available
White hake (*Urophycis tenuis*)	Various locations	Various locations	Various locations	Various locations
Window pane flounder (*Scophthalmus aquosus*)	Lifestage data was not available	Lifestage data was not available	Various locations	Various locations
Witch founder (*Glyptocephalus cynoglossus*)	Scattered along various locations of the coast	Scattered along various locations of the coast	Scattered along the eastern edge of Geroges Bank	Very limited location along the eastern edge of Georges Bank
Winter skate (*Leucoraja ocellata*)	Data not available	Data not available	Scattered along the coast and various location in Chesapeake Bay	Various locations in Chesapeake Bay
Yellowtail flounder (*Pleuronectes ferruginea*)	Lifestage data was not available	Lifestage data was not available	Lifestage data was not available	Lifestage data was not available
Albacore tuna (*Thunnus alalunga*)	Lifestage data was not available	Lifestage data was not available	Lifestage data was not available	Along the eastern portion of Georges Bank
Bigeye tuna (*Thunnus obesus*)	Lifestage data was not available	Lifestage data was not available	Various locations along the coast	Various locations along the coast

Common and Scientific Name	Eggs	Larvae/ YOY[a]	Juveniles	Adults
Skipjack tuna (*Katsuwonus pelamis*)	Lifestage data was not available	Lifestage data was not available	Various locations along the coast	(Spawning adults along the Florida Coast and Gulf of Mexico)
Yellowfin tuna (*Thunnus albacares*)	Lifestage data was not available	Lifestage data was not available	Various locations along the coast	(Spawning adults along the Florida Coast and Gulf of Mexico) Non-spawning adults along various locations of the coast
Swordfish (*Xiphias gladius*)	Data not available	NA	Various locations along the coast	Various locations along the coast
Longbill spearfish (*Tetrapturus pfluegeri*)	Data not available	Data not available	Along the mouth of the Chesapeake Bay and the southeastern region of the state	Along the mouth of the Chesapeake Bay and the southeartern region of the state
Roundscale spearfish (*Tetrapturus georgii*)	Data not available	Data not available	Various distant offshore locations	Various distant offshore locations
White marlin (*Kajikia albidus*)	Data not available	Data not available	Various distant offshore locations	Various distant offshore locations
Basking shark (*Cetorhinus maximus*)	Data not available	Data not available	Various distant offshore locations	Various distant offshore locations
Bigeye thresher shark (*Alopias superciliosus*)	Lifestage data was not available	Lifestage data was not available	Lifestage data was not available	Various distant offshore locations (Lifestage data was not available)
Blue shark (*Prionace glauca*)	NA (neonate)	Lifestage data was not available	Various distant offshore locations	Various distant offshore locations
Dusky shark (*Carcharhinus obscurus*)	Lifestage data was not available	Lifestage data was not available	Various locations offshore	Various locations offshore
Longfin mako shark (*Isurus paucus*)	Lifestage data was not available	Lifestage data was not available	Lifestage data was not available	Various distant offshore locations (Lifestage data was not available)
Porbeagle shark (*Lamna nasus*)	Along the eastern edge of Georges Bank	NA	Distant offshore cluster along the eastern edge of Georges Bank	NA
Sand tiger shark (*Carcharias taurus*)	Scattered along distant offshore locations	NA	Scattered along distant offshore locations	Scattered along distant offshore locations

Common and Scientific Name	Eggs	Larvae/ YOY[a]	Juveniles	Adults
Shortfin mako shark (*Isurus oxyrinchus*)	Lifestage data was not available	Lifestage data was not available	Lifestage data was not available	Lifestage data was not available (Various locations offshore)
Silky shark (*Carcharhinus falciformis*)	Lifestage data was not available	Lifestage data was not available	Lifestage data was not available	Various distant offshore locations (Lifestage data was not available)
Smooth dogfish (*Mustelus canis*)	Lifestage data was not available	Lifestage data was not available	Lifestage data was not available	Various distant offshore locations (Lifestage data was not available)
Tiger shark (*Galeocerdo cuvier*)	Lifestage data was not available	NA	Lifestage data was not available	Various offshore locations

Source: (NOAA, 2015b)

[a] Young of the Year (YOY): "All of the fish of a species that were born in the past year, from transformation to juvenile until January 1" (USEPA, 2015c)

Shellfish and Other Invertebrates

Virginia is home to both freshwater and marine shellfish. Approximately 70 percent of the state's 82 species of freshwater mollusks are in decline, with 31 species listed as threatened or endangered (VDGIF, 2017o). Well known freshwater bivalve[95] species include Appalachian monkeyface (*Quadrula sparsa*), oyster mussel (*Epioblasma capsaeformis*), Tennessee heelsplitter (*Lasmigona holstonia*), pocketbook, (*Lasmigona holstonia*), and the rainbow mussel, (*Villosa iris*). Aside from a multitude of freshwater invertebrates whose adult forms are terrestrial insects (e.g., flies, beetles, etc.) other well-known Virginia freshwater invertebrates that spend their lives in aquatic systems include the crayfish, hellgrammites, the state-threatened spiny riversnail (*Io fluvialis*), and the eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*) (VDGIF, 2010).

Marine shellfish and other invertebrates common to Virginia waters include species such as bay scallop (*Argopecten irradians*), eastern or Virginia oysters (*Crassostrea virginica*), hard clam (*Mercenaria mercenaria*), blue crab (*Callinectes sapidus*), and horseshoe crab (*Limulus Polyphemus*) (WC, 2014). Bay scallops prefer shallow coastal bays and estuaries with sandy and muddy bottoms and eelgrass beds and occur in the lower Chesapeake Bay. Eastern or Virginia oysters are found throughout the Chesapeake Bay on firm bottom areas called oyster bars. Hard shell clams are found along beaches and coastal bays in sand or muddy sand in the lower Chesapeake Bay. Blue crab males are often found in the upper reaches of the Chesapeake Bay, where water is fresher, while females are typically found farther downstream where salinities are higher. Horseshoe crab inhabit sandy beaches and mud flats of coastal bays and near shore waters from spring to fall, and move to offshore shoals and slews in the winter (Chesapeake Bay Program, 2012a).

[95] Bivalve: "An aquatic mollusk whose compressed body is enclosed within a hinged shell." (USEPA, 2015c)

Oyster populations, including the eastern or Virginia oyster of the Chesapeake Bay are only a small fraction of their historical abundance due to disease-related mortality, habitat degradation, reduced water quality, and harvest pressure. Virginia is implementing multiple strategies to restore a native oyster population into Chesapeake Bay. The Chesapeake Bay Watershed Agreement involves multiple state public agencies, representing the entire watershed. The agreement includes habitat restoration, enhancement, and protection goals for sustainable fisheries and both aquatic and terrestrial habitats. The Maryland and Virginia Oyster Restoration Interagency Teams include multi-agency federal, state, and local agency scientists and specialists responsible for oyster species and habitat restoration and management plans. The plans include the Lafayette, Lynnhaven, and Piankantank Rivers in Virginia (Chesapeake Bay Program, 2012b).

Marine Mammals

All marine mammals (i.e., whales, dolphins, porpoises, seals, and sea lions) are protected under the Marine Mammal Protection Act (MMPA). A subset of these mammals is also protected under the ESA. Three toothed whale species have been sighted off the Virginia coast and include the sperm whale (*Physeter macrocephalus*), pygmy sperm whale (*Kogia breviceps*), and Sowerby's beaked whale (*Mesoplodon bidens*). Five whale species that may occasionally be observed offshore of Virginia, include the Northern Atlantic right whale (*Eubalaena glacialis*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), minke whale (*Balaenoptera acutorostrata acutorostrata*), and sei whale (*Balaenoptera borealis*). Four species of seal, the harp seal, harbor seal, hooded seal, and gray seal, occur in Virginia waters (JMU, 2014). This section briefly introduces the marine mammal species found in Virginia waters. Detailed information on the marine mammal species listed under the ESA is presented in Section 15.1.6.6.

Many whale species occur offshore of Virginia as transient[96] individuals as they migrate northward towards feeding grounds and southward towards warmer breeding grounds. Occasionally individuals are beached or stranded along the coast or in Chesapeake Bay. A few species of whales exhibit distinctive behaviors. In contrast to migratory patterns displayed by other whale species, minke whales breed during the summer months in the northern hemisphere; however, they spend very little time at the surface and are therefore rarely seen. Sei whales feed far offshore in the open ocean and are unlikely to approach nearshore areas. Humpback whales are the most commonly observed whale during whale watch tours. The North Atlantic right whale spends the spring and summer months off the coast (JMU, 2014).

The harbor and gray seals are the more common seal species in Virginia, inhabiting coastal waters and basking on sand bars or offshore rocks. Harp seals and hooded seals normally prefer deep seas and thick ice to rest upon; gray seals prefer strong currents and bask along rocky shores of temperate waters (JMU, 2014).

[96] Transient: "Pertaining to the land" (USEPA, 2015c)

Sea Turtles

Six species of sea turtles occur in U.S. waters, all of which are protected under the ESA. Five of these sea turtles occur in Virginia's waters, typically off the coast or in Chesapeake Bay and include the loggerhead, green turtle, Kemp's ridley, leatherback, and hawksbill. For more information on sea turtles, refer to Section 15.1.6.6. (VDGIF, 2017p)

Invasive Aquatic Species

As previously discussed, Virginia has adopted regulations that prohibit or regulate the possession, transport, importation, sale, purchase and introduction of select invasive species, both plants and animals. The list of all prohibited and regulated invasive species are presented in the 2012 Virginia Invasive Species Management Plan (ISMP) developed by the Invasive Species Working Group (ISWG) an interagency working group and advisory committee, enabled by the Code of Virginia (§ 2.2-220.2). The ISMP identifies 13 managed or monitored invasive aquatic species including fish, mollusks, and invertebrates in Virginia[97] (VAISC, 2005).

Some of the more aggressive invasive aquatic species, requiring more management, include the zebra mussel (*Dreissena polymorpha*), quagga mussel (*Dreissena bugensis*), northern snakehead fish (*Channa argus.*), black carp (*Mylopharyngodon piceus*), New Zealand mudsnail (*Potamopyrgus antipodarum*), and rusty crayfish (*Orconectes rusticus*) (USDA, 2017).

15.1.6.6. Threatened and Endangered Species

The USFWS is responsible for administering the ESA (16 U.S.C §1531 et seq.) in Virginia. The USFWS has identified 50 endangered[98] and 20 threatened[99] species known to occur in Virginia (USFWS, 2015d). Of these 70 listed species, 9 have designated critical habitat,[100] as shown in Figure 15.1.6-3 (USFWS, 2015e). There are no candidate[101] species identified by USFWS as occurring within the state (USFWS, 2015f). The 70 listed species include 5 mammals, 5 reptiles, 4 birds, 6 fish, 1 amphibian, 32 invertebrates, and 17 plants, all of which are discussed in detail under the following sections (USFWS, 2015d).

[97] For more information, visit this website: http://www.dcr.virginia.gov/natural-heritage/vaisc/plan.htm
[98] 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))
[99] 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))
[100] 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))
[101] Candidate species are plants and animals that the USFWS has "sufficient information on their biological status and threats to propose them as endangered or threatened under the ESA, but for which development of a proposed listing regulation is precluded by other higher priority listing activities." (USFWS, 2014a)

Mammals

Four endangered and one threatened mammal species are federally listed and known to occur in Virginia (Table 15.1.6-5). These species include one squirrel and four bats. The Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*) is found along the Appalachian Mountains. The northern long-eared bat (*Myotis septentrionalis*) is found throughout the state, while the Gray Bat, Indiana Bat, and Virginia Big-eared Bat are found along the Appalachian Mountains. Information on the habitat, distribution, and threats to the survival and recovery is provided below.

Table 15.1.6-5: Federally Listed Mammal Species of Virginia

Common Name	Scientific Name	Federal Status	Critical Habitat	Habitat Description
Terrestrial Mammals				
Carolina Northern Flying Squirrel	*Glaucomys sabrinus coloratus*	Endangered	No	Northern hardwoods; found high in the Appalachian Mountains where climate is cool
Gray Bat	*Myotis grisescens*	Endangered	No	Caves in limestone karst regions near rivers; found in the western region of the state
Indiana Bat	*Myotis sodalis*	Endangered	No	Trees and snags, caves, and abandoned mines; found throughout the western region of the state
Northern Long-eared Bat	*Myotis septentrionalis*	Threatened	No	Trees and snags, caves, and abandoned mines; found throughout the state
Virginia Big-eared Bat	*Corynorhinus townsendii virginianus*	Endangered	No	Caves in karst regions with large presence of oak hickory or beech maple hemlock trees; found in the mountains of western Virginia

Source: (USFWS, 2015d)

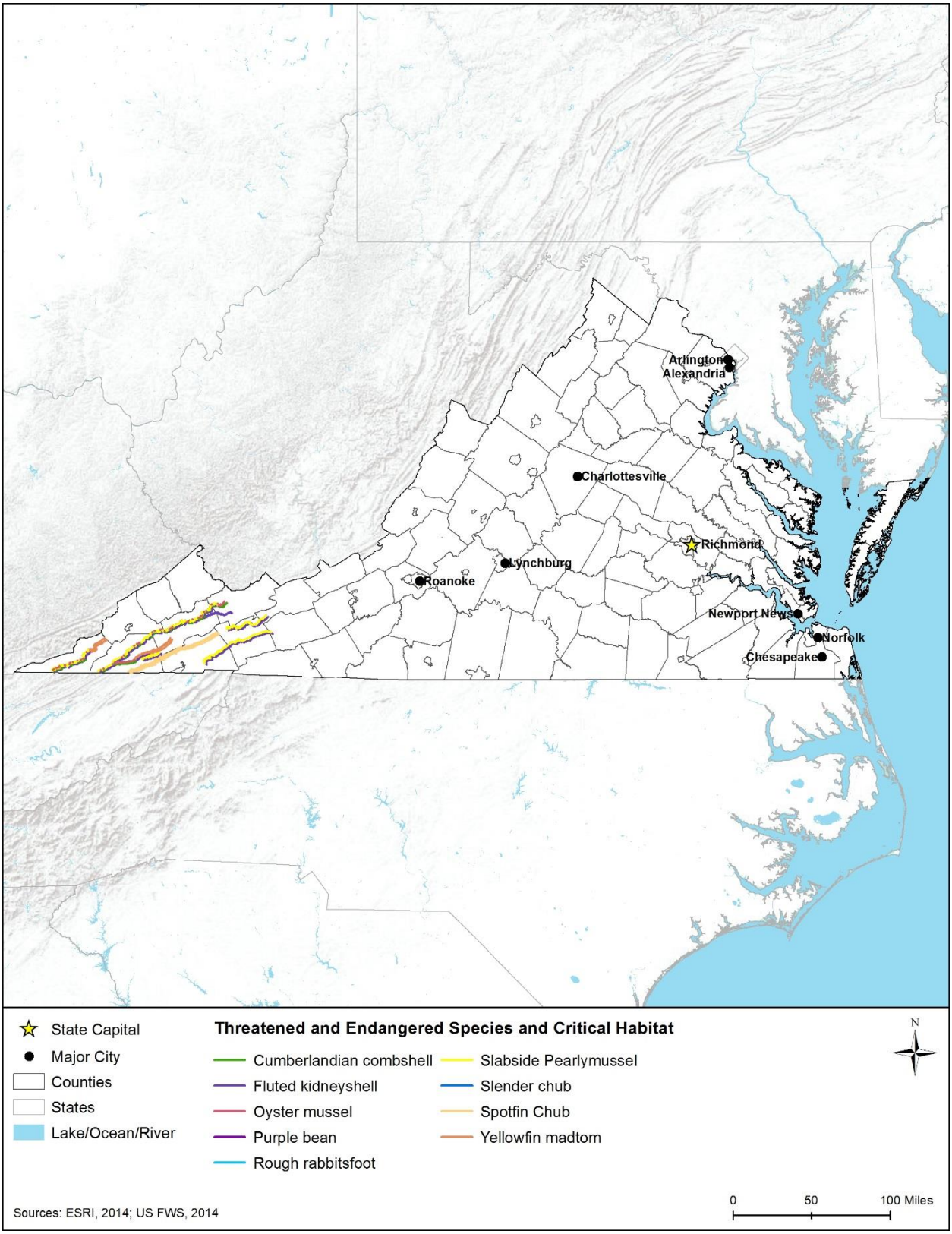


Figure 15.1.6-3: Federally Designated Critical Habitat in Virginia

Terrestrial Mammals

Carolina Northern Flying Squirrel. The endangered Carolina northern flying squirrel is a small nocturnal squirrel that can grow 10 to 12 inches in length and weight 4 to 5 ounces. This species has grey with brownish to reddish fur along the back and greyish white fur in the front (USFWS, 2015g) (VDGIF, 2015h). The Carolina northern flying squirrel was listed as endangered in 1985 (50 FR 26999 27002, July 01, 1985). Regionally, this squirrel is known to occur in North Carolina, Virginia, and Tennessee. In Virginia, this species is on the verge of extirpation and is known to occur only in Grayson, Smyth, and Washington counties (USFWS, 2015g).

The primary habitat for the Carolina northern flying squirrel include northern hardwoods, such as yellow birch (*Betula alleghaniensis*), red spruce (*picea rubens*), and fraser fir (*Abies fraseri*) found at high elevation habitats in the Appalachian Mountains were the climate is moist and cool. This species is active year-round and nests in tree cavities of northern hardwoods during the winter. Additionally, this squirrel feeds mainly on fungi, lichens, and occasionally eats nuts. The current threats to this species include limited sub-species and various human-related impacts, such as habitat destruction, fragmentation, clearing of forest, introduction of insect pest, and development (USFWS, 1990a).

Gray Bat. The endangered grey bat (*Myotis grisescens*) is medium sized, insectivorous[102] bat weighing approximately 7 to 16 grams and it is longer than any other *mytosis*. The gray bats have dark gray fur after molt in July or August and then the fur often transitions to a chestnut brown or russet. This species was federally listed as endangered in 1976 (41 FR 17736-17740, April 28, 1976). Regionally, this species is known to occur in limited geographic regions of limestone karst within southeastern states from Kansas and Oklahoma east to Virginia and North Carolina (USFWS, 1997a) (USFWS, 2015h). In Virginia, the gray bat is known to occur in 12 counties in the western region of Virginia (USFWS, 2015h).

The gray bats live in caves all year, they hibernate in deep vertical caves in the winter and roost in caves scattered along rivers the rest of the year. Most caves are in limestone karst regions and near rivers where these bats could feed on flying aquatic and terrestrial insects. Current threats to this species include human disturbance, habitat loss and degradation due to flooding, and commercialization of caves such as adding gates that alter the air flow, humidity, and temperature of caves (USFWS, 1997a).

Indiana Bat. The endangered Indiana bat (*Myotis sodalist*) is a small, insectivorous mammal measuring approximately 3.0 to 3.5 inches in length with a wingspan of 9.5 to 10.5 inches. The Indiana bats have dull grayish chestnut fur and strongly resembles the more common little brown bat (*Myotis lucifugus)* (USFWS, 2015i) (VDGIF, 2015i). The Indiana bat was originally federally listed as "in danger of extinction" under early endangered species legislation in 1967 (32 FR 4001, March 11, 1967) and was grandfathered into the ESA of 1973 as an endangered species (Harrington, 1982). In 2009, only 387,000 Indiana bats were known to exist in its range, less than half of the population of 1967 (USFWS, 2015i). Regionally, this species is currently found in the central portion of the eastern U.S., from Vermont west to Wisconsin, Missouri, and

[102] Insectivorous: "An animal that feeds on insects." (USEPA, 2015c)

Arkansas, and south and east to northwest Florida. In Virginia, the Indiana bat is known to occur in 44 counties throughout the state (USFWS, 2015j).

In the fall, the Indiana bats migrate to their hibernation sites in caves and abandoned mines in order to mate and build up fat reserves for hibernation season in the winter. Upon emerging from hibernation, the bats feed near their hibernations sites (within 10 miles) before they migrate to their summer habitats, where the females roost (USFWS, 2015j). Some of these summer habitats can be as far as 300 miles away from their hibernation areas (USFWS, 2004a). Indiana bats roost in trees during the day and feed at night in a variety of habitats, although streams, floodplain forests, ponds, and reservoirs are preferred. Females roost together in maternity colonies under the loose bark of dead or dying trees, or under the loose bark of shaggy-barked trees, although the physical characteristics of individual trees appear to be more of a factor than the species of tree. Nevertheless, tree species that have been noted as preferred by Indiana bat include shagbark hickory (*Carya ovata*), white oak (*Quercus alba*), silver maple (*Acer saccharinum*), sugar maple (*Acer saccharum*), green ash (*Fraxinus pennsylvanica*), eastern cottonwood (*Populus deltoides*), and American elm (*Ulmus rubra*) (USFWS, 2012a).

The threats to this species include the disturbance and intentional killing of hibernating and maternity colonies, disturbances to air flow in caves from the improper installation of security gates, habitat fragmentation and degradation, the use of pesticides or other environmental contaminants, and White Nose Syndrome (USFWS, 2004a) (USFWS, 2015i). White Nose Syndrome is a rapidly spreading fungal disease that afflicts hibernating bats (USGS-NWHC, 2015).

Northern Long-eared Bat. The northern long-eared bat (*Myotis septentrionalis)* is brown furred, insectivorous bat with long ears. Reaching a total length of 3 to 3.7 inches in length it is a medium size relative to other members of the genus *Myotis* (USFWS, 2015k). The northern long-eared bat was first proposed as endangered in 2013 (*78 FR 61046, October 2, 2013*), and then listed 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, 2015l). In Virginia the northern long-eared bat is known to occur throughout the state (VDGIF, 2015j).

This species hibernates in caves and mines that exhibit constant temperatures, high humidity, and no 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, 2015l).

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 U.S. 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, 2015l).

Virginia Big-eared Bat. The endangered Virginia big-eared bat (*Corynorhinus townsendii virginianus*) is a light to dark brown furred, insectivorous mammal measuring 1.5 to 2 inches

long and weighting 7 to 12 grams. The Virginia big-eared bat was listed as endangered in 1979 (44 FR 69206-69208, November 30, 1979). Regionally, this species is known or believed to occur only in Kentucky, North Carolina, Tennessee, Virginia, and West Virginia. In Virginia, it is known to occur in 12 counties in the western region of the state (USFWS, 2015m).

This species resides in caves for both the summer and winter time, usually in karst regions with large presence of oak hickory or beech maple hemlock trees. The Virginia big-eared bat prefers cold area in the entrance of caves and in the winter during hibernation they move deeper in the caves (USFWS, 1984a). The preferred habitat for the Virginia big-eared bat are found in the mountains of western Virginia. The primary current threats to the Virginia big-eared bat are human disturbance and pesticides, and additional threats include filling, removal of rock, and flooding of caves as these action destroy the habitats for the bats (VDGIF, 2015k).

Reptiles

Three endangered and two threatened reptile species are federally listed and believed or known to occur in Virginia as summarized in Table 15.1.6-6. All five sea turtles, the 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 Chesapeake Bay and the coast of Virginia. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in Virginia is provided below.

Table 15.1.6-6: Federally Listed Reptile Species of Virginia

Common Name	Scientific Name	Federal Status	Critical Habitat	Habitat Description
Green Sea Turtle	*Chelonia mydas*	Threatened	No	Beaches for nesting, open ocean convergence zones, and coastal areas for bottom feeding; found in the coast of Virginia.
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered	No	Warm, shallow, coastal waters of reefs, lagoons, inlets, and bays with submerged aquatic vegetation; found in the coast of Virginia.
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Endangered	No	Muddy or sandy bottoms where prey items can be found, in waters rarely greater than 160 feet deep; found along the coast of Virginia.
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	No	Coastal waters and the open sea environment; found on the coast of Virginia.
Loggerhead Sea Turtle	*Caretta*	Threatened	No	Open sea environment and inshore area such as salt marshes, creeks, bays, and lagoons; found along the coast of Virginia.

Source: (USFWS, 2015d)

Green Sea Turtle. The threatened green sea turtle occurs throughout tropical and subtropical oceans and is among the largest of the hard-shelled sea turtles growing to as much as 440 pounds

and four feet in length (NOAA, 2015c) (USFWS, 2015n). The breeding populations in Florida were listed as endangered, whereas all other populations were listed as threatened in 1978 (*43 FR 32800-32811, July 28, 1978*). Regionally, green sea turtles are found from Maine south to Florida, and throughout the Gulf of Mexico and the Caribbean Sea (NOAA, 2015c). There is a proposal for identification of a North Atlantic green sea turtle distinct population that would be listed as threatened, continuing its current listing status (80 FR 51763-51764, August 26, 2015).

Green sea turtles are found in the shallow waters (except during migration) of shoals, bays, lagoons reefs, and inlets, often where submerged aquatic vegetation exists. They use three primary types of habitat – beaches for nesting, open ocean convergence zones, and coastal areas for bottom feeding. Hatchlings consume both plants and animals, while adult green sea turtles are herbivorous feeding on seagrasses and algae (NOAA, 2015c). Breeding takes places in subtropical to tropical oceans every two, three, or four years between June and September, with peak nesting in June and July (NOAA, 2015c) (USFWS, 2015n). Hatching usually occurs at night, and many green sea turtle hatchlings seek refuge and food in masses of floating sea plants (USFWS, 2015n).

Current threats include disease, loss or degradation of nesting habitat, disorientation of hatchlings by lighting, nest predation, marine pollution, watercraft strikes, and incidental take from channel dredging and commercial fishing operations (NOAA, 2015c) (NOAA, 2015d).

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). The hawksbill sea turtle has overlapping plates that are thicker than those of other sea turtles. This protects them from being battered against sharp coral and rocks during storm events. Adults range in size from 30 to 36 inches and weigh 100 to 200 pounds. Its upper shell is dark brown with faint yellow streaks and a yellow under shell. The hawksbill is found throughout all of the oceans of the world (NOAA, 2015e) (USFWS, 2015o). Even though in the Atlantic they range from the East Coast of the U.S. to northern Brazil, they are rarely found offshore of the East Coast states (USFWS, 2013a). In Virginia, there are only occasional occurrences (USFWS, 2015p).

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 most 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, 2015o).

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, 2015e).

Kemp's Ridley Sea Turtle. The endangered Kemp's Ridley sea turtle is considered the smallest sea turtle species and the most endangered. These turtles grow up to two feet long and weigh up to 100 pounds (NOAA, 2015f) (USFWS, 2015q). 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 and grandfathered into the ESA in 1973 (Harrington, 1982) (USFWS, 2015q). 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).

Kemp's Ridley sea turtle gather in large groups in Tamaulipes, 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, 2015g). 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, 2015r).

Leatherback Sea Turtle. The endangered leatherback sea turtle is the deepest-diving and most wide-ranging sea turtle found in all of the world's oceans. It is the largest of all sea turtle, reaching four to eight feet long and weighing 500 to 2000 pounds (USFWS, 2015s). The leatherback sea turtle was listed as endangered in 1970 (35 FR 8491 8498, June 2, 1970) and was grandfathered into the ESA of 1973 (Harrington, 1982). 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 as well as in some location as far as Newfoundland and Argentina. The occurrence in the U.S. is rare for the Atlantic population, with the most significant location on the east coast being in southeastern Florida (NOAA, 2015f) (USFWS, 2015t).

The preferred habitat for this species include open oceans but they can occur in coastal waters. The leatherback sea turtle diet consists of jellyfish, salps, and other soft-bodied animals. This species will forage in both coastal waters and the open sea environment (NOAA, 2015f). For reproduction the female leatherback sea turtles nest at 2 to 3 year intervals during the months of March to July. Creation of nesting sites occur during the night and each turtle will nest up to 11 nests per nesting season (USFWS, 2015s). Current major threats to the species include harvesting of their eggs, hunting, incidental capture in fishing gear, and consumption of plastics that were mistaken for jellyfish (NOAA, 2015f).

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 weigh up to 250 pounds. This species has a reddish-brown carapace and flippers, and is characterized by its large head (USFWS, 2015u). The loggerhead sea turtle was initially listed as threatened throughout its range in 1978, and by 2011 nine different distinct populations were listed and the northwestern Atlantic Ocean population remained listed as threatened (76 FR 58868 58952, September 22, 2011) (USFWS, 2015v). Regionally, this turtle is known to occur throughout temperate and tropical regions in the Atlantic, Pacific, and Indiana Oceans with the most nesting areas located in the western Atlantic Ocean. Nesting by the loggerhead sea turtle occurs from Texas to Virginia along the southeastern coast of the U.S. (USFWS, 2008).

The preferred habitat for the loggerhead sea turtle is the open sea environment, but they also occur in inshore areas such as salt marshes, creeks, bays, and lagoons. Open beaches are the preferred location for nesting along the coast. Coral reefs and rocky places are the preferred feeding areas for the loggerhead sea turtles (NOAA, 2014a). Current threats to the logger head sea turtle include incidental captures in fishing gear, direct harvesting of eggs, and loss and degradation of habitats (NOAA, 2014a) (USFWS, 2008).

Birds

Two endangered and two threatened bird species are federally listed and known to occur in Virginia (Table 15.1.6-7). Three of the listed bird species, the piping plover (*Charadrius melodus*), the red knot (*Calidris canutus rufa*), and the roseate tern (*Sterna dougallii dougallii*) are found along the coast of Virginia, while the red-cockaded woodpecker (*Picoides borealis*) is found further inland within the counties of Southampton and Sussex. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in Virginia is provided below.

Table 15.1.6-7: Federally Listed Bird Species of Virginia

Common Name	Scientific Name	Federal Status	Critical Habitat	Habitat Description
Piping Plover	*Charadrius melodus*	Threatened	No	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 Virginia.
Red Knot	*Calidris canutus rufa*	Threatened	No	Intertidal marines, estuaries, and bays; found along the coast of Virginia.
Red-cockaded Woodpecker	*Picoides borealis*	Endangered	No	Mature pine forests; found in Southampton and Sussex counties.
Roseate Tern	*Sterna dougallii*	Endangered	No	Salt marsh, islands and beaches with sparse vegetation; found along the coast of Virginia.

Source: (USFWS, 2015d)

Piping Plover. The threatened piping plover is a small, sand-colored migratory shorebird; it is approximately 6.5 to 7 inches in length with a wingspan up to 19 inches and weighs between 1.5 to 2.3 ounces. It was first listed as endangered in 1985 for the Great Lakes watershed of both the U.S. 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 US. (USFWS, 2001). In Virginia, the piping plover occurs along the coastal beaches (USFWS, 2015w).

This species feeds in the intertidal zone of ocean beaches, ocean washover areas, mudflats, sand flats, wrack lines,[103] and the shorelines of coastal ponds, lagoons, and salt marshes. They feed on worms, fly larvae, beetles, crustaceans, and other marine macroinvertebrates[104] (USFWS, 1996).

[103] Wrack lines are part of the shore just above the mean high tide line where kelp is deposited on the sand.
[104] Macroinvertebrates are organisms that are large enough to be seen with the naked eye (macro), and lack a backbone (invertebrate). (USEPA, 2015c)

The preferred habitat are wide, open, sandy beaches with little vegetation. This species nests in small creeks or wetlands and create shallow nests 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 the eggs hatch (USFWS, 1996) (USFWS, 2001). Piping plovers breed in three geographic regions of North America and are 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, 2015x). Current threats to this species include habitat loss and degradation, human disturbance, pets, predation, flooding from coastal storms, and environmental contaminants (USFWS, 1996) (USFWS, 2001).

Photo credit: FWS **Red Knot**

Red Knot. The threatened red knot is a medium-sized shorebird; it is approximately 9 inches in length with a wing span up to 20 inches, making it among the largest of the small sandpipers (USFWS, 2005a). It was recently 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, 2005a) (USFWS, 2014a). Virginia has become a major staging area for this species as they migrate to the arctic, staging areas are known to be along the coast of Virginia (Center for Conservation Biology, 2015) (USFWS, 2015y).

The preferred habitat is intertidal marines, estuaries, and bays. Mussel beds are important food sources for the red knot. The red knots eat mussels and other mollusks mostly all year, however during migration season they eat horseshoe crab (*Limulus polyphemus*) (USFWS, 2005a). Current threats to the red knot include sea level rise, climate change, and reduced food availability at their migration stopover sites (USFWS, 2014a).

Red-cockaded Woodpecker. The endangered 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, 2015z). The red-cockaded woodpecker was listed as endangered in 1970 under early endangered species legislation (35 FR 16047-16048 October 13, 1970) and was grandfathered into the ESA in 1973 (Harrington, 1982). Regionally, this species is known to occur in open pine forests in the southeast from Virginia south to Florida and west to Oklahoma and Texas. In Virginia, the red-cockaded woodpecker is known to occur only in two counties, Southampton and Sussex, in southeastern Virginia (USFWS, 2015z) (USFWS, 2015aa).

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 and branches and flakes away bark in search of insects. Its diet consist of mainly insects including beetles, ants, spiders, other insect found on pine trees, and occasional wild fruits and pine seeds. Current threats to the red-cockaded woodpecker include lack of suitable habitats (USFWS, 2003).

Roseate Tern. The endangered roseate tern is approximately 16 inches in length with light-gray wings and a black cap. During breeding season, the roseate tern's white chest gains a rosy tinge, and its bill and legs turn from black to orange-red (USFWS, 2011a). The roseate tern was listed as endangered in 1987 in the northeast region and threatened in the southeast region (52 FR 42064-42066, November 2, 1987) (USFWS, 1987). This bird nest in colonies on sand/gravel beaches or pebbly/rocky offshore barrier islands along the Atlantic coast from Nova Scotia south to Long Island, New York, and on the southern tip of Florida. The northeastern population appear to winter primarily in the waters off Trinidad and northern South America from the Pacific coast of Columbia to eastern Brazil (USFWS, 1998a). In Virginia, populations of roseate terns are known to occur in coastal beaches in Accomack, Northampton and Virginia Beach counties (USFWS, 2015ab).

This species is a marine bird that breeds along the coasts on salt marsh islands and beaches with sparse vegetation. The roseate tern feeds on small fish such as the American sand lance. Present threats include vegetation changes in breeding areas, disturbances from human activities in coastal areas, competition with gulls for suitable nest sites, and predation (USFWS, 2011a).

Fish

Two endangered and four threatened fish species are federally listed and known to occur in Virginia as summarized in Table 15.1.6-8. The Roanoke logperch (*Percina rex*) is found in rivers and streams in the central region of the state. The Blackside Dace, Duskytail Darter, Slender Chub, Spotfin Chub, and Yellowfin Madtom are found on the southwestern region of the state along rivers and streams associated to the Tennessee River system such as the Clinch River, Powell River, and Copper Creek. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in Virginia is provided below.

Table 15.1.6-8: Federally Listed Fish Species of Virginia

Common Name	Scientific Name	Federal Status	Critical Habitat	Habitat Description
Blackside Dace	*Phoxinus cumberlandensis*	Threatened	No	Small upland headwaters and creeks with cool water pools and riparian vegetation; found in the western region of Virginia along the Powell and Clinch Rivers and their tributaries.
Duskytail Darter	*Etheostoma percnurum*	Endangered	No	Upland rocky areas in gently flowing pools that are one to four feet deep, and in large creeks and rivers; found along Copper Creek and Clinch River.
Roanoke Logperch	*Percina rex*	Endangered	No	Medium to large streams and rivers with warm water and moderate gradient; found in rivers and streams in the southern regions of the state.
Slender Chub	*Erimystax cahni*	Threatened	Yes, critical habitat designation have been given to regions of the Clinch and Powell Rivers.	Clear, warm, moderate to fast flowing shallow waters; found along the Clinch and Powell rivers.
Spotfin Chub	*Erimonax monachus*	Threatened	Yes, critical habitat has been designated along North Fork Holston River.	Clear large creeks or medium size rivers up in montane areas; found along stream associated to the Tennessee River system.
Yellowfin Madtom	*Noturus flavipinnis*	Threatened	Yes, critical habitat has been designated to regions of the Powell River and Copper Creek.	Medium to large streams in gently flowing pools with rocks and stones; found along Powell river, Clinch River, and other tributaries.

Source: (USFWS, 2015d)

Blackside Dace. The threatened blackside dace (*Phoxinus cumberlandensis*) is a small freshwater fish that grow less than 3 inches long. This species has an olive to gold colored back with silver or red underline and two dark black stripes along each side. During breeding season, the males are distinguished by the change of color on the belly to a bright red (USFWS, 1988). The blackside dace was listed and threatened in 1987 (52 FR 22580-22585, June 12, 1987). Regionally, this species is known to occur in Kentucky, Tennessee, and Virginia. In Virginia, the blackside dace is known to occur in 10 counties in the western region of the state along the Powell and Clinch Rivers and their tributaries (USFWS, 2015ac).

Suitable habitats for the blackside dace consist of small upland headwaters and creeks. The blackside dace tends to occur more in cool water pools with bedrock, undercut banks, or brush and associates with lush riparian vegetation. This species feeds on algae on rocks or objects in the water and during the winter they feed on aquatic insects and other unidentified organisms. Current threats to the blackside dace include siltation from mining, agriculture, and road construction as well as unregulated acid mine drainage (USFWS, 1988).

Duskytail Darter. The endangered duskytail darter (*Etheostoma percnurum*) is a small fish that grows approximately 2.5 inches and has a straw to olive color body with white to light greyish belly and dark grey on top of head. It is difficult to distinguish the sex, however, during breeding season the male's head tends to get darker and swollen (USFWS, 1994a). The duskytail darter was listed as endangered in 1993 (58 FR 25758-25763, April 27, 1993). Regionally, this species is known to occur in Kentucky, Tennessee, and Virginia. In 2002 and 2007, non-essential experimental populations were created in multiple regions of Tennessee. In Virginia, it is known to occur in 10 different counties in the western region of the state along Copper Creek and Clinch River (USFWS, 2015ad).

Suitable habitats for the duskytail darter are upland rocky areas in gently flowing pools that are one to four feet deep, and also runs in large creeks and rivers. This species is an insectivore that feeds on microcrustaceans, chironomid larvae[105], and heptageniids[106]. Current threats to this species include silt and runoff from agricultural activities and impoundment[107] (USFWS, 1994a).

Roanoke Logperch. The endangered Roanoke logperch is one of the larger darter fish that grows approximately six inches long. This species is dark green with yellowish to green sides and white to yellowish body. It is distinguished by its elongated and cylindrical to slab-sided body (USFWS, 1992a). The Roanoke logperch was listed as endangered in 1989 (54 FR 34468 34472, August 18, 1988). Regionally, this species is known to occur only in North Carolina and Virginia. The first Roanoke logperch was collected in the Roanoke River near Roanoke, Virginia and currently it is known to occur in 30 counties within Virginia (USFWS, 2015ae).

The preferred habitat for the Roanoke logperch include medium to large streams and rivers with warm water and moderate gradient. Males tend to occur more in shallow riffles while the females tend to occur more in deep runs over gravel, which are the ideal conditions for spawning. Spawning occurs during the months of March or April. This species feeds mainly on aquatic insects, most of their diet consist of caddisfly larvae and chironomids found under stones which they move with their snout. Current threats to the survival of the Roanoke logperch include destruction and degradation of habitat by turbidity and silt, chemical spills, organic pollution, channelization, impoundment, and the intrusion of cold water into their habitats (USFWS, 1992a).

Slender Chub. The slender chub (*Erimystax cahni*) is a small fish with a brown body, white belly, and long snout. The chub grows to approximately 3 inches in length and has been known to feed on insect larvae, snails, and mussels. The species was federally listed as threatened in 1977 and designated with critical habitat (42 FR 47840-47845, September 22, 1977). The slender chub typically inhabits the "clear, warm, moderate to fast flowing shallow water of the Clinch and Powell rivers in Tennessee and Virginia" (USFWS, 1983a). In 2007, an experimental population was established for the lower Holston River in Tennessee *(72 FR 52434-52461, September* 13, 2007*)* (USFWS, 2015af). Figure 15.1.6-3 depicts these rivers and the slender chub's critical habitat.

[105] Larvae of Chironomidae, or lake flies.
[106] Family of mayflies.
[107] Loss of aquatic habitat.

Threats to species populations have to do with its specific habitat requirements in fine-gravel shoals. This fragile habitat has been compromised by dams, temperature changes from upstream water releases, coal mining operations, pollution, and sedimentation. (USFWS, 1983a)

Spotfin Chub. The spotfin chub (*Erimonax monachus*) is a small fish with an elongated body that grows approximately 3.7 inches. It has an olive color body with silver on the sides and white at the bottom (USFWS, 1983b). This species was listed as endangered in 1977 (42 FR 45526-45530, September 9, 1977). Historically, it was known to occur along the Tennessee River and its associated streams with occurrences in Alabama, Georgia, North Carolina, Tennessee, and Virginia. Currently, it is only known to occur in the states of Alabama, North Carolina, and Virginia with multiple non-essential experimental populations in Tennessee. In Virginia, it is known to occur in nine counties along several streams associated with the Tennessee River watersheds (USFWS, 1983b) (IUCN, 2014). Figure 15.1.6-3 below depicts these rivers and streams and the spotfin chub's critical habitat.

Suitable habitats for the spotfin chub consist of clear large creeks or medium size rivers up in montane areas. These water systems must have cool and warm water with moderate gradients and gravel at the bottom. The spotfin chub uses the gravel at the bottom of creeks or rivers to lay their eggs in between rocks for protection. Current threats to the survival of this species include dams that disrupt the natural flow, channelization of streams, and water quality degradation from siltation, industrial runoff, and urban runoff. (USFWS, 1983b) (IUCN, 2014)

Yellowfin Madtom. The yellowfin madtom (*Noturus flavipinnis*) is a small catfish, usually less than six inches in length. The fish is one of few poisonous freshwater fishes in the United States and has poison glands at the base of sharp spines protruding from its body. The yellowfin madtom was listed as threatened in 1977 and designated with critical habitat (42 FR 47840-47845, September 22, 1977). The species is native to parts of the Upper Tennessee River Basin in Tennessee and Virginia. In Virginia, the species can be found in the main branch of the Powell River, the Clinch River, and major tributaries, such as Copper Creek with critical habitat designations along the Powell River and Copper Creek (USFWS, 1983c). Figure 15.1.6-3 depicts these rivers and the yellowfin madtom's critical habitat.

Suitable habitats for the yellowfin madtom include medium to large streams in gently flowing pools with rocks and stones. The species has been reintroduced in Abrams Creek of Frederick County and in 2002, experimental populations were instituted in the North Fork Holston River (67 FR 52420-52428, August 12, 2002). Major threats to this species have been the construction of dams, chemical spills, sedimentation of rivers, and pollution from mining operations (USFWS, 2012b).

Amphibians

One endangered amphibian species is federally listed and known to occur in Virginia as summarized in Table 15.1.6-9. The Shenandoah salamander *(Plethodon shenandoah)* is restricted to three mountains within the Shenandoah National Park (NPS, 2015b) (USFWS, 2015ag). Information on the habitat, distribution, and threats to the survival and recovery of each of these species in Virginia is provided below.

Table 15.1.6-9: Federally Listed Amphibian Species of Virginia

Common Name	Scientific Name	Federal Status	Critical Habitat	Habitat Description
Shenandoah Salamander	*Plethodon shenandoah*	Endangered	No	Forested areas in relatively high elevations; found in the Hawksbill, Pinnacles, and Stony Man Mountains within the Shenandoah National Park

Source: (USFWS, 2015d)

Shenandoah Salamander. The endangered Shenandoah salamander is a member of the family of *Plethodon,* which are lungless species that breathe through their skin. This salamander has a slender body that grows from 3.5 to 4.5 inches and has a two phase body color. The first is a strip phase with a blackish body and a red to yellowish strip along the dorsal and the second is a dark phase with an all black colored body and no strip. The Shenandoah salamander was listed as endangered in 1989 (54 FR 34464-34468, August 18, 1989) and as the name implied, it is known to occur only in three mountains within the Shenandoah National Park; the Hawksbill, Pinnacles, and Stony Man Mountains (NPS, 2015b) (USFWS, 2015ag).

Suitable habitat for the Shenandoah salamander consist of forested areas in relatively high elevations. The high elevation provide cool and moist habitats that are crucial to the survival of these salamanders. The forestry condition allow for higher abundance of mites, beetles, flies, and other invertebrates that complete the diet of this species. Current threats to the survival of the Shenandoah salamander include non-native insect disease infestations that kill trees, acid depositions degrading soils, human use of park, and climate change. Since this species require cool and moist habitats in high elevation, climate change is becoming a major threat to their survival (NPS, 2015b).

Invertebrates

There are 29 endangered and 3 threatened invertebrate species that are federally listed and known to occur in Virginia as summarized in Table 15.1.6-10. One crayfish, the Big Sandy crayfish (*Cambarus callainus*) is primarily located in the western part of the state. All of the listed mussels are known to occur in the westernmost region of the state along the rivers associated to the Tennessee River system, except the dwarf wedgemussel (*Alasmidonta heterodon*) which is found in rivers on eastern regions of the state and the James spinymussel *(Pleurobema collina)* which is found in rivers on the northern region of the state. The Lee County cave isopod *(Fusconaia cuneolus)* is found in the westernmost region of the state, while the Madison Cave isopod (*Antrolana lira*) is found in the northcentral region of the state in caves along the Appalachian Mountains. The northeastern beach tiger beetle (*Cicindela dorsali*s) is found along the Chesapeake Bay and the only listed butterfly, the Mitchell's Satyr butterfly *(Neonympha mitchellii mitchellii)*, occurs in restricted regions of Floyd and Patrick Counties (VDCR, 2015c). Information on the habitat, distribution, and threats to the survival and recovery of each of these species in Virginia is provided below.

Table 15.1.6-10: Federally Listed Invertebrate Species of Virginia

Common Name	Scientific Name	Federal Status	Critical Habitat	Habitat Description
Appalachian Monkeyface (Pearlymussel)	*Quadrula sparsa*	Endangered	No	Shallow areas of fast flowing streams with sand and gravel bottoms; found along the Clinch River.
Birdwing Pearlymussel	*Lemiox rimosus*	Endangered	No	Rivers of swift currents with sand and gravel substrates; found in parts of the Powell and Clinch Rivers.
Cracking Pearlymussel	*Hemistena lata*	Endangered	No	Medium-sized rivers with swift-moving, turbulent water over gravel and cobble bottoms; found in parts of the Powell and Clinch Rivers.
Cumberland Bean (Pearlymussel)	*Villosa trabalis*	Endangered/ Non-Essential Experimental Population	No	Small rivers and streams with clean fast flowing water and sand and gravel substrates in riffle and shoal areas; found along the North Fork Holston River and Clinch River.
Cumberland Monkeyface (Pearlymussel)	*Quadrula intermedia*	Endangered/ Non-Essential Experimental Population	No	Rivers of swift currents with sand and gravel substrates in riffle and shoal areas; found in regions of the Powell River.
Cumberlandian Combshell	*Epioblasma brevidens*	Endangered/ Non-Essential Experimental Population	Yes, critical habitat is designated in regions of the Clinch and Powell Rivers and their tributaries.	Rivers of swift currents with sand and gravel substrates in riffle and shoal areas; found in regions of the Powell, Clinch, and the Holston Rivers.
Dromedary Pearlymussel	*Dromus dromas*	Endangered	No	Shoal areas in rivers within moderately moving water, and with sand and gravel bottoms; found in regions of the Powell and Clinch Rivers.
Dwarf Wedgemussel	*Alasmidonta heterodon*	Endangered	No	Creek and river areas with slow to moderate current and sand, gravel, or muddy bottoms; found along rivers on the eastern region of the state.
Fanshell	*Cyprogenia stegaria*	Endangered	No	Large rivers with sand and gravel and moderate current; found along rivers on the western region of the state including the Powell and Clinch Rivers.
Finerayed Pigtoe	*Fusconaia cuneolus*	Endangered	No	Silt-free sand, gravel, and cobble substrates of free-flowing smaller streams; found along the Clinch River.
Fluted Kidneyshell	*Ptychobranchus subtentum*	Endangered	Yes, critical habitat has been designated in	Medium-sized creeks to large rivers: found along river

Common Name	Scientific Name	Federal Status	Critical Habitat	Habitat Description
			Powell and Clinch Rivers.	associated to the Tennessee River system.
Green Blossom (Pearlymussel)	*Epioblasma torulosa gubernaculum*	Endangered	No	Fast-flowing freshwater over firm gravel and shoal areas; found along Clinch River.
James Spinymussel	*Pleurobema collina*	Endangered	No	Sand and gravel bottoms of unpolluted free-flowing streams with a variety of slow to moderate flow regimes; found in rivers and streams in the central region of the state.
Lee County Cave Isopod	*Lirceus usdagalun*	Endangered	No	Rocks and gravel submerged in cave streams; found in two cave systems in Lee County.
Littlewing Pearlymussel	*Pegias fabula*	Endangered	No	Medium size rivers and streams with high gradient and cool clear water; found along the North Fork Holston River and the Clinch River.
Madison Cave Isopod	*Antrolana lira*	Threatened	No	Calcite saturated waters in karst aquifers; found in the northcentral region of the state.
Big Sandy Crayfish	*Cambarus callainus*	Threatened	No	Freshwater, burrows beneath loose cobbles on the stream bottom.
Mitchell's Satyr Butterfly	*Neonympha mitchellii*	Endangered	No	Wetlands that are low nutrient wetlands and receive carbonate rich groundwater; found in regions within the counties of Floyd and Patrick.
Northeastern Beach Tiger Beetle	*Cicindela dorsalis*	Threatened	No	Long, wide and dynamic beaches; found on sandy beaches on the Chesapeake Bay.
Oyster Mussel	*Epioblasma capsaeformis*	Endangered/ Non-Essential Experimental Population	Yes, critical habitat has been designated along the Powell and Clinch River.	Medium-sized rivers and sometimes large rivers in areas with coarse sand; found in rivers within the Tennessee River system.
Pink Mucket (Pearlymussel)	*Lampsilis abrupta*	Endangered	No	Major rivers and their tributaries with mud and sand in shallow riffle areas; found along the Clinch River.
Purple Bean	*Villosa perpurpurea*	Endangered	Yes, critical habitat has been designated along the Clinch and Powell Rivers.	Headwater areas where medium- to high-speed freshwater currents occur over sandy or gravelly bottoms; found along the Clinch River and its tributaries.
Rough Pigtoe	*Pleurobema plenum*	Endangered	No	Shoal areas of medium to large rivers with sand and gravel river bottoms; found in rivers at the westernmost region of the state.

Common Name	Scientific Name	Federal Status	Critical Habitat	Habitat Description
Rough Rabbitsfoot	*Quadrula cylindrica strigillata*	Endangered	Yes, critical habitats have been designated along the Clinch and Powell Rivers.	Medium-sized to large rivers in moderate to swift current; found in the southwest corner of Virginia.
Sheepnose Mussel	*Plethobasus cyphyus*	Endangered	No	Large rivers and streams with moderate to swift currents and shallow shoal habitats; found along the Powell and Clinch Rivers.
Shiny Pigtoe	*Fusconaia cor*	Endangered/ Non-Essential Experimental Population	No	Large streams with silt-free substrates of sand, gravel, and cobble; found along the Powell and Clinch Rivers and associated streams.
Slabside Pearlymussel	*Pleuronaia dolabelloides*	Endangered	Yes, critical habitat is designated along the Fork Holston and Clinch Rivers.	Large creeks and rivers with sand and gravel bottoms and moderate current; found along the Holston Rivers and Clinch River.
Snuffbox Mussel	*Epioblasma triquetra*	Endangered	No	Small to medium sized creeks, lakes, and rivers with shoal habitats and swift current; found along the Clinch and Powell Rivers.
Spectaclecase (Mussel)	*Cumberlandia monodonta*	Endangered	No	Sheltered areas in large rivers; found along the Clinch River and associated streams.
Spruce-fir Moss Spider	*Microhexura montivaga*	Endangered	No	Well-drained mosses growing on shady rocks in mountain forests with Fraser fir and red spruce; found on few mountain tops in southwest Virginia.
Tan Riffleshell	*Epioblasma florentina walkeri*	Endangered	No	Rivers of swift currents with sand and gravel substrates; found along the Middle Fork Holston River, parts of the Clinch River, and Indian Creek in the Appalachian mountains.
Virginia Fringed Mountain Snail	*Polygyriscus virginianus*	Endangered	No	Areas where the soil has significant clay and limestone components and in shady areas of persistent moisture; found along the New River in Pulaski County.

Source: (USFWS, 2015d)

Appalachian Monkeyface (Pearlymussel). The endangered Appalachian monkeyface (*Quadrula sparsa*) is a medium size mussel that grows up to 2 inches. Its shell is yellowish green to brown color with a bumpy texture on top (USFWS, 2011b). The Appalachian monkeyface mussel was federally listed as endangered in 1976 (41 FR 24062-24067, June 6, 1976). Regionally, this species is known to occur in rivers and streams in Tennessee and Virginia. Currently within

Virginia, it is known to occur only in the western region of the state along the Clinch River (USFWS, 2011b) (USFWS, 2015ah).

Suitable habitats for the Appalachian monkeyface include shallow areas of fast flowing streams with sand and gravel bottoms. This species, like most mussels, is a filter feeder that eats bacteria, phytoplankton, algae, and diatoms. However, it is not known which species of fish serve as host fish for these mussels to complete the development of the larvae. Current threats to this species include dams that disrupt the natural flow, pollution from agricultural, and water quality degradation from additional source such as coal mining (USFWS, 2011b).

Birdwing Pearlymussel. The birdwing pearlymussel *(Lemiox rimosus)* is a freshwater mussel of approximately 2 inches in length and 1 inch in width. The shells are marked by irregular growth lines and are generally dark olive green to black in coloration (USFWS, 2011c). The species was federally listed as endangered in 1976 (41 FR 24062-24067, June 14, 1976) and was introduced as an experimental population in portions of Tennessee and Alabama in 2007 and 2001 respectively (USFWS, 2015ai). Historically, the species was found across the Cumberland and Tennessee River basins. In Virginia, birdwing pearlymussel currently is known to exist in parts of the Powell and Clinch River in the Appalachian mountains of western Virginia (USFWS, 2015ai).

The birdwing pearlymussel is found buried in rivers of swift currents with sand and gravel substrates in riffle[108] and shoal areas (USFWS, 2011c). Though populations of the birdwing pearlymussel are declining in some locations, generally the species is stable, but isolated and susceptible to fluctuations in water quality and temperature. The species has experienced decreasing water quality from coal mining, construction activities, and riverine development such as channelization and building of dams. Additional risk for the species include climate change which has the potential to affect host fish species and habitats for the birdwing pearlymussel larvae (USFWS, 2011c).

Cracking Pearlymussel. The endangered cracking pearlymussel (*Hemistena lata*) is a freshwater mussel with a flattened, stretched, swollen, mid-sized shell. The outside of the shell is dark green to brown with green bands, while the inside ranges from light blue to purple (USFWS, 1991a). The cracking pearlymussel was federally listed as endangered in 1989 (54 FR 39850-39853, September 28, 1989). Regionally, the species is found from the western stretch of Virginia to the northeastern area of Alabama (USFWS, 2015aj). Within Virginia, the cracking pearlymussel is only known to occur in the Powell and Clinch Rivers in the west side of the state (USFWS, 1991a).

Habitat for the cracking pearlymussel includes medium-sized rivers with swift-moving, turbulent water over gravel and cobble bottoms. Though, the species has also been observed beneath dams and within muddy and sandy bottoms of slow-moving waterways. Threats to the species include habitat degradation due to pollution from toxic sources such as nearby mining and coal power plants. Additional threats include damming and water alterations from extreme water

[108] Riffle: a short, relatively shallow and coarse-bedded length of stream over which the steam flows at slower velocity. (USEPA, 2015c)

temperature changes, water quality fluctuations, and variations in the rate of water flow (USFWS, 1991a).

Cumberland Bean (Pearlymussel). The endangered Cumberland bean *(Villosa trabalis)* is a small to medium size freshwater mussel with an elongated oval shaped shell that grows approximately 2.2 inches. Its shell is smooth with no ridges and is an olive green, yellowish to brown, or blackish colored shell with dark green rays (USFWS, 2011d). The Cumberland bean was federally listed as endangered in 1976 (41 FR 24062-24067 June 14, 1976) and an experimental population was established in Alabama and Tennessee in 2007 and 2001 respectively. Regionally, this species is known to occur in Alabama, Kentucky, North Carolina, and Virginia. In Virginia, the Cumberland bean is known to occur in the western region of the state along the North Fork Holston River and Clinch River (USFWS, 2015ak).

Suitable habitats for the Cumberland bean consist of small rivers and streams with clean fast flowing water and with sand and gravel substrates in riffle and shoal areas. The reproduction cycle for this species is similar to most other mussels, however, these mussels have been associated with the fantail darter (*Etheostoma flabellare*) and striped darter (*Etheostoma virgatum*) as their host fish. Like most mussels, current threats to the survival of this species include channelization, impoundment, siltation from coal mining[109], and pollution from urban and agricultural runoff (USFWS, 1984b) (USFWS, 2011d).

Cumberland Monkeyface (Pearlymussel). The Cumberland monkeyface is a freshwater mussel of approximately 3 inches in length with a green yellow shell covered in distinguishing dark green dots and chevrons. The Cumberland and Appalachian monkeyface mussels are similar in appearance, and differentiated only by careful comparison of shell features, markings, and valve sizes (USFWS, 1984c). The species was federally listed as endangered in 1976 (41 FR 24062-24067, June 14, 1976) and was introduced as an experimental population in portions of Tennessee and Alabama in 2007 and 2001 respectively (USFWS, 2015al). Historically, the species was found across the Cumberland and Tennessee River basins. In Virginia, the Cumberland monkeyface exists only in parts of the Powell River, though noted improvements in the Clinch River suggest the potential for suitable habitats along the river (USFWS, 2007a).

Suitable habitats for the Cumberland monkeyface includes rivers of swift currents with sand and gravel substrates in riffle and shoal areas (USFWS, 1984c). Populations of the Cumberland monkeyface are declining, isolated, and susceptible to fluctuations in water quality and temperature. Threats to the species include degrading water quality from coal mining, water pollution, sedimentation from construction activities, and changes in water flow and temperatures from channelization and impoundments. Additional risk for the species include competition for habitat and host fish from invasive species such as the Asian Clam *(Corbicula fluminea)* and Zebra mussel *(Dreissena polymorpha)* (Terwilliger, Tate, & Woodward, 1994) (USFWS, 1984c).

Cumberlandian Combshell. The Cumberlandian combshell *(Epioblasma brevidens)* is a freshwater mussel of approximately two to three inches in length. The yellow shells are marked

[109] Siltation from coal mining is the runoff and sedimentation in water bodies from coal mining operations.

by distinctive rays of fine green broken dots and dashes (USFWS, 2004b). The species was federally listed as endangered in 1997 (62 FR 1647-1658, January 10, 1997) and was designated with critical habitat in Virginia in 2004 (69 FR 53136-53180, August 31, 2004). In 2001 and 2007, experimental populations were introduced in portions of the Tennessee river valley of Alabama and Tennessee (USFWS, 2015am). Historically, the species was found across the Cumberland and Tennessee River basins. In Virginia, the Cumberlandian combshell exists only in parts of the Powell, Clinch, and the Holston Rivers in the western part of the state. As depicted in Figure 15.1.6-3, critical habitat for the Cumberlandian combshell is defined within the Clinch and Powell Rivers and their tributaries (USFWS, 2004c).

Suitable habitats for the Cumberlandian combshell include rivers of swift currents with sand and gravel substrates in riffle and shoal areas (USFWS, 2004b) (USFWS, 2015am). Populations of the Cumberlandian combshell are declining, isolated, and susceptible to fluctuations in water quality and temperature. Historically, the species experienced significant challenges to water quality from coal mining, construction activities, riverine development (such as channelization and building of dams), and collection by pearl hunters. Additional risk for the species include climate change which has the potential to affect host fish species and habitat for the Cumberlandian combshell larvae (USFWS, 2004b).

Dromedary Pearlymussel. The endangered dromedary pearlymussel (*Dromus dromas*) is a freshwater mussel named for its mid-shell hump observed on larger specimens, reaching a length of approximately 3.5 inches long. The shell is mostly round, with a lighter brown color interspersed by green discolorations and streaks, whose growth lines are often bumpy. The dromedary pearlymussel was federally listed as endangered in 1976 (41 FR 24062-24067, June 14, 24067). While the species is found in the Powell and Clinch Rivers in western Virginia, its range reaches to the northwestern corner of Alabama (Terwilliger, Tate, & Woodward, 1994) (USFWS, 1983d) (USFWS, 2015an).

Suitable habitat for the species consists of the shoals in rivers within moderately moving water with sand and gravel bottoms. It has also been found in deeper, slower moving portions of rivers. Threats to the dromedary pearlymussel include pollution from coal mining and coal production which has resulted in habitat degradation. Additional threats include competition from exotic species such as the Asian clam (*Corbicula fluminea*) and zebra mussel (*Dreissena polymorpha*) (Terwilliger, Tate, & Woodward, 1994).

Dwarf Wedgemussel. The endangered dwarf wedgemussel is a small, brown or yellowish-brown freshwater mussel that usually grows less than 1.5 inches in length (USFWS, 2010a). The dwarf wedgemussel was federally listed as endangered in 1990 throughout its range (55 FR 9447-9451, March 14, 1990). In Virginia, it is known to occur throughout 43 counties in the eastern region of the state along a few rivers and streams including Potomac, Nottoway, and South Anna Rivers (USFWS, 1993a) (USFWS, 2015ao).

The dwarf wedgemussls are sedimentary filter feeders that feed off suspended particles and algae at the bottom of rivers. This species inhabits creek and river areas with slow to moderate current and sand, gravel, or muddy bottoms. This species is a bradytictic beeder, meaning that the females become gravid in the early fall and glochidia are released by mid-spring. This species

requires either the tessellated darter (*Etheostoma olmstedi*) or the mottled sculpin (*Cottus bairdi*) in order to complete their lifecycle, as they serve as hosts for the dwarf wedgemussel. The current threats to this species include silt deposition, water quality degradation, sedimentation from development, and agricultural runoff (USFWS, 2010a).

Fanshell. The endangered fanshell *(Cyprogenia stegaria)* is a medium-sized freshwater mussel with a subcircular light green to yellow shell with green rays (USFWS, 1991b). It was federally listed as endangered in 1990 (55 FR 25591-25595, June 21, 1990). Regionally, this species in known to occur from Virginia west to Illinois and in Alabama with a non-essential experimental population in Tennessee. In Virginia, it is known to occur in 10 counties in the western region of the state along a few rivers and streams including the Powell and Clinch Rivers (USFWS, 1991b) (USFWS, 2015ap).

Suitable habitat for the fanshell consist of large rivers with sand and gravel and moderate current. For their reproductive cycle, these mussels require stable, undisturbed habitat and host fish to complete the mussel's larvae development. The current threats to the fanshell include dams and reservoirs, as both dams and reservoirs flood suitable habitat location reducing the abundance of sand and gravel along with the presence of host fish. Additionally, water quality degradation is another threat to the survival of the fanshell. Silt and pollution from dredging, agriculture, and industrial runoff have become a major cause for the reduction of these mussels (USFWS, 1997b).

Finerayed Pigtoe. The endangered finerayed pigtoe *(Fusconaia cuneolus)* is a medium-sized pearly mussel, distinguishable by the color of its shell, or thin outer "skin" layer, with fine green rays or streaks over a yellow-green to brown background (USFWS, 1984d) (USFWS, 2015aq). The finerayed pigtoe was federally listed as endangered in 1976 (41 FR 24062-24067, June 14, 1976). In 1984, only seven populations were known to exist within its range in Virginia, Tennessee, and Alabama. Since then, two of the seven populations have been considered extirpated[110]. Nonessential experimental populations were created in 2001 in Alabama in the free-flowing reach of the Tennessee River, and in 2007 in Tennessee in portions of the French, Broad, and Holston rivers (USFWS, 2015aq). Despite long-term decline, the overall status of the species is currently considered to be stable. This is primarily due to its Clinch River, Virginia population which makes up the vast percentage of its global abundance (USFWS, 2013b). The local range for the species extends throughout at least ten Virginia counties (USFWS, 2015aq).

Suitable habitat for the finerayed pigtoe consists of silt-free sand, gravel, and cobble substrates of free-flowing smaller streams (USFWS, 2015aq). The primary causes for this species' decline was loss of habitat resulting from intensive industrial and agricultural development since the early 1900s. Habitat destruction and pollution, specifically caused by dam construction, coal mining/production, and application of herbicides and pesticides, significantly contributed to the decline of the species (USFWS, 2013b).

Fluted Kidneyshell. The endangered fluted kidneyshell (*Ptychobranchus subtentum*) is a relatively large-sized mussel reaching up to 13 centimeters (cm) or 5 inches (in) in length (USFWS, 2015ar). The shell is roughly oval, greenish yellow and brownish in color, and appears

[110] Locally extinct.

inflated. The fluted kidneyshell was federally listed as endangered in 2013 and designated a critical habitat (78 FR 59269-59287, October 28, 2013), Figure 15.1.6-3 displays regions designated with critical habitat. The species is a "Cumberlandian Region" mussel, restricted to the Cumberland (in Kentucky and Tennessee) and Tennessee (in Alabama, Kentucky, Tennessee, and Virginia) river systems. The local range for the species extends throughout at least ten Virginia counties (USFWS, 2015ar). The fluted kidneyshell has been eliminated from more than 50 percent of the total number of streams from which it was historically known, and the current overall population of the species range-wide is declining (USFWS, 2013c).

The fluted kidneyshell occurs in medium-sized creeks to large rivers, inhabiting sand and gravel substrates in relatively shallow riffles and shoals with fast or swift current. Species threats include dams/impoundments, mining activities, poor water quality, excessive sedimentation, and environmental contaminants (USFWS, 2013c).

Green Blossom (Pearlymussel). The endangered green blossom (*Epioblasma torulosa gubernaculum*) is a medium-sized, irregularly oval-shaped mussel which has a more flattened shell in comparison to its relative species. The outer-shell has readily apparent growth lines, is generally even and glossy, with a yellow tinge and faint green streaks (USFWS, 1984e). The green blossom was federally listed in 1976 (41 FR 24062-24067, June 14, 1976). Historically, this species was found within the Tennessee River watershed, reaching north of Knoxville, Tennessee into the western-most corner of Virginia. The green blossom has been most recently sighted within the Clinch River (USFWS, 1984e) (USFWS, 2015as). The local range for the species extends throughout at least 10 Virginia counties (USFWS, 2015as).

Green blossom pearlymussel are generally found in fast-flowing freshwater over firm gravel and shoal areas, where the stream flows at a slower rate, but with higher turbulence than usual. Threats to the green blossom include damming, the buildup of sediments, and pollution which result in habitat degradation for the species (USFWS, 1984e).

James Spinymussel. The endangered James spinymussel is a small freshwater mussel with a yellowish to dark brown shell that grows approximately three inches in length and has one to three short spines on its shell. The James spinymussel was federally listed as endangered in 1988 (53 FR 27689 27693, July 22, 1988). It is regionally known to occur in North Carolina, Virginia, and West Virginia. In Virginia, it is known to occur in rivers and streams within 42 counties in the central region of the state (USFWS, 1990b) (USFWS, 2015at).

Suitable habitat for the James spinymussel consist of sand and gravel bottoms of unpolluted free-flowing streams with a variety of slow to moderate flow regimes. This species feeds on plankton and reproduces sexually with the assistance of seven different host fish. Current threats to this species include loss and depletion of suitable habitat. Degradation of water quality from siltation, impoundment, pollution, and sewage discharge causes these mussels to be more vulnerable to competition. Additionally, the increased invasion of the non-native Asiatic clam (*Corbicula fluminea*) is causing a major threat to the survival of the James spinymussel (USFWS, 1990b).

***Lee County Cave Isopod*[111].** The Lee County cave isopod is a small freshwater isopod that grow up to 0.3 inches. These isopods have seven pair of legs and two pair of antennas but lack eyes and pigmentation. The Lee county isopod was federally listed as endangered in 1992 (57 FR 54722-54726, November 20, 1992). This species is native to Virginia but has a very restricted range. Occurrences of this species have only been document in two caves in Lee County (USFWS, 2010b) (USFWS, 2015au).

The preferred habitat for these isopods include rocks and gravel submerged in cave streams. Little is known about their life history but based on studies it is known that these isopods feed on detritus and bacterial films growing on rocks and in terms of their reproduction it is only known that females lay an average of approximately 27 eggs. Additionally, the Lee County cave isopod are very sensitive to changes in water quality and quantity. Aside from water quality, additional threats to their survival include non-point source pollution, toxic spills, and the use of sinkholes as disposal sites for industrial, household, and agricultural waste (USFWS, 2010b) (VNHP, 2008).

Littlewing Pearlymussel. The littlewing pearlymussel *(Pegias fabula)* is a small freshwater mussel that grows up to 1.5 inches. The shell of this species is light green or dark yellowish with dark rays, but usually the shell is eroded and has a chalky appearance (USFWS, 2015av). The littlewing pearlymussel was federally listed as endangered 1988 (53 FR 45861-45865, November 14, 2015). Historically, the littlewing pearlymussel was known to occur in numerous rivers associated to the Tennessee River systems and the Cumberland River systems. Presently in Virginia, it is only known to occur in small populations along the North Fork Holston River and the Clinch River (USFWS, 1989) (USFWS, 2015ce).

Suitable habitats for the littlewing pearlymussel consist of medium size rivers and streams with high gradient and cool clear water. Usually these mussels are found behind huge rocks. As with most other mussels, this species is also known to feed on bacteria, phytoplankton[112], algae, and diatoms[113]. The reproduction cycle for this species is similar to most mussels, however, it is not known what species of fish serve as host for these mussels. Specific factor for the decline of populations is not known but is believe that current threats are similar to other mussels which include dams, dredging, and water quality degradation (USFWS, 1989) (USFWS, 2015av).

Madison Cave Isopod. The Madison Cave isopod is a freshwater eyeless and unpigmented bug that grows approximately 0.7 inches and is the only species of its genus. It has a flattened body with two pair of antennas, one short and one long pair. The Madison Cave isopod was listed as threatened in 1982 (47 FR 43699-43701, October 4, 1982). It is regionally known to exist in the Great Valley of Virginia and West Virginia (USFWS, 2010c) (USFWS, 2015aw). In Virginia, there have been documented occurrences of small populations in Angusta, Rockingham, Warren, and Clarke counties (USFWS, 2010c).

[111] Isopods are crustaceans.
[112] Phytoplankton are photosynthesizing microscopic organisms that inhabit the upper sunlit layer of almost all oceans and bodies of fresh water.
[113] Diatoms are a major group of algae.

Suitable habitat for the Madison Cave isopod include calcite saturated waters in karst aquifers such as flooded limestone caves. Little is known about the life history and diet of this species, but studies suggest that the reproduction rate is low for the Madison Cave isopod and most of the occurring population consist of adult isopods. Additionally, no information is known about the feeding habitats but it is believed these isopods feed on fine particles. Presently, the major threat to the survival of this species is the contamination of groundwater from agricultural and urban runoff (USFWS, 2010c).

Big Sandy Crayfish. The Threatened Big Sandy crayfish is a freshwater crustacean that lives in "shallow excavations under loose cobbles and boulders on the stream bottom". It prefers fast flowing streams and rivers with low levels of sedimentation (USFWS, 2017). Adults can be up to 4 inches long with body coloration ranging from olive brown to light green. Its legs are ligh green to green blue. The Big Sandy crayfish was federally listed as Threatened in 2016 (81 FR 20449-20481). It is known to exist in Virginia in Buchanan, Dickenson, Giles, Norton, and Wise Counties.

The Big Sandy crayfish are "are at an increased risk of extinction primarily due to land-disturbing activities that increase erosion and sedimentation, and subsequently degrade the stream habitat". Other factors include unpermitted stream dredging, competition from other crayfish, toxic spills, and climate change (USFWS, 2016a).

Mitchell's Satyr Butterfly. The endangered Mitchell's satyr butterfly is a medium sized butterfly that has a wingspan of approximately 1.75 inches. Its wings are mostly all brown with multiple black circular spots and silver center on the lower region of both wings (USFWS, 1999a). The Mitchell's satyr butterfly was federally listed as endangered in 1991 (56 FR 28825-28828, June 25, 1991). It was historically known to occur in 30 locations within the states in the Great Lakes region, however, it has been extirpated from many locations. Isolated populations have been documented in regions of Virginia, North Carolina, and Alabama. In Virginia, this species is known to occur in a few regions within the counties of Floyd and Patrick (USFWS, 2015ax) (The Xerces Society, 2015).

Suitable habitats for the Mitchell's satyr butterfly are very rare. These species require rare wetlands called fens. These wetlands are low nutrient wetlands that receive carbonate rich groundwater and contain sedges and various grassy plants, which are suitable to feed the Mitchell's satyr caterpillars. Little is known about the reproduction cycle but it is known that it is similar to most butterflies. The eggs are laid in leaves and hatch into caterpillars in a week, after a year the caterpillars hibernate during winter and develop into butterflies in the spring. Current threats to the survival of this species include loss of habitat, pesticides and pollutants, and butterfly collections. The habitats that this species depend on are being removed for development or are being degraded by pollution from agriculture and runoff (USFWS, 1999a).

Northeastern Beach Tiger Beetle. The threatened northeastern beach tiger beetle grows up to more than 0.5 inches and was first listed as threatened in 1990 (55 FR 32088-32094, August 7, 1990). This species is identified by its bronze to greenish coloration on head and chest with wide, cream-colored markings on its wing covers. This beetle was once found in swarms along Massachusetts, New Jersey, Maryland and Virginia beaches but has lost most of its coastal

habitat and has less than five percent survival rate from larvae to adult life stages. In Virginia this species of beetles are known to exist in the eastern portion of the state along the Chesapeake Bay (USFWS, 1994b) (USFWS, 2015ay).

Found on long, wide and dynamic beaches, this species is most active near the water's edge on warm sunny days between June and September. The adult northeastern beach tiger beetle prefers small to medium course sand with low organics and will forage on small invertebrates or scavenge off of dead marine organisms, including fish, crabs and amphipods. Maturity of these species requires two to three years of larvae transformations, which takes place in self-made burrows along the beaches. Once they reach maturity the northeastern beach tiger beetle disperses to distances of approximately four miles (USFWS, 1994b).

Primary threats to this species are from human activities, including loss of habitat from coastal development, recreational uses such as off-road vehicles, as well as contamination from pollution, pesticides, and oil slicks. Natural threats to this species survival include winter storms, beach erosion, flood tides, hurricanes, parasites, and predators, all of which could be impacted by climate change (USFWS, 1994b).

Oyster Mussel. The endangered Oyster mussel (*Epioblasma capsaeformis*) is distinguishable by its dull to sub-shiny, yellowish-green shell with numerous narrow dark green rays or streaks (USFWS, 2015az). The inside of the shell is whitish to bluish-white in color. The oyster mussel was federally listed as endangered in 1997 (62 FR 1647 1658, January 10, 1997) and was designated critical habitat in 2004 (69 FR 53136-53180, August 31, 2004). The species historically occurred throughout much of the Cumberland River region of Tennessee and Cumberland River drainages in Alabama, Kentucky, Tennessee, and Virginia. By 1991, the oyster mussel was considered to be extremely rare, with small populations in only three streams of the Tennessee River system in Tennessee and Virginia (USFWS, 2004b). Nonessential experimental populations were as created in 2001 in Alabama in the free-flowing reach of the Tennessee River, and in 2007 in Tennessee in portions of the French, Broad, and Holston rivers. The local range for the species extends in rivers throughout at least 10 Virginia counties (USFWS, 2015az). These rivers and the critical habitat for the oyster mussel are shown in Figure 15.1.6-3.

The oyster mussel inhabits small to medium-sized rivers and sometimes specific areas of large rivers, in areas with coarse sand to boulder substrate and moderate to swift currents. Species threats include habitat loss from human-induced degradation, including dams/impoundments, channelization, and mining activities, resulting in deforestation, industrial contamination, sedimentation in the upper Tennessee River system (USFWS, 2004b).

Pink Mucket (Pearlymussel). The endangered pink mucket *(Lampsilis abrupta)* is a medium size mussel with a smooth yellowish-brown round shell. This species was federally listed as endangered in 1976 (41 FR 24062-24067, June 14, 1976). The pink mucket was historically known to occur from Oklahoma east to Virginia and Illinois south to Louisiana, however, due to different factors the populations of these species have decreased and are now only known to occur in small populations throughout its historical range. In Virginia, it is known to occur along in the Clinch River (USFWS, 1985) (USFWS, 1997c) (USFWS, 2015ba).

Suitable habitat for the pink mussel consist of major rivers and their tributaries with mud and sand in shallow riffle areas. Threats to the survival of this species include dams that disrupt the natural flow, impoundment, and water quality degradation (USFWS, 1997c).

Purple Bean. The endangered purple bean (*Villosa perpurpurea*) is a freshwater mussel whose shell is small to medium-sized, compacted, and broad. The outside shell color ranges from dark green to green-black, and its inside coloring ranges from light to dark purple, potentially accented by a pink coloring (Terwilliger, Tate, & Woodward, 1994) (USFWS, 2004b). The purple bean was federally listed as endangered in 1997 (62 FR 1647-1658, January 10, 1997) and was designated a critical habitat along the Tennessee and Cumberland River basin, including the Powell and Clinch Rivers in 2004 (69 FR 53136-53180, August 8, 2004). The purple bean mussel has a relatively limited regional range, from the western area of Virginia south to the eastern half of Tennessee (USFWS, 2015bb). Within Virginia, the species occurs primarily within the Clinch River, with the largest population found in Copper Creek, a tributary of the Clinch River (Terwilliger, Tate, & Woodward, 1994). This rivers along with the designated critical habitats are shown in Figure 15.1.6-3.

Purple bean habitat is primarily constrained to headwater areas, where medium- to high-speed freshwater currents occur over sandy or gravelly bottoms, and beneath larger rocks which may provide protection. Threats to the species include "silt from agricultural land-use and logging, oil and gas exploration, and the cutting of riparian vegetation along stream banks," along with potential competition from exotic species such as the zebra mussel (*Dreissena polymorpha*) (Terwilliger, Tate, & Woodward, 1994).

Rough Pigtoe. The endangered rough pigtoe (*Pleurobema plenum*) is a somewhat triangular-shaped freshwater mussel. The mussel appears inflated, and has a dirty-yellow or rust-colored shell marked by uneven growth markings. The rough pigtoe was federally listed in 1976 (41 FR 24062-24067, June 14, 24067). It is only known to occur in five streams around the Mississippi watershed, including the Tennessee, Cumberland, Clinch, Green, and Barren Rivers (USFWS, 1984f). Regionally, the species' range extends from western Virginia to north Alabama and southern Indiana. The local range for the species extends from the south into the westernmost region of Virginia, and is believed or known to occur within ten Virginia counties (USFWS, 2015bc).

The rough pigtoe is primarily observed in shoal areas of medium to large rivers, burying itself in the sand or gravel river bottom. Threats to the rough pigtoe include damming, the buildup of sediments, and pollution which result in habitat degradation for the species (USFWS, 1984f). A recent threat includes suffocation and competition from the tiny, prolific, and exotic zebra mussel species (*Dreissena polymorpha*) (USFWS, 2015bd).

Rough Rabbitsfoot. The endangered rough rabbitsfoot (*Quadrula cylindrica strigillata*) is an oval-shaped, bumpy-shelled freshwater mussel, sometimes with knobs on the backside of the shell. The outer layer of the shell is usually yellow-green in color, with green patterns and discolorations throughout. The interior color transitions from silver to a shiny iridescent white at the back of the shell (USFWS, 2004b). The species was listed as endangered in 1997 (62 FR 1647-1658, January 10, 1997), and is considered endemic to the upper Tennessee River system,

specifically within the Cumberland River region. The rough rabbitsfoot's limited range is located to the southwest corner of Virginia, and has been historically only found in three streams in Tennessee and Virginia. Critical habitat was established for rough rabbitsfoot within the Clinch and Powell rivers (USFWS, 2004b), shown in Figure 15.1.6-3.

Rough rabbitsfoot exists primarily within "medium-sized to large rivers in moderate to swift current but often exists in areas close to, but not in, the swiftest current," laying on its side upon sediments in mid-river whirlpools. Reasons for the species' initial decline includes exploitation by the Mississippian pearling industry and eating the mussels, along with habitat degradation by human-induced alterations through damming, channelization, pollution, among other causes. (USFWS, 2004b)

Sheepnose Mussel. The endangered sheepnose mussel (*Plethobasus cyphyus*) is a medium sized freshwater mussel that usually grows about five inches. The sheepnose shell is a light yellow to dull yellowish brown with darker ridges (USFWS, 2012c). After multiple status reviews since 2004, the USFWS listed the sheepnose mussel as endangered in 2012 (77 FR 14914-14949, March 13, 2012). This species historically occurred mostly along the Mississippi River, but has been eliminated from two-thirds of the locations where it once occurred and now only occurs in 25 streams (USFWS, 2012c) (USFWS, 2015be). In Virginia, it is known to occur along the Powell and Clinch Rivers (USFWS, 2015be).

The sheepnose mussels live in large rivers and streams with moderate to swift currents and feed on suspended algae, bacteria, detritus[114], and microscopic animals. This species prefers shallow shoal habitats above course sand and gravel. For reproduction the sheepnose prefers a stable undisturbed habitat with the presence of sauger (*Sander Canadensis*), its only host fish. Threats include sedimentation, dams that restrict natural flow, habitat reduction, water quality degradation, contaminations of nutrients, and invasive species of zebra mussels (*Dreissena polymorpha*) (USFWS, 2012c).

Shiny Pigtoe. The endangered shiny pigtoe (*Fusconaia cor*) is a freshwater mussel which grows to lengths of approximately two inches long. The species' shell is yellow-brown with very dark green streaks and is irregularly oval-shaped (USFWS, 1984g). The shiny pigtoe was federally listed as endangered in 1976 (41 FR 24062-24067, June 14, 1976). The species' range extends from the western region of Virginia across Tennessee to the northern regions of Alabama. The listing indicates experimental populations in various portions of the Tennessee River, reaching just south of the western border of Virginia, and a protected area is indicated within the Clinch River around Pendleton Island. Within Virginia, shiny pigtoes are believed or known to occur in the westernmost region of the state, within at least 14 counties (USFWS, 2015bf).

The shiny pigtoes are found in "relatively silt-free substrates of sand, gravel, and cobble in good flows of larger streams" (USFWS, 2015bf). Since the species is a filter feeder, a primary threat has consisted of water quality degradation due to pollution and mining development. Additional threats consist of water flow alterations and damming practices (USFWS, 1984g).

[114] Waste or debris.

Slabside Pearlymussel. The endangered slabside pearlymussel *(Pleuronaia dolabelloides)* is a medium sized mussel that grows about 3.5 inches. The shell of this species is a tawny to brown color with few green rays (USFWS, 2012d). After multiple status reviews, the USFWS listed the slabside pearlymussel as endangered in 2013 (78 FR 25041-25044, April 29, 2013). Regionally, this species is known to occur only in the Tennessee and Cumberland River systems within the states of Alabama, Kentucky, Mississippi, Tennessee and Virginia. In Virginia, a few populations are known to occur along the North Fork and Middle Fork Holston Rivers, critical habitats have been designated along the Clinch River and other rivers associated to the Tennessee River system, as depicted in Figure 15.1.6-3 (USFWS, 2012d) (USFWS, 2015bg).

The preferred habitat for the slabside pearlymussel consists of large creeks and rivers with sand and gravel bottoms and moderate current. The sladside pearlymussel, as most other mussels, are always at the bottom of the creeks and rivers feeding on diatoms, algae and other microorganisms. These mussels also have similar reproduction cycles as other mussels but this species is a summer brooder. The larvae is released from the females starting in mid-May to August and must attach to a fish host to be fully developed by mid-summer (USFWS, 2012d).

The primary threat to the decline of the slabside pearlymussel is the loss and degradation of suitable habitats. Impoundments of rivers is the major cause of this decline. Impoundments of rivers change the temperature of water, alters the natural flow, and decreases the abundance of host fish. Additionally, water quality degradation from polluted discharges, runoff, and siltation have also become threats to the survival of this species (USFWS, 2012d).

Snuffbox Mussel. The endangered snuffbox mussel (*Epioblasma triquetra*) is a small to medium size freshwater mussel that usually grows from 1.8 to 2.8 inches. The snuffbox has a yellow, green, or brown triangular shell with green rays (USFWS, 2012e). This species was federally listed as endangered in 2012 (77 FR 8632-8665, February 14, 2012) (USFWS, 2015bh). The snuffbox total population has reduced by 62 percent from its historical range. Currently this species only occurs in 79 streams and 14 rivers compared to 210 streams and lakes in its historical rang (USFWS, 2012e) e. In Virginia, small populations of the snuffbox mussel are known to occur along the Clinch and Powell Rivers and associated streams (USFWS, 2015bh).

The snuffbox mussels live in small to medium sized creeks, lakes, and rivers and feed on suspended algae, bacteria, and dissolved organic material. This species prefers shoal habitats with swift current over sand and gravel as they usually burrow deep in sand. For reproduction a stable and undisturbed habitat is required with a sufficient population of host fish such as logperch (*Percina caprodes*) and several other darters. Current threats to this species include sedimentation, pollution and water quality degradation, dams that restrict natural flow, and invasive non-native species of zebra mussels (USFWS, 2012e).

Spectaclecase (Mussel). The endangered spectaclecase mussel (*Cumberlandia monodonta)* is a large (up to nine inches long) freshwater mussel. As its name suggest, its brownish to black shell is large with a somewhat curved appearance and moderate inflation (USFWS, 2012f). This species was first listed as federally endangered in 2012 (77 FR 14914-14949, April 12, 2012). Today the spectaclecase mussel has suffered a 55 percent decrease in distribution and only occurs in 20 of the 44 streams it once inhabited. Most populations are now fragmented and

limited to short reaches of streams in the 12 states it occurs: Alabama, Arkansas, Illinois, Iowa, Kansas, Kentucky, Minnesota, Missouri, Tennessee, Virginia, West Virginia, and Wisconsin (USFWS, 2012f) (USFWS, 2015bi). In Virginia, it is known to occur along the Clinch River and associated streams (USFWS, 2015bi).

Suitable habitat for the spectaclecase mussel include sheltered areas in large rivers. This species seeks out areas that are sheltered from the force of the river current such as beneath rock slabs, firm mud banks, and in-between tree roots. Spectaclecase mussels spend their entire lives partially or completely buried in river bottom substrate, and some specimens have been recorded up to 70 years old. This species of mussel has a complex reproduction cycle, they have a parasitic life stage and are dependent on a host fish for successful rearing and relocation of larvae young. The current major threat to the survival of this species are dams. Dams alter the natural flow and temperature regime of rivers, blocking fish passage which are necessary to prevent fragmentation and connect populations. Sedimentation of rivers, pollution, channelization, and invasive zebra mussels also pose threats to this species (USFWS, 2012f).

Spruce-fir Moss Spider. The spruce-fir moss spider *(Microhexura montivaga)* is one of the smallest members of tarantulas, measuring 0.10 to 0.15 inch. The spider ranges from light brown to darker reddish browns. The species was federally listed as endangered in 1995 (60 FR 6968-6974, February 06, 1995). Historically, the spruce-fir moss spider lived throughout the mountains of southern Appalachia and today is present on few mountain tops in western North Carolina, eastern Tennessee, and southwest Virginia (USFWS, 1998b).

Typical habitat for this spider is damp and well-drained mosses growing on shady rocks in mountain forests of Fraser fir and red spruce. However, Fraser fir trees in the Southern Appalachian Mountains have recently suffered from infestation by the balsam wooly adelgid (*Adelges piceae)*, a small wingless insect that infests and kills firs. Death and thinning of the tree canopy results in significant changes in the forest, specifically increased temperatures and decreased moisture which directly affects suitable habitats for this species. Additionally, top threats for the spruce-fir moss spider include habitat destruction from logging operations, storm damage, air pollution, climate changes, disease, and insect damage (USFWS, 1998b).

Tan Riffleshell. The tan riffleshell *(Epioblasma florentina walker)* is a dull green mussel with faint green and white rings around its shell. It was federally listed as endangered in 1977 (42 FR 42351-42353, August 23, 1977). Historically, the species was found across the Cumberland and Tennessee River basins (USFWS, 1984h). Currently, in Virginia, the tan riffleshell exists in the Middle Fork Holston River, parts of the Clinch River, and Indian Creek in the Appalachian mountains of western Virginia (USFWS, 2013d).

Generally, the tan riffleshell is found in rivers with swift currents having sand and gravel substrates in riffle areas (USFWS, 1984h). The restricted population has experienced significant challenges to water quality from specific chemical spills and sedimentation from construction activities. Additional threats include riverine development (such as channelization and building of dams) and climate change which has the potential to affect host fish species and habitat for riffleshell larvae (USFWS, 2013d).

Virginia Fringed Mountain Snail. The Virginia fringed mountain snail *(Polygyriscus virginianus)* is a small snail with a shell of approximately 0.18 inches in diameter and 0.06 inches in height. The shell is a pale greenish color and has four spiral lines with less prominent spiral lines between them. The snail itself is white and it is believed that it is blind. This snail is an extremely rare species that was thought to be extinct as recent as 1970. It was federally listed as endangered in 1978 (43 FR 28932-28935, July 3, 1978) (USFWS, 2015bj). This snail is known to occur in only six miles of bluffs along the New River in Pulaski County, Virginia (USFWS, 1983e).

The Virginia Fringed Mountain snail is usually found in areas where the soil has significant clay and limestone components and in shady areas of persistent moisture and angular rocks. The snails live underground at depths of approximately 4 and 24 inches and have never been observed at the surface. Threats to the species include loss of shading vegetation, widening of an adjacent road, and reactivation of quarry operations which could include vibrations and blasting (USFWS, 1983e) (USFWS, 2015bj).

Plants

Nine endangered and eight threatened plant species are listed and known to occur in Virginia (Table 15.1.6-11). The 17 plant species listed all have different ranges throughout the state from the Appalachian Mountains in the west to regions of the Chesapeake Bay in the east. Information on the habitat, distribution, and threats to the survival and recovery of each is provided below.

Table 15.1.6-11: Federally Listed Plant Species of Virginia

Common Name	Scientific Name	Federal Status	Critical Habitat	Habitat Description
Eastern Prairie Fringed Orchid	*Platanthera leucophaea*	Threatened	No	Occurs in a wide variety of habitats from mesic prairies to wetlands.
Harperella	*Ptilimnium nodosum*	Endangered	No	Shallow ponds in hilly terrain and along gravelly stream-banks of swift moving water; found in Stafford County.
Michaux's Sumac	*Rhus michauxii*	Endangered	No	Sandy or rocky in open woods; found in Brunswick, Dinwiddle, and Nottoway counties.
Northeastern Bulrush	*Scirpus ancistrochaetus*	Endangered	No	Palustrine wetlands and vernal ponds; found in central Virginia.
Peter's Mountain Mallow	*Iliamna corei*	Endangered	No	Northwest-facing slopes; found in Peter’s Mountain in Giles County.
Roan Mountain Bluet	*Hedyotis purpurea var. montana*	Endangered	No	Rocky exposures at high elevations; found in the Appalachian Mountains.
Rock Gnome Lichen	*Gymnoderma lineare*	Endangered	No	Rocky exposures at high elevations; found in the Appalachian Mountains.

Common Name	Scientific Name	Federal Status	Critical Habitat	Habitat Description
Seabeach Amaranth	*Amaranthus pumilus*	Threatened	No	Coastal areas of barrier beaches; found in Northampton and Accomack Counties.
Sensitive Joint-vetch	*Aeschynomene virginica*	Threatened	No	Sediments in intertidal zones and salty rivers; found in the eastern regions of Virginia.
Shale Barren Rock Cress	*Arabis serotina*	Endangered	No	Shale barrens with open, scrubby vegetation and pine, oak, and other woodland species; found in northcentral Virginia.
Small Whorled Pogonia	*Isotria medeoloides*	Threatened	No	Hardwood stands that include beech, birch, maple, oak, hemlock, and hickory; found in 20 counties throughout the state.
Small-anthered Bittercress	*Cardamine micranthera*	Endangered	No	Stream beds and sandbars; found along the Dan River basin.
Smooth Coneflower	*Echinacea laevigata*	Endangered	No	Open woods, glades, cedar barrens, dry limestone bluffs, and roadsides; found in Upper Roanoke, Middle Roanoke, and Upper Dan watersheds.
Swamp Pink	*Helonias bullata*	Threatened	No	Forested wetlands; found within the southern Appalachian Mountains.
Virginia Round-leaf Birch	*Betula uber*	Threatened	No	Creek watershed in rocky soils; found in Cressy Creek floodplain.
Virginia Sneezeweed	*Helenium virginicum*	Threatened	No	Wetlands and limestone ponds; found in the Shenandoah Valley.
Virginia Spiraea	*Spiraea virginiana*	Threatened	No	Rocky often flood scoured banks of high velocity streams and rivers; found along the Appalachian Mountains.

Source: (USFWS, 2015d)

Eastern Prairie Fringed Orchid. The threatened eastern prairie fringed orchid (*Platanthera leucophaea*), also known as the eastern prairie orchid, is an upright plant that grows up to 40 inches tall. It has a single flower spike that has as many as 40 white flowers containing a three-part fringed lip and a one to two inch tube-like nectar spur (USFWS, 2015bk). The species was first listed in 1989 (54 FR 39857-39863, September 28, 1989). The eastern fringed prairie orchid is known or believed to occur in Illinois, Indiana, Iowa, Maine, Michigan, Missouri, Ohio, Virginia, and Wisconsin. Within Virginia, the species is known or believed to occur in Augusta, Staunton, and Waynesboro counties.

The prairie orchid grows in a variety of habitats, from wetlands to prairies and requires full sun. Seedlings require soil fungi (called mycorrhizae) to establish themselves and develop more complete root systems. Seed capsules mature over the growing season and are dispersed by the wind from late August through September (USFWS, 2015bl). Plants may only flower once every few years. Threats to the eastern prairie orchid include altered hydrology, invasive plant species, succession to woody vegetation, foot traffic, and collection (USFWS, 1999b).

Harperella. Harperella (*Ptilimnium nodosum*), or pond harperella, is a perennial herb that grows between half a foot and three feet tall. Its thin stalks have quill-like leaves and end in small white flowers with typically five petals each (USFWS, 2015bm). The species was listed as endangered in 1988 within the Northeast Region (53 FR 37978-37982, September 28, 1988). Harperella's range reaches down the east coast from Maryland down to Georgia and extends across to Oklahoma. Within Virginia, Harperella is known or believed to exist in Stafford County, located in the eastern regions of the state, inland from Chesapeake Bay (USFWS, 2015cf).

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 destroyed due to aforementioned reasons by either overwhelming water coverage or severe dehydration can detrimentally impact the species' survival, as even natural water changes can remarkably influence a subpopulation's survival (USFWS, 2015bm).

Michaux's Sumac. The endangered 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 flowers within the same plant, which flower in June and July and produce a red drupe fruit in August through October (USFWS, 2015bn). Michaux's sumac was listed as endangered in 1989 (54 FR 39850-39857, September 29, 1989). This species is endemic to the coastal plain and piedmont of Virginia, and is distributed throughout the Atlantic coastal plains in the southern U.S. The largest known population is located at Fort Pickett, Virginia (USFWS, 2015bn).

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

Northeastern Bulrush. The endangered northeastern bulrush (*Scirpus ancistrochaetus*) is a member of the sedge family and is a leafy perennial herb up to 48 inches in height with brown florets and thistles (USFWS, 1993b). The northeastern bulrush was listed as endangered in 1991 (56 FR 21091 21096, May 7, 1991). The northeastern bulrush is known to occur from New Hampshire south to Virginia. In Virginia, the species is known to occur in eight counties. (USFWS, 2015bo)

The northeastern bulrush occurs in palustrine wetlands and vernal ponds with seasonally fluctuating water levels and surrounded by woodlands. The current threats to the northeastern bulrush include alterations to the surrounding hydrology,[115] either by drier or wetter conditions (USFWS, 2015bo).

Peter's Mountain Mallow. The endangered Peter's Mountain mallow (*Iliamna corei*) is a herbaceous perennial up to 3.5 feet tall with maple-like leaves and large pink odorless flowers (USFWS, 2010d). Peter's Mountain mallow was listed as endangered in 1986 (51 FR 17343-

[115] Hydrology: "The way water moves and is distributed via precipitation, runoff, storage and evaporation" (USEPA, 2015c)

17346, May 12, 1986). Peter's Mountain mallow is only known to occur on Peter's Mountain in Giles County, Virginia (VDCR, 2008).

The species' habitat is found on the northwest-facing sandstone slopes at approximately 3,000 feet above sea level and prefers direct sunlight. Threats to the species include wildland fire, weak seed dispersal, competition from other plant species, and canopy shading (USFWS, 2010d).

Roan Mountain Bluet. The endangered Roan Mountain bluet (*Hedyotis purpurea var. montana*) contains larger funnel-shaped red-purple flowers, small oval leaves, and small round fruit (USFWS, 2011e). Roan Mountain bluet was listed as endangered in 1996 (55 FR 12793-12797, April 5, 1996). The Roan Mountain bluet is known to occur in high mountains of North Carolina, Tennessee, and Virginia. In Virginia, the Roan Mountain bluet is only believed to occur in Grayson County (USFWS, 2015bp).

Suitable habitat includes rocky exposures at high elevations above 4,000 feet above mean sea level. Threats to the species include development, and human recreational activities at trail-side locations (USFWS, 2011e).

Rock Gnome Lichen. The endangered rock gnome lichen (*Gymnoderma lineare*) grow in dense colonies and contain small narrow blue-grey strap-like lobes (USFWS, 2015bq). The rock gnome lichen was listed as endangered in 1995 (60 FR 3557-3562, January 18, 1995). The rock gnome lichen is known to occur throughout the Appalachian Mountains (USFWS, 2015bq). In Virginia, the rock gnome lichen only occurs in Grayson County (USFWS, 2015br).

Habitat for the rock gnome lichen is limited to vertical rock faces where water seeps flow during wet periods and generally occurs in areas of high elevation and with high humidity. The greatest threat to the rock gnome lichen is from human activities in recreational trail areas, as well as development, and lack of canopy shading (USFWS, 2015bq).

Seabeach Amaranth. The threatened seabeach amaranth (*Amaranthus pumilus*) is an annual plant with pinkish-red stems and small rounded leaves up to one inch in diameter. Flowers are small and yellow and inconspicuous. The seabeach amaranth flowers in June and July and continues to flower until their death in the fall (USFWS, 2015bs). The seabeach amaranth was listed as threatened in 1993 (58 FR 18035-18042, April 7, 1993). Seabeach amaranth occurs on coastal areas between New York and South Carolina. In Virginia, seabeach amaranth only occur in coastal areas of Northampton and Accomack Counties (USFWS, 2015bs).

This annual grows in coastal areas along barrier beaches just above the high tide line spreading close to the ground. This species shares habitat with other protected species such as the piping plover and roseate tern. The plants trap sand and subsequently can create mounds up to three cubic yards in size. Threats to seabeach amaranth include beach stabilization structures, off-road vehicles, habitat fragmentation, and insects that prey heavily on the plants (USFWS, 2015bs).

Sensitive Joint-vetch. The threatened sensitive joint-vetch (*Aeschynomene virginica*) is an annual plant from the legume family that can grow up to 6 feet tall. It has yellow pea-shaped flowers during the months of July to October (USFWS, 2010e) (USFWS, 2015bt). The species was listed in 1992 as threatened (57 FR 21569-21574, May 20, 1992). Sensitive joint-vetch are

found in four states: Maryland, New Jersey, North Carolina, and Virginia. In Virginia, they have been observed sporadically in 12 counties located throughout the state (USFWS, 2015cg).

They are found throughout the outer fringes of the intertidal zone from fresh water to salty tidal rivers and marshes on accumulated sediment. These sites are nutrient deficient, and may suffer from muskrat herbivory.[116] Threats include dredging and filling marshes, dam construction, shoreline stabilization, human development, sedimentation, invasive species and salt-water intrusion from sea level rise (USFWS, 2010e) (USFWS, 2015bt).

Shale Barren Rock Cress. The endangered shale barren rock cress (*Arabis serotina*) is a member of the mustard family and is a biennial plant with a flowering stem composed of 3 to 41 branches. Flowers are small with cream-white petals and yellowish-brown seeds (USFWS, 2015bu). Mature plants reach up to 40 inches in height. The shale barren rock cress was listed as endangered in 1989 (54 FR 29655-29658, July 13, 1989). This species only occurs in restricted populations in the states of Virginia and West Virginia, in the mid-Appalachian shale barrens[117] (USFWS, 2015bu).

Suitable habitat is limited to the shale barrens with open, scrubby vegetation and pine, oak, and other woodland species (USFWS, 1991c). Shale barrens are also isolated islands of habitat with steep elevations and exposures with relatively sparse vegetation, high temperatures, and low moisture (USFWS, 2015bu). Threats to the species include drought, herbivory by deer, and habitat degradation (USFWS, 1991c).

Small Whorled Pogonia. The threatened small whorled pogonia is a member of the orchid family which grows between 10 to 14 inches in height with greenish yellow flowers (USFWS, 2015bv). 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 eastern to Illinois (USFWS, 2016b). In Virginia, the small whorled pogonia is known to occur in 20 counties throughout the state (USFWS, 2015bv) (USFWS, 2016b).

The small whorled pogonia occurs in hardwood stands that include 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. One distinct feature of this species is that it can remain dormant underground for multiple years before reappearing (USFWS, 1992b). Current threats to small whorled pogonia include habitat loss due to urban expansion and forestry practices (USFWS, 2015bv).

Small-anthered Bittercress. The endangered small-anthered bittercress (*Cardamine micranthera*) is a slender perennial herb with fiberous roots and one branch stem that grows up to 15.8 inches in height, and basal leaves up to two inches in diameter (USFWS, 2006). The snall-antered bittercress was listed as endangered in 1989 (54 FR 38947-38950, September 21, 1989). The small-anthered bittercress only occurs in the Dan River basin in south central Virginia (Stokes County) and north central North Carolina (USFWS, 2015bw).

[116] Heavy eat-outs of vegetative regrowth in wetlands by specific species.
[117] Steep slopes of exposed shale.

Suitable habitat for the small-anthered bittercress include seepages,[118] wet rock crevices, stream banks, sandbars, and wet woods along streams. Threats to the species include channelization and impoundments, water quality problems, encroachment of invasive species, and herbicides from adjacent agricultural fields (USFWS, 2015bw).

Smooth Coneflower. The endangered smooth coneflower (*Echinacea laevigata*) is a perennial herb in the aster family that grows up to 3.3 feet from a vertical root stock and 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, 2015bx). 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. (USFWS, 2015bx). Populations in Virginia are found in Upper Roanoke, Middle Roanoke, and Upper Dan watersheds (VDCR, 2015d).

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 (USFWS, 2015bx).

Photo credit: FWS

Swamp Pink

Swamp Pink. The threatened swamp pink (*Helonias bullata*) is an obligate wetland species[119] 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, 2015by). The swamp pink was federally listed as threatened in 1988 (53 FR 35076-35080, September 9, 1988). The swamp pink is found on the coastal plains of three states (Delaware, New Jersey, and Maryland) and isolated spots of the southern Appalachian Mountains. Within Virginia the species is found in four counties: Augusta, Nelson, Caroline, and Henrico (VDCR, 2015e).

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, 2015by).

Virginia Round-leaf Birch. The threatened Virginia round-leaf birch (*Betula uber*) is a deciduous single-trunk tree that reaches approximately 50 feet in height and has dark brown bark (USFWS, 2015bz). The Virginia round-leaf birch was listed as threatened in 1978 (43 FR 17910, May 27, 1978). The Virginia round-leaf birch only occurs in Virginia, in Smyth County along the Cressy Creek floodplain. The tree was discovered in 1918 and was not seen again until 1975.

[118] Water from an underground source seeps to the surface.
[119] 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." (USACE, 2012)

In 2005, there were nearly 1,000 artificially propagated trees in the wild and in botanical gardens (USFWS, 2005b).

Suitable habitat for the Virginia round-leaf birch is within the forest band along the creek watershed in rocky soils (USFWS, 2015bz). Threats include fire, drought, flooding, and human activity such as vandalism (USFWS, 2005b).

Virginia Sneezeweed. The threatened Virginia sneezeweed (*Helenium virginicum*) is an herbaceous plant with yellow flowers that grows to a height of 3.5 feet. The Virginia sneezeweed was listed as threatened in 1998 (63 FR 59239-59244, November 11, 1998). This species is found in along the western edge of the Blue Ridge Mountains in the Shenandoah Valley (USFWS, 2010f).

Suitable habitat for the Virginia sneezeweed includes wetlands and the shores of shallow limestone ponds. Threats include habitat loss from development, logging, off-road vehicles, and incompatible agricultural practices (USFWS, 2010f).

Virginia Spiraea. The threatened Virginia spiraea is a perennial shrub species with many branches. The shrub ranges in height from three to seven feet tall with elliptic leaves two to three inches long. The shrub's white flowers appear in June and July at the ends of branches (USFWS, 2015ca). The Virginia spiraea was first listed as threatened by endangered species legislation in 1990 (55 FR 24241-24247, June 15, 1990). Regionally the species occurs along 24 stream systems in Georgia, Tennessee, North Carolina, Kentucky, West Virginia, Virginia, and Ohio. In Virginia, it is known to occur along the Appalachian Mountains within the counties of Carrol, Dickenson, Grayson, and Wise (USFWS, 2015ca).

The Virginia spiraea inhabits rocky often flood scoured banks of high velocity streams and rivers. It is believed that scour is important to the species as it discourages tree growth and prevents canopy closure. Flood frequency and intensity have a large influence on development of suitable habitat for the species. Major threats to the species include dam and reservoir construction that remove or eliminate the species habitat altogether. Damage to the plants from people using the river for recreation is another common threat. Physical damage to the plant stems from hikers, fishermen, boaters, and rafters has been observed at many documented sites of Virginia spiraea. This activity is often a result of an attempt to clear the river bank for fishing or camping sites (USFWS, 2015ca).

15.1.7. Land Use, Recreation, and Airspace

15.1.7.1. Definition of the Resources

The following summarizes major land uses, recreational venues, and airspace considerations in Virginia, 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" (FAO, 2017) . 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 man-made 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, beaches, caves, lakes, forests, recreational facilities, museums, historic sites, and other areas/facilities (OECD, 2003). Recreational resources are typically managed by state, county, or local governments.

Descriptions of land uses are presented in three primary categories: forest and woodlands, 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.

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, 2015). 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 responsible for 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, 2015b) (FAA, 2016). The FAA works with state aviation officials and airport planners, military airspace managers, and other organizations in deciding how best to use airspace.

15.1.7.2. 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 Virginia. However, most site-specific land use controls and requirements are governed by local county, city, and village laws and regulations. Land use planning in Virginia is the primary responsibility of local governments (i.e., county, city, and town). The main planning tools for local governments include the comprehensive plan, zoning ordinance, and subdivision ordinance. The Code of Virginia sets forth the authority for each of these tools. The comprehensive plan provides guidance for the zoning ordinance and subdivision ordinance; it proposes land uses and locations of public facilities and utilities and projects long-term population growth. The zoning ordinance sets forth the rules used to govern the land by dividing localities into zoning districts and establishes allowable uses within the districts (e.g., agriculture, industry, commercial use). The subdivision ordinance manages the process for dividing large land parcels into smaller lots (Chesapeake Bay Foundation, 2003).

Because the Nation's airspace is governed by federal laws, there are no specific Virginia State laws that would alter the existing conditions relating to airspace for this Draft PEIS. However, Code of Virginia Title 5.1 Aviation, Chapter 1 addresses the State’s code concerning obstructions to air navigation (Virginia Law, 2015c).

15.1.7.3. Land Use and Ownership

For the purposes of this analysis, land use in Virginia has been classified into three primary land use groups: forest and woodlands,[120] agricultural,[121] and developed.[122] Land ownership within Virginia has been classified into four main categories: private, federal, state, and tribal.

[120] Forest and woodlands: Areas characterized by tree cover (natural or semi-natural woody vegetation, generally greater than 6 meters tall); tree canopy accounts for 25-100 percent of the cover. (USGS, 2012a)
[121] Agricultural: Areas characterized by herbaceous vegetation that has been planted or is intensively managed for the production of food, feed, or fiber; or is maintained in developed settings for specific purposes. Herbaceous vegetation accounts for 75-100 percent of the cover. (USGS, 2012a)
[122] Developed: Areas characterized by a high percentage (30 percent or greater) of constructed materials (e.g., asphalt, concrete, buildings, etc.). (USGS, 2012a)

Land Use

Forest and woodland comprises the largest portion of land use, with 63.0 percent of the land area in Virginia occupied by this category. Agriculture is the second largest area of land use with 22.1 percent of the total land area. Developed areas and surface water account for approximately 13.6 percent and 1.2 percent, respectively, of the total land area in Virginia. The remaining percentage of land includes public land and other land covers that are not associated with specific land uses, equating to approximately 0.1 percent of Virginia's land area (Table 15.1.7-1 and Figure 15.1.7-1 (USGS, 2012a).

Table 15.1.7-1: Virginia Land Use

Land Use	Square Miles	Percent of Land
Forest and Woodland	24,953	63.0%
Agricultural Land	8,747	22.1%
Developed Land	5,351	13.6%
Surface Water	480	1.2%
Other	63	0.1%

Source: (USGS, 2012a)

Forest and Woodland

Forest and woodland areas occur throughout the State and are interspersed with agricultural areas. The most forested areas are located in the Blue Ridge and the Appalachian Mountains (USGS, 2012a). Most forest and woodland areas throughout Virginia are privately owned (approximately 83 percent). Approximately 17 percent of forest and woodland areas are publicly owned by federal and state agencies (Virginia Department of Forestry, 2015a). Section 15.1.6.3, Vegetation, presents additional information about vegetation.

National Forests

Two National Forests are located in Virginia: The George Washington and Jefferson National Forests. These National Forests stretch along the Appalachian Mountains, covering large portions of Virginia (2,616 sq. mi.), West Virginia (193 sq. mi.), and Kentucky (1.5 sq. mi.). The forests are comprised of Appalachian hardwood and mixed pine-hardwood forest types, and are managed for multiple uses, including recreation activities (e.g., camping, hiking) and timber production. The forests include 325 miles of the Appalachian National Scenic Trail, 143 miles of National Recreation Trails, the Mount Rogers National Recreation Area (219 sq. mi.), three National Scenic Areas, three National Forest Byways, 23 Wilderness areas, and 1,094 square miles managed for the production of timber and wood products (USFS, 2015a).

State Forests

The Virginia Department of Forestry manages 24 state forests throughout Virginia, totaling 107 square miles. These forests are managed for multiple-use purposes, including general recreation (e.g., hiking and wildlife viewing), timber production, hunting, forest research/educational purposes, watershed protection, and wildlife habitat. Table 15.1.7-2 presents the names and associated square miles for each of the 24 state forests (Virginia Department of Forestry, 2015a).

Table 15.1.7-2: Virginia State Forests

State Forest	Square Miles
Appomattox-Buckingham State Forest	31
Big Woods State Forest	3.4
Bourassa State Forest	0.45
Browne State Forest	0.2
Channels State Forest	7.6
Chesterfield State Forest	0.7
Chilton Woods State Forest	0.6
Conway Robinson State Forest	0.7
Crawford's State Forest	0.4
Cumberland State Forest	25.3
Devil's Backbone State Forest	0.9
Dragon Run State Forest	15
Hawks State Forest	0.2
Lesesne State Forest	0.7
Matthews State Forest	0.9
Moore's Creek State Forest	3.7
Niday Place State Forest	0.4
Old Flat State Forest	0.5
Paul State Forest	0.3
Prince Edward-Gallion State Forest	10.1
Sandy Point State Forest	3.2
South Quay State Forest	0.4
Whitney State Forest	0.2
Zoar State Forest	0.6

Source: (Virginia Department of Forestry, 2015b)

Private Forest and Woodland

Approximately 20,711 square miles, or 83 percent, of Virginia's total forestland is owned by private landowners (66 percent), private companies (4 percent), and corporations (13 percent) (Virginia Department of Forestry, 2015a). 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 15.1.6.3, Vegetation, and Section 15.1.8, Visual Resources.

Agricultural Land

Agricultural land exists throughout the State on 8,747 square miles, or 22 percent of the total land area (Table 15.1.7-1) (USGS, 2012a). Approximately 46,000 farms exist in Virginia, of which approximately 90 percent are owned by individuals and families. Agriculture is Virginia's largest industry, employing 55,000 farmers and workers. Virginia's top ten agricultural commodities are broilers, cattle, milk, soybeans, turkeys, greenhouse/nursery products, corn/grain, hay, wheat, and tobacco (VDACS, 2015).

Developed Land

Developed land in Virginia is concentrated within major metropolitan areas and surrounding cities, towns, and suburbs (Table 15.1.7-3). Although only 14 percent of Virginia land is developed, these areas are highly utilized for residential, commercial, industrial, recreational, and government purposes. Table 15.1.7-3 lists the top five developed areas within the state and their associated population estimates.

Table 15.1.7-3: Top Five Developed Areas in Virginia

City	Population Estimate
Virginia Beach	450,980
Chesapeake	233,371
Richmond	217,853
Newport News	182,965
Alexandria	150,575
Total Estimated Population in Developed Areas	**1,235,744**
Total State Estimated Population[a]	**8,326,289**

Source: (U.S. Census Bureau, 2014)

[a] The estimated population in 2016 was 8,411,808

Land Ownership

Land ownership within Virginia is classified into four main categories: private, federal, state, and tribal land (Figure 15.1.7-2).

Private Land

The majority of land in Virginia is privately owned, with most of this land falling under the land use categories of agricultural, forest and woodland, and developed (Figure 15.1.7-1). Highly developed, urban, metropolitan areas transition into suburban, agriculture, forest, and woodland areas, which then transition into more wild and remote areas.

Federal Land

The federal government manages 3,829 square miles of land in Virginia, including national parks and monuments, military bases, national wildlife refuges, and national forests (USGS, 2014c). Five federal agencies manage federal lands throughout the state (Table 15.1.7-4).

Table 15.1.7-4: Federal Land in Virginia

Agency	Square Miles	Type
Department of Defense	504.3	Military Bases
U.S. Fish and Wildlife Service	196	Wildlife Refuges
U.S. Forest Service	2,616	National Forests
National Park Service	510.4	Parks, Monuments, Historic Sites, Trails, Parkways, Seashore
Tennessee Valley Authority	2.3	Reservoirs
Total	3,829	

Source: (USGS, 2014c)

The following is a brief description of federal land ownership in Virginia:

- The Department of Defense owns and manages 504.3 square miles of land used for military bases, forts, airports, and ammunition manufacturing sites (USGS, 2014c).
- The U.S. Fish and Wildlife Service owns and manages 196 square miles of land comprised of 14 National Wildlife Refuges (USGS, 2014c).
- The U.S. Forest Service owns and manages 2,616 square miles of land comprised of the George Washington and Jefferson National Forests (USGS, 2014c).
- The National Park Service manages 510.4 square miles of land comprised of one National Park, one National Seashore, two National Scenic Trails, five National Historic Trails, seven National Historic Parks, two National Parkways, three National Monuments, one National Military Park, one National Historic Site, three National Battlefields, and other affiliated locations managed by the NPS (NPS, 2015d).
- The Tennessee Valley Authority manages 2.3 square miles comprised of the Clear Creek and Beaver Creek Reservoirs (Tennessee Valley Authority, 2015).

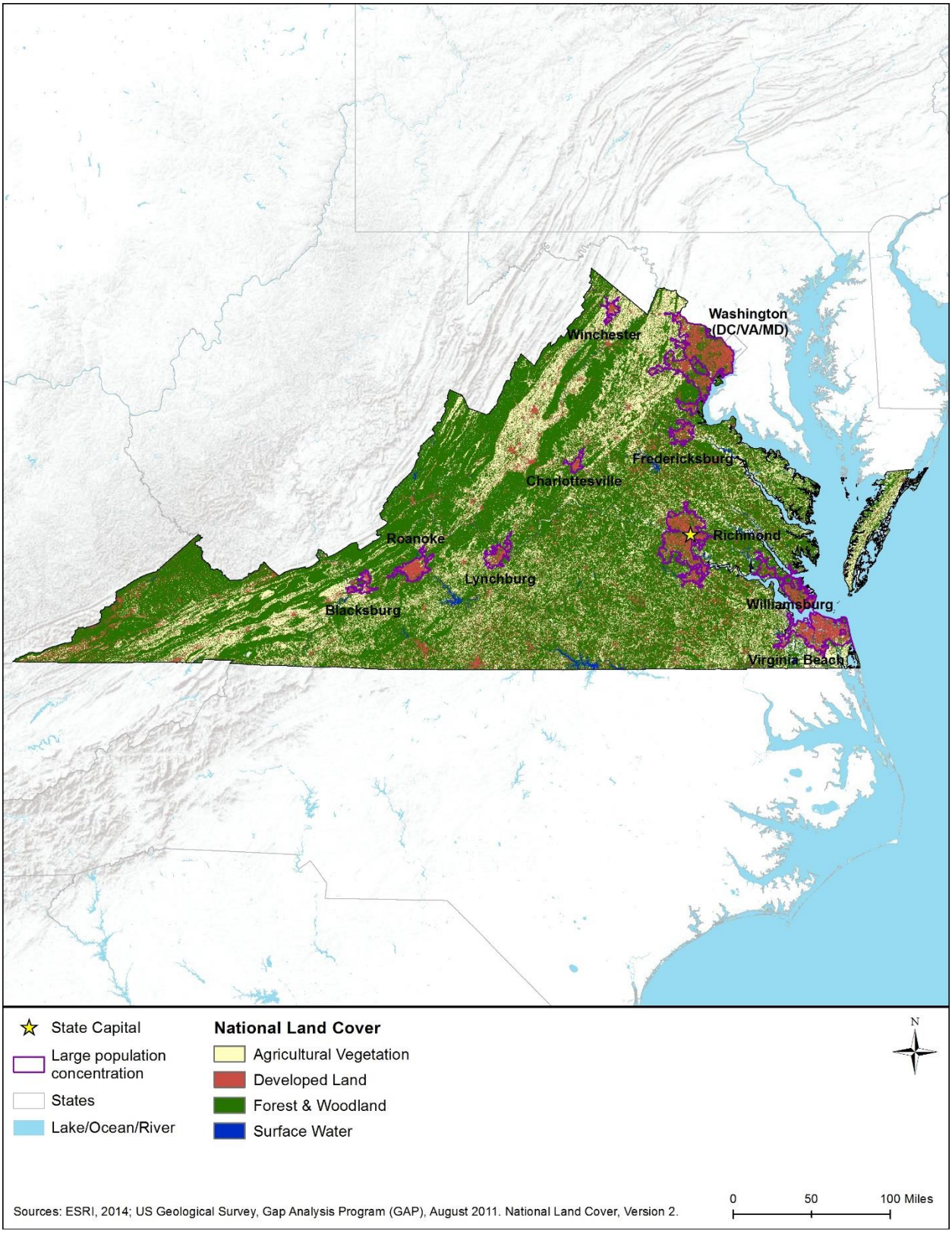


Figure 15.1.7-1: Land Use Distribution

State Land

The Virginia State government manages approximately 638.7 square miles of land comprised of state forests, state parks, and wildlife management areas. These areas are managed primarily by three state agencies: Virginia Department of Forestry, Virginia Department of Conservation and Recreation, and Virginia Department of Game and Inland Fisheries (VDCR, 2015f).

- The Virginia Department of Forestry manages 24 state forests, totaling 107 square miles.
- The Virginia Department of Conservation and Recreation manages 36 State Parks, including campgrounds, cabins, and hiking trails.
- The Virginia Department of Game and Inland Fisheries manages 40 wildlife management areas totaling more than 313 square miles. These areas are managed to maintain healthy fish and wildlife habitat and provide for a variety of wildlife-related recreational opportunities (VDGIF, 2017q).

Tribal Land

Two American Indian tribes own land in Virginia. The Mattaponi Tribe, which is not a federally recognized tribe, owns property that is one of the oldest American Indian properties in the U.S. and is home to approximately 75 tribal members. The property includes a church, a museum, pottery shops, the Fish Hatchery and Science Facility, and a community tribal building. The second tribe that owns property in Virginia is the federally recognized Pamunkey Tribe. Approximately 36 tribal members live on the Pamunkey Tribe reservation (NPS, 2015c). See Section 15.1.11, Cultural Resources, for more information about these tribes.

15.1.7.4. Recreation

Virginia is diverse state, containing the densely-populated Washington, DC metropolitan area and Richmond-Petersburg Metropolitan Statistical Area, the southern portion of the Delmarva shoreline, and sparsely populated areas in central and southern portions of the state. The state is characterized by the Atlantic Ocean and the Chesapeake Bay, which border to the state on the east, and the Blue Ridge Mountains, located in the western and northern portions of the state. Virginia is also characterized by its importance during the Civil War; more than 2,000 military events occurred in Virginia, and many of these sites are popular destinations (Civil War Traveler, 2015). 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 public lakes. Availability of community-level facilities is typically commensurate to the population's needs.

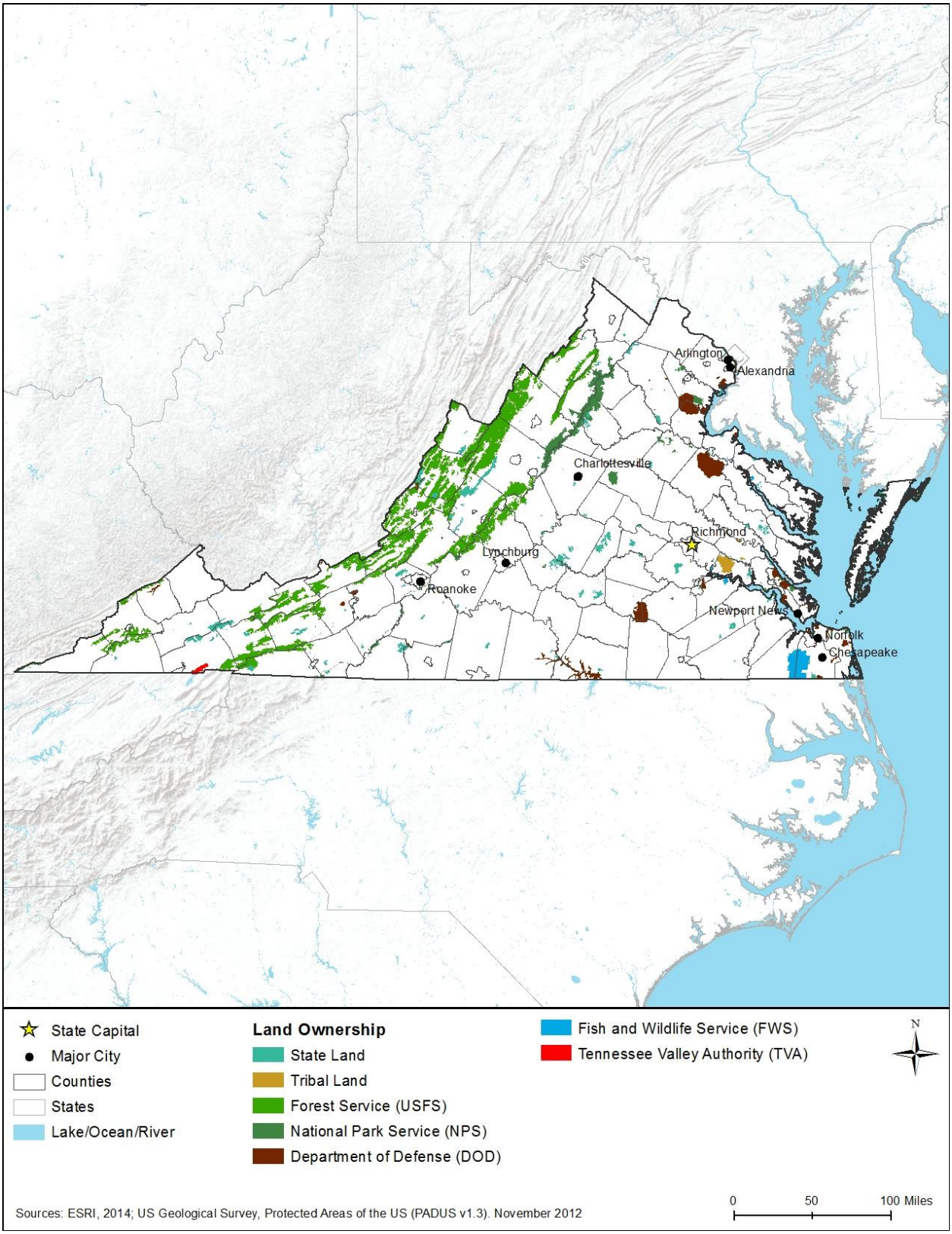


Figure 15.1.7-2: Land Ownership Distribution

This section discusses recreational opportunities available at various locations throughout Virginia. The discussion presents information for six geographic regions in the state. For information on visual resources, see Section 15.1.8, Visual Resources, and for information on the historical significance of locations, see Section 15.1.11, Cultural Resources.

Southwest Region

The Southwest Region is sparsely populated, as it has the largest portion of the Appalachian Mountains of any other region. The region is characterized by dense forests with popular hiking trails and rivers, such as the New River, used for fishing and boating.

The George Washington and Jefferson National Forests, managed as one entity, stretch along the northwestern boundary of Virginia. The forests consist of the Appalachian Mountains, and include the Virginia portion of the Appalachian Trail, the Virginia Creeper Trail, and the Mount Rogers Recreation Area. Containing mountain terrain, glacial lakes, and streams, the forests are known for outdoor recreation: hiking; mountain biking; camping; boating, fishing; swimming; seasonal, licensed big game and small game hunting; and skiing, snowboarding, cross-country skiing, and snowshoeing (USFS, 2015b). Area parks with hiking, boating, and fishing include the New River Trail, Wilderness Road, and Hungry Mother State Parks (VDCR, 2015g).

Blue Ridge Region

The Blue Ridge Region is named for the Blue Ridge Mountains, part of the Central Appalachians, which is the defining geography of the region. The largest region in the state, the Blue Ridge Region contains both areas visited for outdoor activities and connections to the Civil War. The Appomattox Court House National Historical Park has tours of several buildings and a hiking trail connecting historic sites within the village (NPS, 2015ab).

State parks including the Twin Lakes, Smith Mountain Lakes, and Occonoeechee State Parks surround lakes with boating, swimming, fishing, and hiking (VDCR, 2015g). The High Bridge Trail State Park contains the 31-mile High Bridge Trail for hiking, bicycling, and horseback riding (VDCR, 2015g). The Natural Bridge Park contains hiking trails, the Natural Bridge and the Natural Bridge Caverns (Virginia Tourism Corporation, 2015).

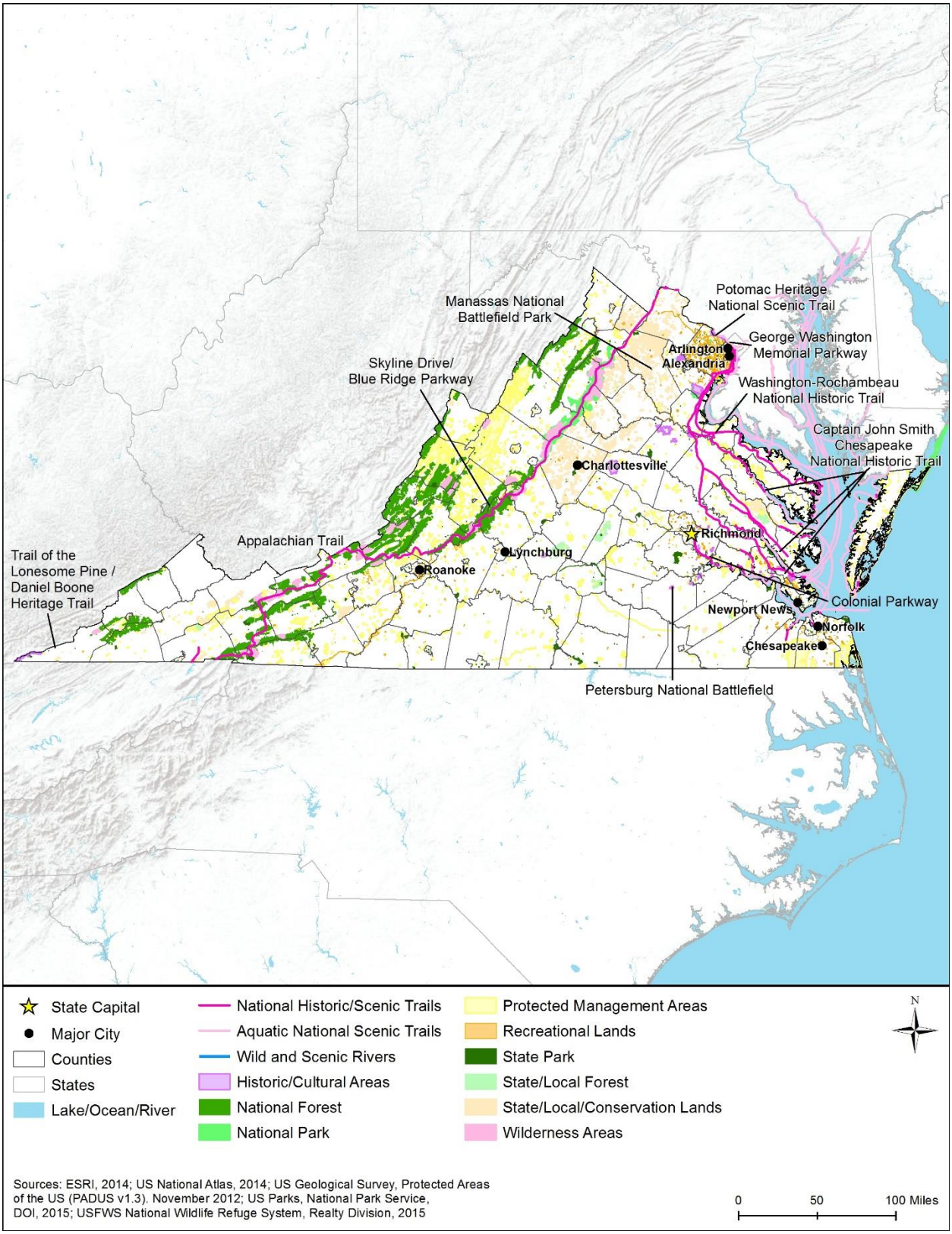


Figure 15.1.7-3: Virginia Recreation Resources

Valley Region

Virginia's Valley Region consists of the valleys and ridges of the Central Appalachians, reaching east to the edge of the Washington, DC Metropolitan Area and south to Charlottesville, known for the historic homes of former presidents. Thomas Jefferson's Monticello, James Madison's Ash Lawn-Highland, and James Monroe's Montpelier, are museums open to the public with hiking, picnicking, and other available recreational activities (The Jefferson Monticello, 2015) (Ash Lawn-Highland, 2015) (The Montpelier Foundation, 2015).

Shenandoah National Park is known for Skyline Drive, which leads to all points of interest within the park; camping, bicycling, hiking, rock climbing, horseback riding, wildlife viewing, and fishing are all available within the park (NPS, 2015e). The Douthat State Park, in the Blue Ridge Mountains, is notable for both stream and lake fishing; boating; camping; and hiking, horseback, and mountain biking trails (VDCR, 2015g).

Northern Region

Virginia's Northern Region primarily consists of the densely populated Washington, DC Metropolitan Area. Recreational opportunities within the Northern Region are multi-use recreation areas or are connected to the area's history. Historic homes open to the public include George's Washington's Mount Vernon and Robert E. Lee's Arlington House with the Arlington Cemetery, Netherlands Carillon, and the U.S. Marine Corps War Memorial (Iwo Jima Memorial) (NPS, 2015f). Manassas National Battlefield Park is known for battlefield tours and living history events, such as historical reenactments and demonstrations of musketry and artillery (NPS, 2015g).

State parks including Mason Neck, Lake Anna, Caledon, and Leesylvania State Parks have hiking trails, swimming, fishing, and boating (VDCR, 2015g). Trails that wind through the region include the Captain John Smith Chesapeake, Potomac Heritage National Scenic Trail, and Washington-Rochambeau (NPS, 2015h). Great Falls National Park is known for whitewater boating, hiking, bicycling, fishing, and horseback riding (NPS, 2015i).

Piedmont Region

The Piedmont Region stretches from the Potomac River south to North Carolina. This region is known for Civil War battlefields and other locations visited due to their historical significance. The City of Richmond is rich in recreational opportunities, including museums, the Richmond International Raceway, Colonial Downs, and the St. James River, popular for fishing, kayaking, and tubing (VDCR, 2015h).

The Richmond National Battlefield Park, a collection of 13 Civil War sites, has museums, ranger-led tours, and hiking and bicycle trails (NPS, 2015j). Sailor's Creek Battlefield State Park has hiking trails following the path of the Civil War and reenactments (VDCR, 2015g).

Tidewater Region

The easternmost region of Virginia is the Tidewater Region. It is bordered by the Chesapeake Bay and the Atlantic Ocean. This region is known for its beach cities, including Virginia Beach, historically significant destinations, and wildlife.

The Colonial National Historic Park contains the settlement of Jamestowne, the Yorktown Battlefield, the Cape Henry Memorial, and the Colonial Parkway connecting the three. The park is known for historical reenactments and tours, hiking, wildlife viewing and birdwatching (NPS, 2015k). Nearby Colonial Williamsburg is a living history museum, with tours and performances as well as recreational activities including spas and golf (The Colonial Williamsburg Foundation, 2015a).

Chincoteague National Wildlife Refuge, the Virginia section of the Assateague Island National Seashore, is one of the top visited National Wildlife Refuges with over 1.5 million annual visitors. Recreation on the island include beaches, swimming, boating, and paved trails for hiking and bicyclists, fishing and crabbing, and permitted seasonal hunting. The wild ponies of Assateague Island are a popular sight for visitors (USFWS, 2007b).

15.1.7.5. 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.

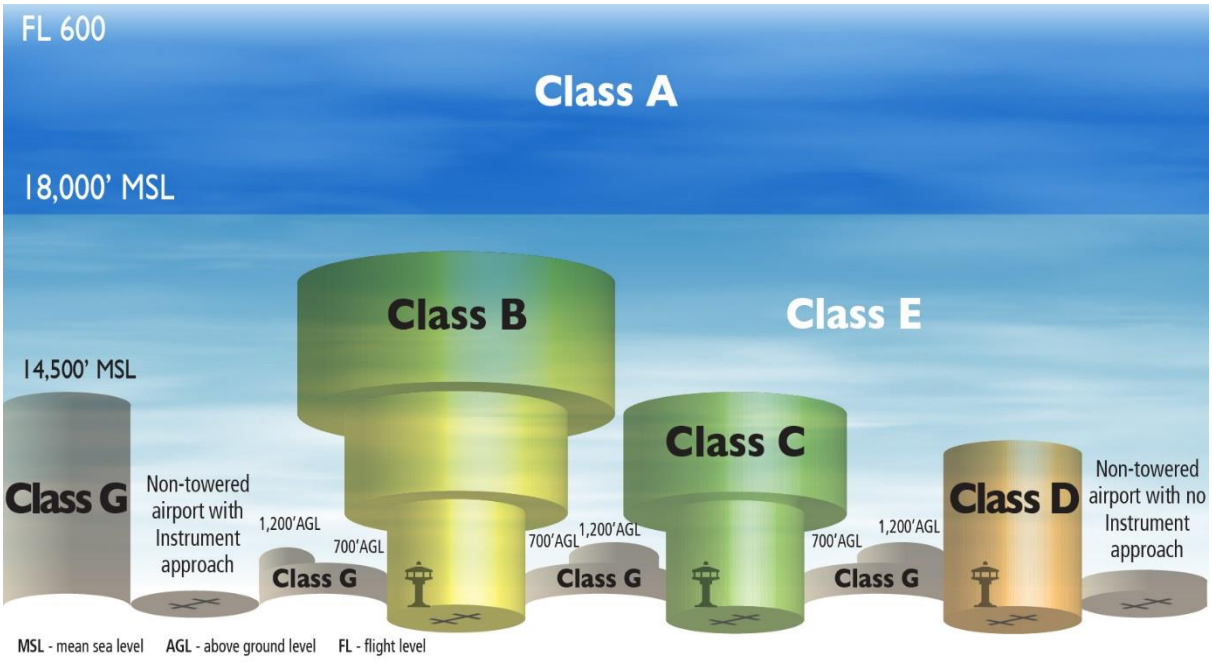
Within each of these two categories, there are four types of airspace: controlled, uncontrolled, special use, and other airspace. The categories and types of airspace are dictated by the complexity or density of aircraft movements, the nature of the operations conducted within the airspace, the level of safety required, and the national and public interest. Figure 15.1.7-4 depicts the different classifications and dimensions for controlled airspace. Air Traffic Control (ATC)[123] service is based on the airspace classification." (FAA, 2008).

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

Controlled Airspace

- **Class A:** Airspace from 18,000 feet to 60,000 feet Mean Sea Level (MSL).[124] 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).[125]
- **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).

[124] 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" (USEPA, 2015c)
[125] IFR - Rules for the conduct of flights under instrument meteorological conditions. (FAA, 2015g)



Source: Derived from (FAA, 2008)

Figure 15.1.7-4: National Air Space Classification Profile

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 15.1.7-5).

Table 15.1.7-5: 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."

SUA Type	Definition
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."

Source: (FAA, 2015c) (FAA, 2008)

Other Airspace Areas

Other airspace areas, explained in Table 15.1.7-6, 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 15.1.7-6: Other Airspace Designations

Type	Definition
Airport Advisory	There are 3 types: • Local Airport Advisory – Operated within 10 statute 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 the State of Hawaii declared national disasters for humanitarian reasons.

Type	Definition
	Only those TFRs annotated with an ending date and time of "permanent" are included in this Final 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.

Source: (FAA, 2015c) (FAA, 2008)

Aerial System Considerations

Unmanned Aerial Systems

Unmanned Aerial 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 UASs 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).

UASs 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. above ground level
- Any construction or alteration:
  - within 20,000 feet. 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 feet. 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.
  - within 5,000 feet 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
- Any construction or alteration located on a public use airport or heliport regardless of height or location." (FAA, 2015d)

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

Virginia Airspace

The Virginia Department of Aviation is responsible for providing a safe aviation system in the state, education, and efficient flight services. The Airport Services Division provides technical assistance with regard to planning, design, construction, and maintenance of airport facilities. The division "conducts statewide aviation system planning and maintains the Virginia Air Transportation System Plan" (Virginia Government, 2015). There are two FAA FSDOs for Virginia located in Richmond and Washington D.C. (FAA, 2015e).

Virginia 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 issues associated with their airports (NASAO, 2015). Figure 15.1.7-5 presents the different aviation airports/facilities located in Virginia, while Figure 15.1.7-6 and Figure 15.1.7-7 present the breakout by public and private airports. There are approximately 431 airports (public and private) within Virginia as presented in Table 15.1.7-7 and Figure 15.1.7-5 (USDOT, 2015b).

Table 15.1.7-7: Type and Number of Virginia Airports/Facilities

Type of Airport or Facility	Public	Private
Airport	64	226
Heliport	0	135
Seaplane	1	2
Ultralight	0	1
Balloonport	0	1
Gliderport	0	1
Total	65	366

Source: (USDOT, 2015b)

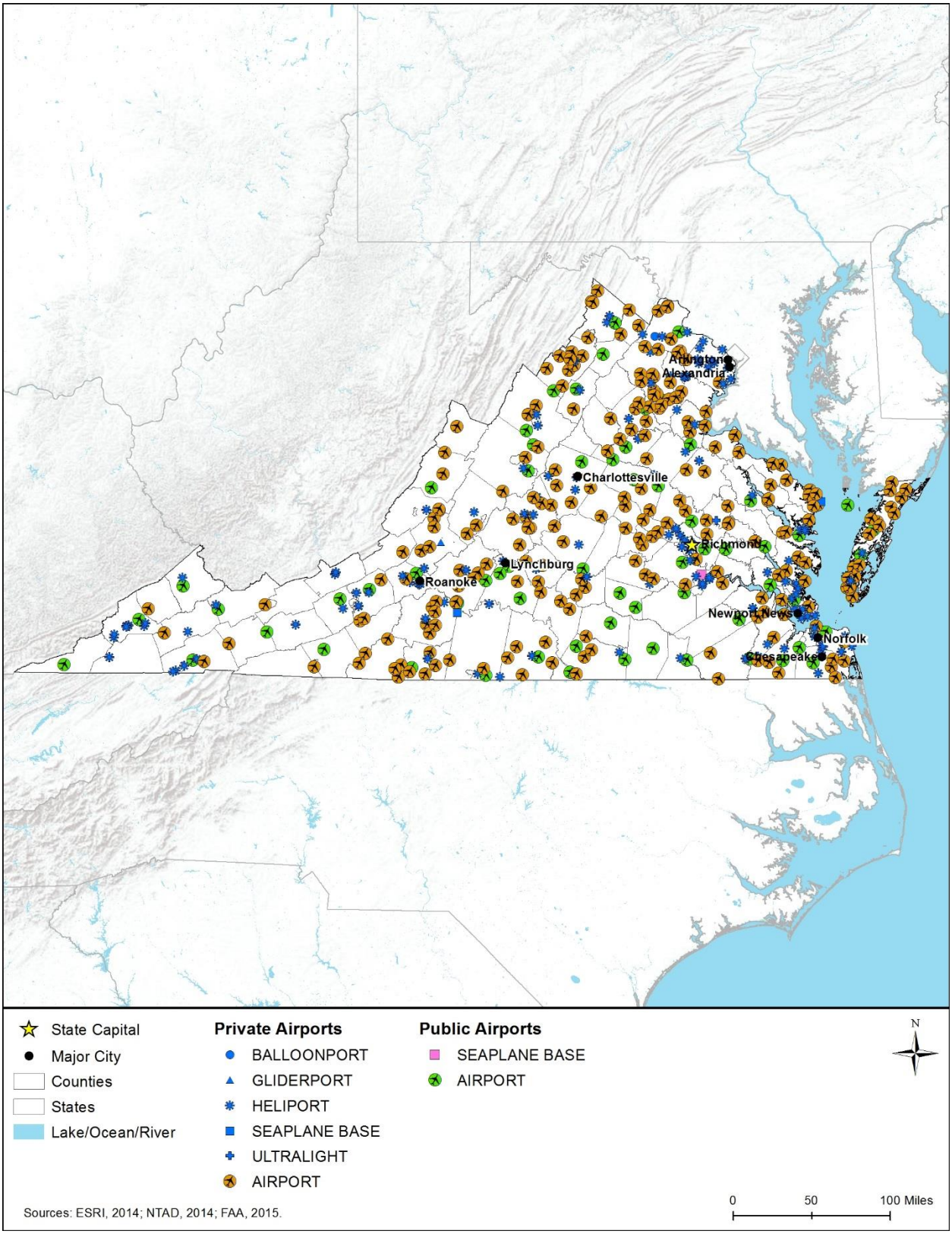


Figure 15.1.7-5: Virginia Public and Private Airports/Facilities

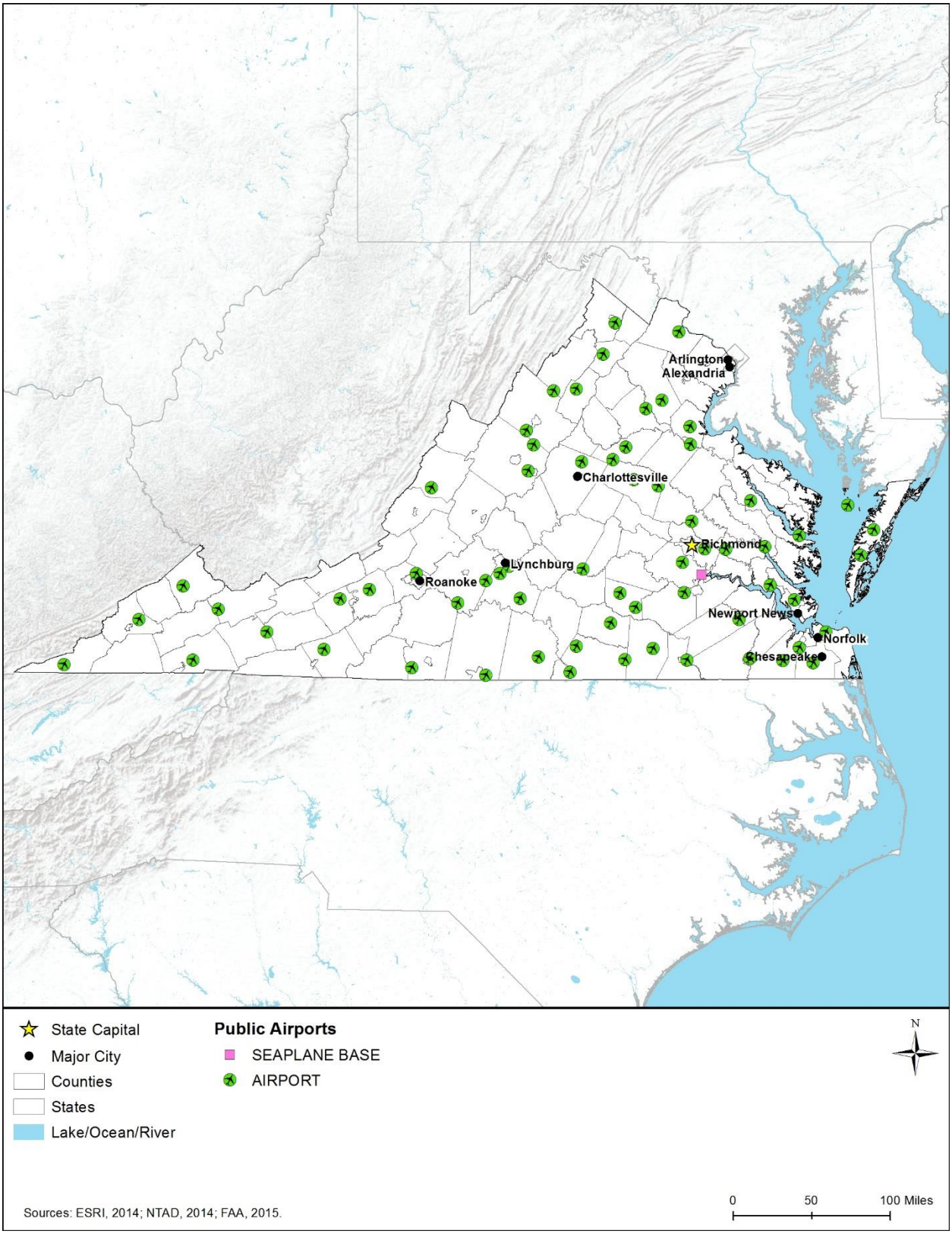


Figure 15.1.7-6: Public Virginia Airports/Facilities

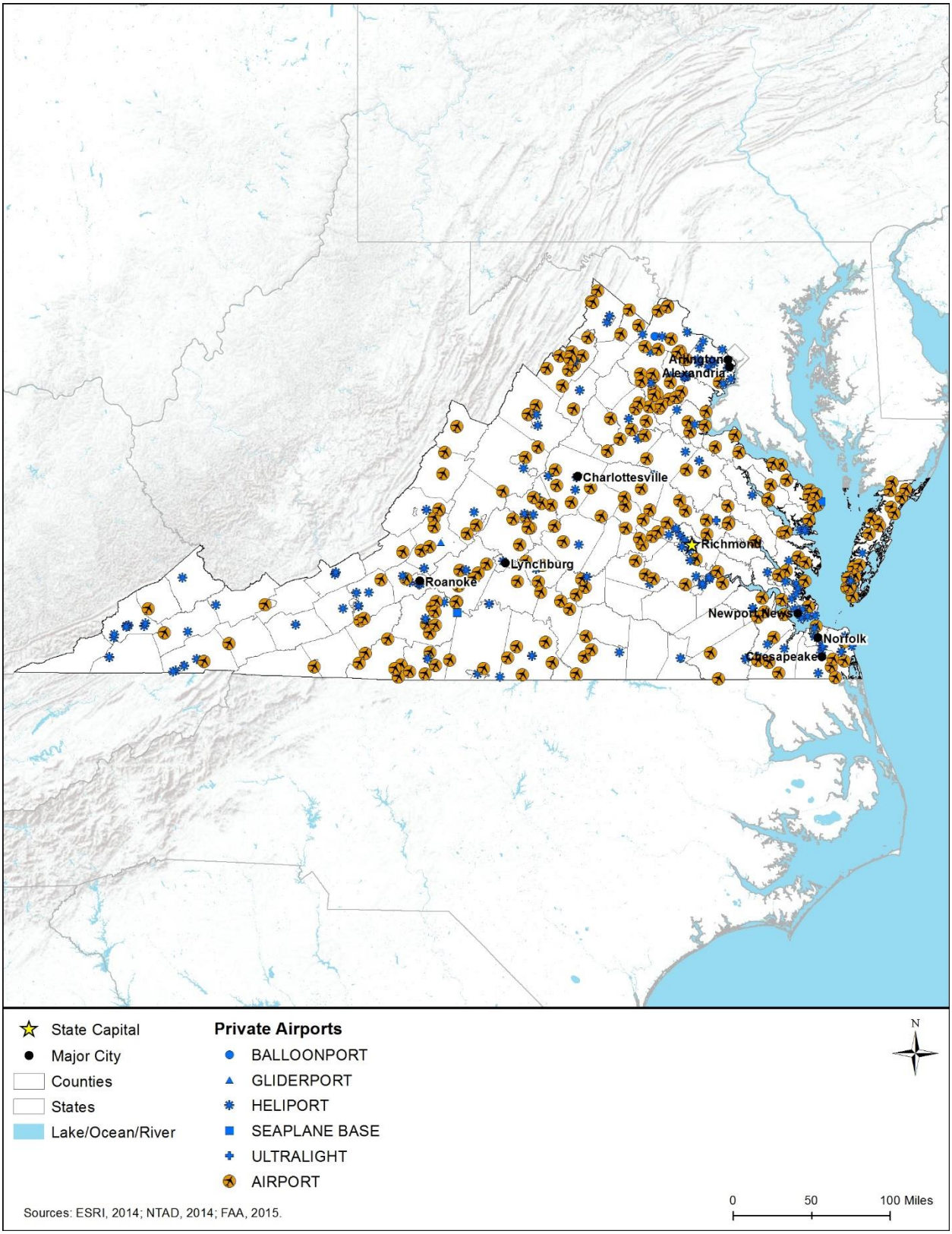


Figure 15.1.7-7: Private Virginia Airports/Facilities

There are Class C, D, and E airports in Virginia as follows:

- Three Class C –
  - Norfolk International Airport
  - Richard Evelyn Byrd International Airport (Richmond, VA)
  - Roanoke Regional/Woodrum Field
- Thirteen Class D –
  - Charlottesville-Albemarle Airport
  - Fort Belvoir, VA
  - Fort Eustis, VA
  - Langley AFB, Hampton Roads, VA
  - Lynchburg Municipal-Preston Glenn Field Airport, Lynchburg, VA
  - Falwell Airport, VA
  - Manassas Regional Airport/Harry P. Davis Field, VA
  - Newport News/Williamsburg International Airport, Newport News, VA
  - Norfolk NAS
  - Oceana NAS (Apollo Soucek Field)
  - Quantico MCAF (Turner Field)
  - NASA Wallops Flight Facility, Wallops Island, VA
  - Snow Hill VORTAC
- Six Class E –
  - Danville Regional Airport
  - Ingalls Field Airport, Hot Springs, VA
  - Lynchburg VORTAC
  - Navy Oceana TACAN
  - NALF Fentress, VA
  - Shenandoah Valley Regional Airport, Staunton/Waynesboro/Harrisonburg, VA

SUAs in Virginia (i.e., seven restricted) are as follows:

- Fort A.P. Hill (Restricted)
  - R-6601A – Surface to but not including 4,500 feet MSL
  - R-6601B – 4,500 feet MSL to but not including 7,500 feet MSL
  - R-6601C – 7,500 feet MSL to 9,000 feet MSL
- Fort Pickett, VA (Restricted)
  - R-6602A – Surface to but not including 4,000 feet MSL
  - R-6602B – 4,000 feet MSL to but not including 11,000 feet MSL
  - R-6602C – 11,000 feet MSL to but not including 18,000 feet MSL
- Chincoteague Inlet, VA (Restricted)
  - R-6604A – Unlimited
  - R-6604B – Unlimited
- Pendleton, VA (Restricted)
  - R-6606 – Surface to and including 51,000 feet MSL
- Quantico, VA (Restricted)
  - R-6608A – Surface to 10,000 feet MSL

  - R-6608B – Surface to 10,000 feet MSL
  - R-6608C – Surface to 10,000 feet MSL
- Tangier Island, VA (Restricted)
  - R-6609 – Surface to FL 200
- Dahlgren Complex, VA (Restricted)
  - R-6611A – Surface to 40,000 feet MSL
  - R-6611B – 40,000 feet MSL to 60,000 feet MSL
  - R-6612 - -Surface to 7,000 feet MSL
  - R-6613A – Surface to 40,000 feet MSL
  - R-6613B – 40,000 feet MSL to 60,000 feet MSL (FAA, 2015f)

Figure 15.1.7-8 depicts the SUAs in the state. Figure 15.1.7-9 present MTRs in the state.

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 National Park Service" (NPS, 2014a). There are 26 national park units (areas managed by the NPS), and other affiliated locations managed by the NPS, within the State of Virginia that have to comply with this agency directive (NPS, 2015d).

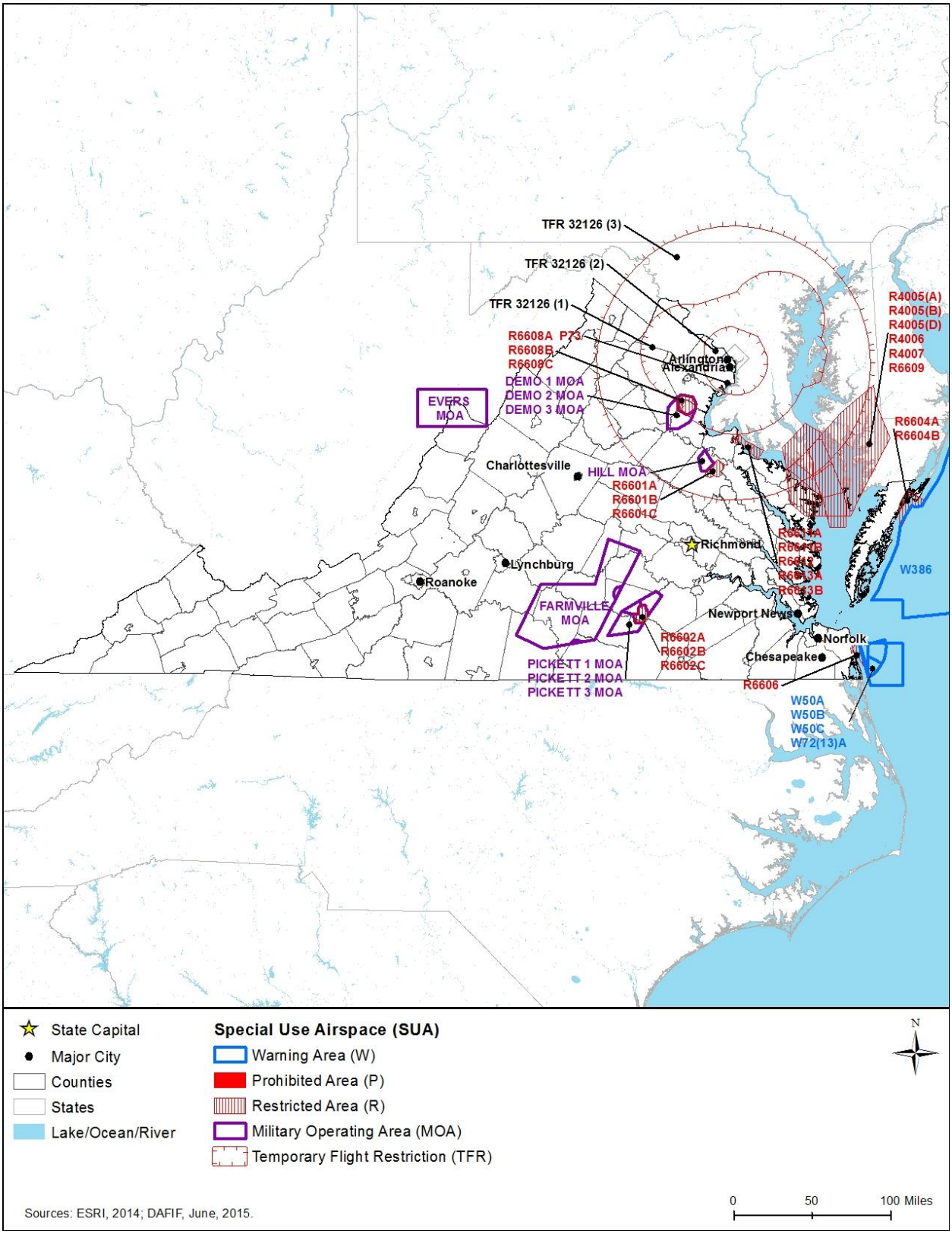


Figure 15.1.7-8: SUAs in Virginia

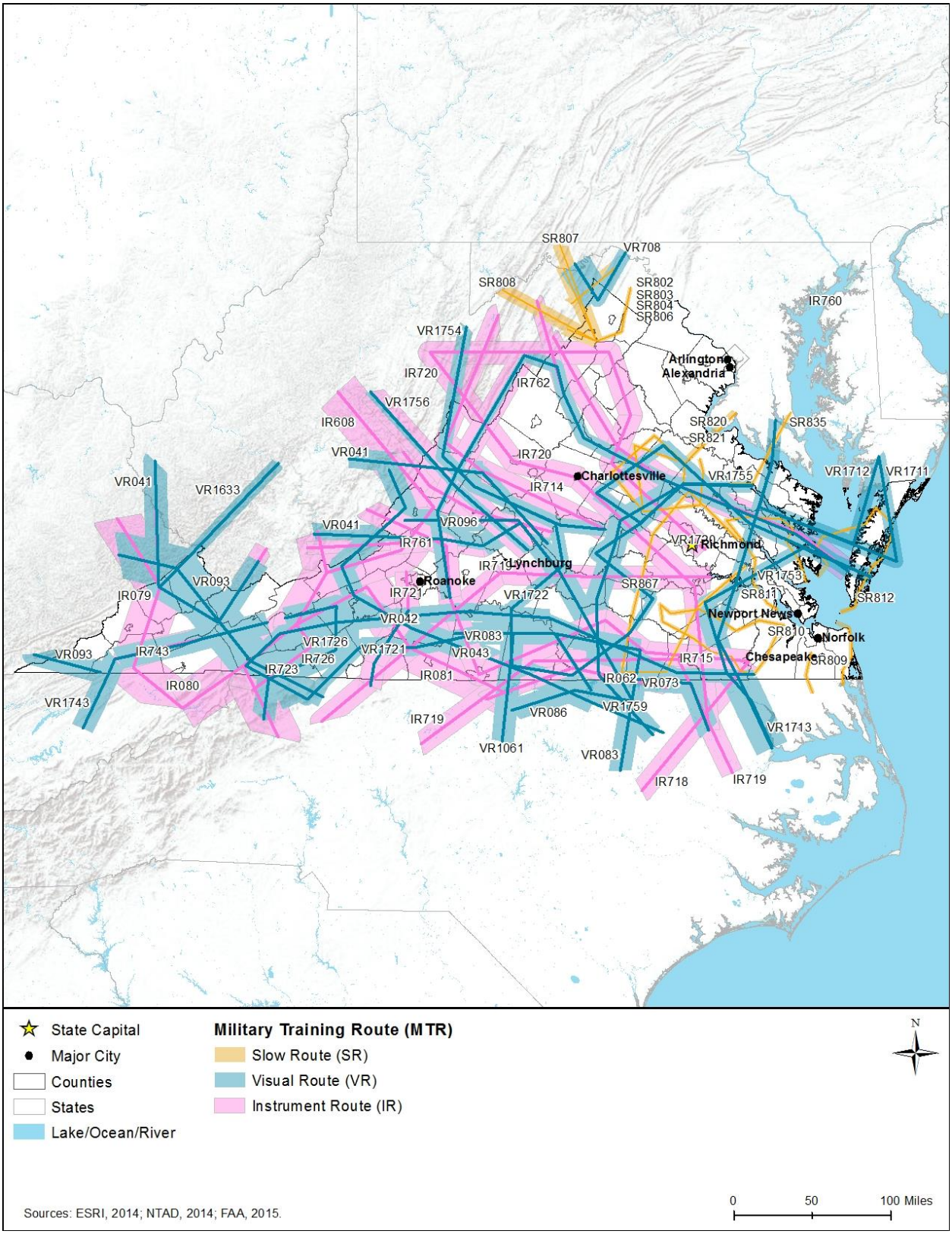


Figure 15.1.7-9: MTRs in Virginia

15.1.8. Visual Resources

15.1.8.1. 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 such as mountain ranges, city skylines, ocean views, unique geological formations, rivers, and constructed landmarks such as bridges, memorials, cultural resources, or statues are considered visual resources. For some, cityscapes are valued visual resources; for others, view of natural areas are valued visual resources. 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 National Historic Preservation Act (NHPA) compliance. A general definition of visual resources used by the Bureau of Land Management (BLM) is "the visible physical features on a landscape (e.g., land, water, vegetation, animals, structures, and other features)" (BLM, 1984).

15.1.8.2. Specific Regulatory Consideration

Table 15.1.8-1 presents state and local laws and regulations that relate to visual resources.

Table 15.1.8-1: Relevant Virginia Visual Resource Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Virginia Antiquities Act	Department of Historic Resources (DHR)	"Prohibits damage to or removal of objects of antiquity from archaeological sites on all state-controlled land."
Virginia Environmental Impacts Report Act	Department of Environmental Quality	Evaluates the environmental impacts of major construction projects initiated by a state agency. DHR is involved when a project might affect historic properties or archaeological sites.
Demolition of State-Owned Buildings	DHR, Art and Architecture Review Board	Requires approval of proposed demolitions of state-owned buildings.
Sale or Lease of Surplus State Property	Department of General Services, Secretary of Natural Resources	Requests opinion whether the sale or lease of surplus property by a state agency "is a significant component of the Commonwealth's natural or historic resources, and if so how to protect the resource in the event of its sale."
The Appropriations Act (§ 4-4.01 Biennial Budget Bill)	Department of General Services and DHR	Ensures review of "rehabilitation and restoration projects on state-owned Registered Historic Landmarks."
Art and Architecture Review Board (§ 2.2-2402 Code of Virginia)	DHR, Art and Architecture Review Board	Requires the review of construction or rehabilitation of any building or structure to be sited on state-owned property.
Cave Protection Act (§ 10.1-1000 Code of Virginia)	Department of Conservation and Recreation (Natural Heritage Division)	"Protects from vandalism all geological, biological, and historic features" in caves and rockshelters located in the Commonwealth.
Underwater Archaeology Permits (§ 10.1-2214 Code of Virginia)	Virginia Marine Resources Commission	"Protects underwater historical properties, including shipwrecks and submerged terrestrial sites."

Source: (Virginia Department of Historic Resources, 2011)

The Virginia Department of Conservation and Recreation supports the Virginia Land Conservation Foundation, which conserves and protects four categories of land: open spaces and parks, natural areas, historic areas, and farmland and forest preservation. According to the VLCF, the "Commonwealth's working farms and forests, natural areas, parks, rivers, battlefields, and other historic sites are critical to our economy, culture and quality of life" (VDCR, 2015i).

15.1.8.3. Character and Visual Quality of the Existing Landscape

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.

15.1.8.4. 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. Viewsheds containing historic properties and cultural resources may be considered important because of their presence in the landscape. Figure 15.1.11-4 shows areas that are included in the National Register of Historic Places (NRHP) that may be considered visually sensitive. In Virginia, there are 2,993 NRHP listed sites, which include 2 National Heritage Areas, 120 National Historic Landmarks, 1 National Historic Sites, 5 National Historical Parks, and 3 National Monuments. 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. See Section 15.1.11, Cultural Resources, for more information.

The National Park Service is required to protect all aspects of historic landscapes considered significant, such as forests, gardens, trails, structures, ponds, and farming areas using The Secretary of the Interior's Standards for the Treatment of Historic Properties and the Guidelines for the Treatment of Cultural Landscapes (NPS, 2015l). The standards and guidelines "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 the historic properties and the visual resources therein (NPS, 2015l).

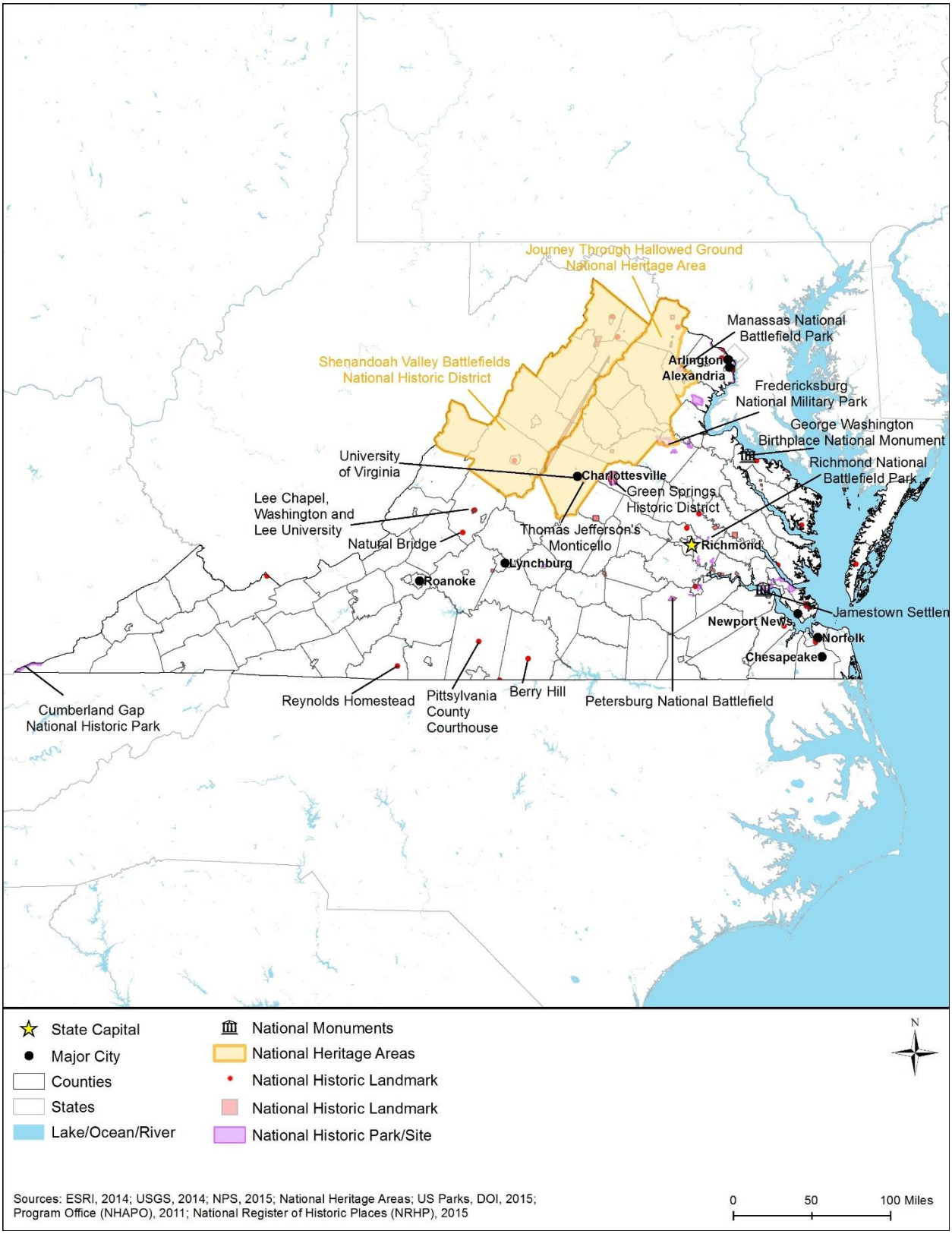
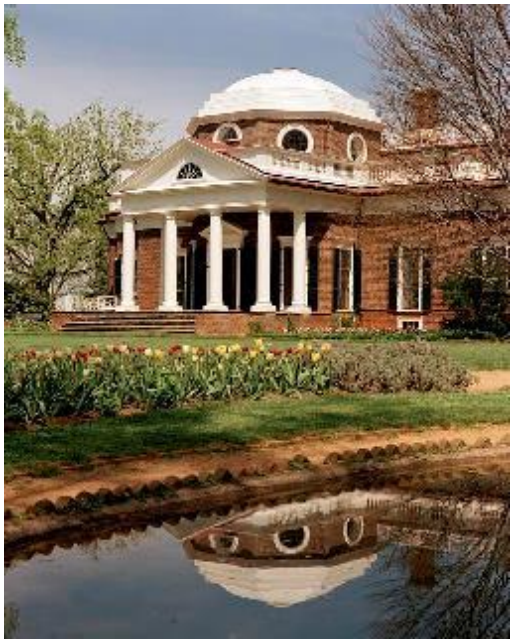


Figure 15.1.8-1: Some Cultural and Heritage Resources that May be Visually Sensitive

World Heritage Site

Sites are designated World Heritage sites if they reflect "the world's cultural and natural diversity of outstanding universal value" (UNESCO, 2015a). To be included on the World Heritage List, sites must meet 1 of 10 criteria reflecting cultural, natural, or artistic significance (UNESCO, 2015b). World Heritage sites are diverse and range from archaeological remains, national parks, islands, buildings, city centers, and cities. The importance of World Heritage-designated properties can be attributed to cultural or natural qualities that may be considered visual resources or are visually sensitive at these sites. Thomas Jefferson's Monticello and the University of Virginia are World Heritage Sites (Figure 15.1.8-2), recognized as cultural sites of neoclassical architecture (NPS, 2015m).



Source: (NPS, 2015m)

Figure 15.1.8-2: Thomas Jefferson's Monticello, World Heritage Site

National Heritage Areas

National Heritage Areas (NHA) 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 Virginia may contain scenic or aesthetic areas considered visual resources or visually sensitive. There are two NHAs in Virginia: the Shenandoah Valley Battlefields National Historic District and the Journey Through Hallowed Ground National Heritage Area. Both are key landscapes of the Civil War, while the latter includes the homes and birthplaces of nine U.S. presidents (NPS, 2015n).

National Historic Landmarks

National Historic Landmarks (NHL) 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, 2015o). Generally, NHLs are comprised of historic buildings such as residences, churches, civic buildings, and institutional buildings. Other types of historic properties include battlefields and canals. The importance of NHL-designated properties can be attributed to scenic or aesthetic qualities that may be considered visual resources or visually sensitive at these sites. In Virginia, there are 120 NHLs, including sites such as Monticello (Figure 15.1.8-2), Montpelier, Mount Vernon, the Pentagon, and the Williamsburg Historic District (NPS, 2015p).

15.1.8.5. Parks and Recreation Areas

Park and recreation areas include state parks, National Recreation Areas, National Seashores, National Forests, and national and state trails. Parks and recreation areas often contain scenic resources and tend to be visited partly because of their associated visual or aesthetic qualities. For additional information about recreation areas, including national and state parks, see Section 15.1.7, Land Use, Recreation, and Airspace.

State Parks

State parks contain natural, historic, cultural, and/or recreational resources of significance to Virginia residents and visitors. There are 36 state parks throughout Virginia, with more than 500 miles of trails, lakes, rivers, and State Forests (Figure 15.1.8-3) (VDCR, 2015j). Natural Bridge is slated to become a Virginia State Park in late 2016. Table 15.1.8-2 contains a list of all of the designated state parks in Virginia. The Civilian Conservation Corps "planted trees, improved beaches and roads, and created 800 state parks, including 10 in Virginia" as noted in Table 15.1.8-2 (VDCR, 2014c).

Table 15.1.8-2: Virginia State Parks

Virginia State Parks		
Bear Creek Lake*	Holliday Lake*	Sailor's Creek Battlefield Historic
Belle Isle	Hungry Mother*	Shenandoah River
Breaks Interstate	James River	Shot Tower
Caledon	Kiptopeke	Sky Meadows
Chippokes Plantation	Lake Anna	Smith Mountain Lake
Claytor Lake	Leesylvania	Southwest Virginia Museum Historical
Douthat*	Mason Neck	Staunton River*
Fairy Stone*	Natural Tunnel	Staunton River Battlefield
False Cape	New River Trail	Twin Lakes*
First Landing*	Occoneechee	Westmoreland*
Grayson Highlands	Pocahontas*	Wilderness Road
High Bridge Trail	Powhatan	York River

Source: (VDCR, 2014c)

* CCC Park

Natural Area Preserves

In 1989, the Virginia Department of Conservation and Recreation (DCR) established the Natural Area Preserve System under the Natural Heritage Program. These lands protect native species, rare plant and animal habitats, and ecologically significant areas by placing legally binding restrictions on future activities and development. There are 62 dedicated natural areas totaling 55,542 acres in the state (VDCR, 2015k); however, only 21 provide access to the public (VDCR, 2014c).

U.S. National Park System and National Forests

The National Park System and U.S. Department of Agriculture (USDA) National Forests contain natural, historic, cultural, visual, ecological, and recreational resources of significance to the nation. Owned by the U.S. government and operated by various federal agencies, these areas are maintained for the public's use. In Virginia, there is one National Park, one National Seashore, two National Scenic Trails, five National Historic Trails, seven National Historic Parks, two National Parkways, three National Monuments, one National Military Park, one National Historic Site, three National Battlefields, and other affiliated locations managed by the NPS (NPS, 2015d). Figure 15.1.8-3 identifies the natural areas protected in the state, including Shenandoah National Park (Figure 15.1.8-4), Assateague National Seashore (Figure 15.1.8-5), and two National Forests (George Washington and Jefferson National Forests) (NPS, 2015q).

Virginia is historically significant because half of the National Battlefield Parks and one of the 11 National Battlefields in the U.S. are located in the state. Table 15.1.8-3 identifies the National Park System and USDA units located in Virginia, two of which are also NHLs. These sites have cultural and historical significance representing American Indian presence, English settlement of North America, and important events in the American Revolutionary War and Civil War. For additional information regarding parks and recreation areas, see Section 15.1.7, Land Use, Recreation and Airspace.

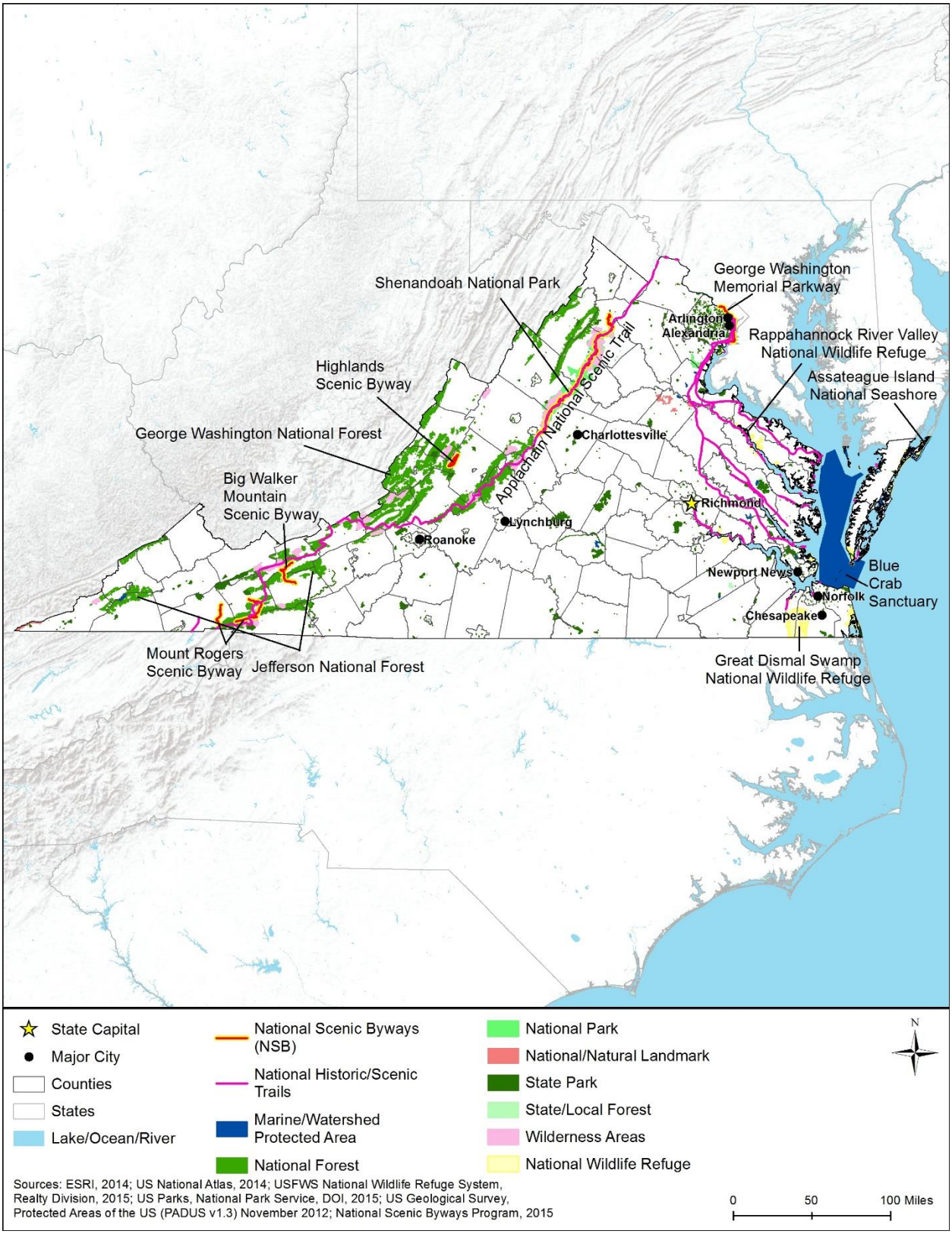


Figure 15.1.8-3: Natural Areas that May be Visually Sensitive

Table 15.1.8-3: Virginia National Park Service Areas

NPS Unit	Designation
Appomattox Court House	National Historical Park
Arlington House, The Robert E. Lee Memorial	National Memorial
Assateague Island National Seashore	National Seashore
Booker T. Washington	National Monument
Cedar Creek and Belle Grove*	National Historical Park
Colonial (Historic Jamestown, Yorktown Battlefield)	National Historical Park
Cumberland Gap	National Historical Park
Fort Monroe	National Monument
Fredericksburg and Spotsylvania County Battlefields Memorial	National Military Park
George Washington Birthplace	National Monument
Harpers Ferry	National Historical Park
Maggie L. Walker	National Historic Site
Manassas	National Battlefield Park
Mount Rogers	National Recreation Area
Petersburg*	National Battlefield
Richmond	National Battlefield Park
Shenandoah National Park	National Park

Source: (NPS, 2015q), (USFS, 2015d)

* Also listed as an NHL

Also, Wolf Trap National Park for the Performing Arts, located in northern Virginia, is the only national park dedicated to the performing arts, with “65 acres of woodland, streams, and wetland with a wide variety of plants, animals, birds, and wildflowers” (NPS, 2015r).

State and Federal Trails

Designated under Section 5 of the National Trails System Act (16 U.S.C. 1241-1251, as amended), National Scenic Trails (NSTs) are defined as extended trails that "provide for maximum outdoor recreation potential and for the conservation and enjoyment of the nationally significant scenic, historic, natural, or cultural qualities of the areas though which they pass” (NPS, 2012a). There are two National Scenic Trails in Virginia. The Appalachian National Scenic Trail extends 2,185 miles from Maine to Georgia. The Potomac Heritage National Scenic Trail connects the Potomac and upper Ohio River basins, highlighting the Chesapeake Bay and Allegheny Highlands (NPS, 2014b).

The National Trails System Act 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). Four National Historic Trails pass through Virginia and surrounding states: Captain John Smith Chesapeake National Historic Trail, Overmountain Victory National Historic Trail, Star-Spangled Banner National Historic Trail, and Washington-Rochambeau National Historic Trail (NPS, 2014b).

Source: (NPS, 2015s)

Figure 15.1.8-4: Big Run Overlook in Shenandoah National Park

Source: (NPS, 2015t)

Figure 15.1.8-5: Assateague Island National Seashore

The Captain John Smith Chesapeake National Historic Trail is the first national water trail in the U.S. (NPS, 2015u), while the Star-Spangled Banner National Historic Trail traverses both land and water (NPS, 2015v).

The Virginia Department of Conservation and Recreation developed a statewide trail action plan in 2009 to create a network of regional and community trails. This system of trails includes five major trails to form a framework across Virginia: Potomac Heritage National Scenic Trail, East Coast Greenway, James River Heritage Trail, Beaches to Bluegrass Trail, and Great Eastern Trail. In addition, Virginia has 460 miles of trails in state parks, 260 miles of forest roads and trails in state forests, shared-use paths managed by the Virginia Department of Transportation, and wildlife trails managed by the Virginia's Department of Game and Inland Fisheries (VDCR, 2014d).

15.1.8.6. Natural Areas

National Wilderness Areas

In 1964, Congress enacted the Wilderness Act of 1964 as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. A designation as a National Wilderness Area is the highest level of conservation protection given by Congress to federal lands. 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." Over 106 million acres of federal public lands have been designated as wilderness areas. These designated wilderness areas are managed by the U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and National Park Service. (NPS, 2015w). Twenty-five percent of these federal lands are in 47 national parks (44 million acres) and part of National Park System.

Virginia is home to 20 federally managed Wilderness Areas (Table 15.1.8-4).

Table 15.1.8-4: Virginia Wilderness Areas

Virginia Wilderness Areas			
Barbours Creek	Kimberling Creek	Priest	Shenandoah
Beartown	Lewis Fork	Raccoon Branch	St. Mary's
Brush Mountain East	Little Dry Run	Ramsey Draft	Three Ridges
Garden Mountain	Little Wilson Creek	Rich Hole	
Hunting Camp Creek	Mountain Lake	Rough Mountain	
James River Face	Peters Mountain	Shawvers Run	

Source: (NPS, 2015w)

Many of these Wilderness Areas are in the Jefferson National Forest or Allegheny Mountains (NPS, 2015w).

Federal and State Forests

The George Washington and Jefferson National Forests extend from Virginia to West Virginia and Kentucky along the Appalachian Mountains. These two national forests contain nearly 1.8 million acres, while being home to 325 miles of the Appalachian National Scenic Trail, 12 National Recreation Trails totaling 143 miles, the 140,000 acre Mount Rogers National Recreation Area, three National Scenic Areas, and three National Forest Scenic Byways (USFS, 2015c).

The Virginia Department of Forestry manages 24 state forests that total 68,626 acres as shown in Table 15.1.8-5 (Virginia Department of Forestry, 2015c). This State Forest System maintains aesthetics and wildlife habitats for Virginians, and creates natural reserves. Visual resources include a variety of tree species, wildlife habitats, and mountain vistas.

Table 15.1.8-5: Virginia State Forests

Virginia State Forests			
Appomattox-Buckingham State Forest	Chilton Woods State Forest	Hawks State Forest	Paul State Forest
Big Woods State Forest	Conway Robinson State Forest	Lesesne State Forest	Prince Edward-Gallion State Forest
Bourassa State Forest	Crawfords State Forest	Matthews State Forest	Sandy Point State Forest
Browne State Forest	Cumberland State Forest	Moore's Creek State Forest	South Quay State Forest
Channels State Forest	Devil's Backbone State Forest	Niday Place State Forest	Whitney State Forest
Chesterfield State Forest	Dragon Run State Forest	Old Flat State Forest	Zoar State Forest

Source: (Virginia Department of Forestry, 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 U.S.C. 1271-1287). These rivers have outstanding natural, cultural, and recreational values, including potential visual resources. Virginia does not have any National Wild, Scenic, or Recreational Rivers.

However, the state does have 815 miles of Virginia Designated Scenic Rivers (33 rivers).[126] The Virginia Scenic Rivers Act of 1970 established the Scenic Rivers Program managed by the Virginia Department of Conservation and Recreation. The program protects rivers and streams with visual appeal, historic and natural features, and unique habitat or species, among other qualifying criteria (VDCR, 2015l).

National Wildlife Refuges and State Wildlife Management Areas

National Wildlife Refuges (NWRs) are a network of lands and waters managed by the U.S. Fish and Wildlife Service. These lands and waters are "set aside for the conservation, management and, where appropriate, restoration of fish, wildlife, and plant resources and their habitats"

[126] http://www.dcr.virginia.gov/recreational-planning/srmain

(USFWS, 2015cb). There are 14 NWRs in Virginia, with Great Dismal Swamp being the largest (Figure 15.1.8-6). Fisherman Island, Nansemond, Plum Tree Island, and Wallops Island are not open to the public due to the critical nature of their habitats for wildlife, or safety concerns for the public (USFWS, 2015cc).

The Virginia Department of Game and Inland Fisheries "maintains 41 (wildlife) management areas totaling more than 203,000 acres for the benefit of all citizens for a variety of outdoor recreational opportunities"[127] (Virginia Department of Game and Inland Fisheries, 2015). Visual resources within the wildlife management areas include views and sites of animals, their environments, and natural resources found there. For additional information on wildlife refuges and management areas, see Section 15.1.6, Biological Resources.

Table 15.1.8-6: National Wildlife Refuges in Virginia

NWR Name	
Back Bay	James River
Chincoteague	Nansemond
Eastern Shore Of Virginia	Occoquan Bay
Elizabeth Hartwell Mason Neck	Plum Tree Island
Featherstone	Presquile
Fisherman Island	Rappahannock River Valley
Great Dismal Swamp	Wallops Island

Source: (USFWS, 2015cc)

National Natural Landmarks

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, 2014c). These landmarks may be considered visual resources or visually sensitive. In Virginia, there are 10 designated NNLs located entirely or partially within the state as described below in Table 15.1.8-7. One example is the 112,000 acre Great Dismal Swamp, it is among the largest remaining swamp habitats on the Atlantic seaboard and is estimated to have once covered more than one million acres (Figure 15.1.8-6) (USFWS, 2015cd).

[127] http://www.dgif.virginia.gov/

Table 15.1.8-7: Virginia National Natural Landmarks and Associated Visual Attributes

National Natural Landmark	Visual Attributes
Butler Cave-Breathing Cave	Two major cave systems, 40-foot waterfall, natural bridge, "floating" crystalline formations, underground lake
Caledon Natural Area	Virgin upland forest
Charles C. Steirly Natural Area	"a small essentially virgin stand of climax bald cypress-water tupelo swamp forest"
Grand Caverns	Unique shield formations, draperies, flowstone, stalactites, and stalagmites
Great Dismal Swamp	Swamp, wildlife refuge, Underground Railroad Network to Freedom site designations
Luray Caverns	cascades, columns, stalactites, stalagmites and pools
Montpelier Forest	Mature forests of oak, hickory, and poplar
Rich Hole	Cove hardwood forest, virgin oak and hickory forests, watershed
Seashore Natural Area	parallel dunes, two distinct forest types of semitropical character, wildlife sanctuary
The Virginia Coast Reserve	barrier island-lagoon complex, wildlife refuge

Source: (NPS, 2012b)

Source: (USFWS, 2015cd)

Figure 15.1.8-6: Great Dismal Swamp

15.1.8.7. 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. The U.S. Department of Transportation, Federal Highway Administration, manages the National Scenic Byways Program (FHWA, 2015b). Virginia has five designated National Scenic Byways:

- Blue Ridge Parkway (469 miles);
- Colonial Parkway (23 miles);
- George Washington Memorial Parkway (25 miles);
- Journey Through Hallowed Ground Byway (180 miles); and
- Skyline Drive (105 miles) (FHWA, 2015c).

The first three are also designated All-American Roads, which are the most scenic byways with multiple inherent qualities (e.g., cultural, historic, scenic) (FHWA, 2012). The Journey Through Hallowed Ground Byway is said to hold "more historic sites than any other in the US," while Skyline Drive includes scenic vistas of Shenandoah National Park (FHWA, 2015c).

The Virginia Department of Transportation manages over 2,500 miles of Virginia Byways, "containing aesthetic or cultural value near areas of historical, natural, or recreational significance" throughout the state (VDOT, 2015b).

Estuaries

The Chesapeake Bay is the largest estuary in North America and the second largest in the world. The National Park Service manages the Chesapeake Bay Gateways and Watertrails Network, and "the collaborative strategies to support President Obama's Executive Order 13508 for the protection and restoration of the Chesapeake Bay." (NPS, 2015x) The waterways that make up the Chesapeake Bay support a variety of plants, animals, and aquatic life.

15.1.9. Socioeconomics

15.1.9.1. 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 U.S.C. 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. 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.

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 Programmatic Environmental Impact Statement (PEIS) addresses environmental justice in a separate section (Section 15.1.10). This PEIS also addresses the following topics, sometimes included within socioeconomics, in separate sections: land use and recreation (Section 15.1.7, Land Use, Recreation, and Airspace), infrastructure and public services (Section 15.1.1, Infrastructure), and aesthetic considerations (Section 15.1.8, Visual Resources).

The financial arrangements for deployment and operation of the FirstNet network 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 NPSBN. This socioeconomics section provides some additional, broad context, including data and discussion of state and local government revenue sources that FirstNet may affect.

Wherever possible, this section draws on nationwide datasets from federal sources such as the U.S. Census Bureau (Census Bureau)[128] 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

[128] 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. In many cases, the FirstNet PEIS report tables contain data from multiple Census Bureau tables and sometimes incorporate other sources.

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 is 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.

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.

15.1.9.2. Specific Regulatory Consideration

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.

15.1.9.3. Communities and Populations

This section discusses the population and major communities of Virginia. 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 15.1.9-1 presents the 2014 population and population density of Virginia in comparison to the East region[129] and the nation. The estimated population of Virginia in 2014 was 8,326,289. The population density was 211 persons per square mile (sq. mi.), which is lower than the population density of both the region (312 persons/sq. mi.) and higher than the nation (90 persons/sq. mi.). In 2014, Virginia was the 12th largest state by population among the 50 states and the District of Columbia, 36th largest by land area, and had the 15th greatest population density (U.S. Census Bureau, 2015e; U.S. Census Bureau, 2015t).

Table 15.1.9-1: Land Area, Population, and Population Density of Virginia

Geography	Land Area (sq. mi.)	Estimated Population 2014	Population Density 2014 (persons/sq. mi.)
Virginia	39,594	8,326,289	210
East Region	237,157	73,899,862	312
United States	3,531,905	318,857,056	90

Sources: (U.S. Census Bureau, 2015e; U.S. Census Bureau, 2015t) (USGS, 2012a)

[129] The East region comprises the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia, as well as the District of Columbia. Throughout the socioeconomics section, figures for the East region represent the sum of the values for all "states" (including the District of Columbia) in the region, or an average for the region based on summing the component parameters. For instance, the population density of the East region is the sum of the populations of all its states, divided by the sum of the land areas of all its states.

Population growth is an important subject for this PEIS given FirstNet's mission. Table 15.1.9-2 presents the population growth trends of Virginia from 2000 to 2014 in comparison to the East region and the nation. The state's annual growth rate slightly declined in the 2010 to 2014 period compared to 2000 to 2010, from 1.23 percent to 1.00 percent. The growth rate of Virginia in the latter period was twice the growth rate of the region (0.50 percent), and was slightly higher than the nation's growth rate (0.81 percent).

Table 15.1.9-2: Recent Population Growth of Virginia

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
Virginia	7,078,515	8,001,024	8,326,289	922,509	325,265	1.23%	1.00%
East Region	69,133,382	72,444,467	73,899,862	3,311,085	1,455,395	0.47%	0.50%
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, 2015d; U.S. Census Bureau, 2015e):

[a] 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 15.1.9-3 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. 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 Virginia's population will increase by approximately 1.4 million people, or 17 percent, from 2014 to 2030. This reflects an average annual projected growth rate of 0.98 percent, which is consistent with the historical growth rate from 2010 to 2014. The projected growth rate of the state is nearly double that of the region (0.57 percent) and slightly higher than the projected growth rate of the nation (0.80 percent).

Table 15.1.9-3: Projected Population Growth of Virginia

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
Virginia	8,326,289	9,701,508	9,775,166	9,738,337	1,412,048	17.0%	0.98%
East Region	73,899,862	78,925,282	82,842,294	80,883,788	6,983,926	9.5%	0.57%
United States	318,857,056	360,978,449	363,686,916	362,332,683	43,475,627	13.6%	0.80%

Sources: (U.S. Census Bureau, 2015e; ProximityOne, 2015; UVA Weldon Cooper Center, 2015)

[a] AARC = Average Annual Rate of Change

Population Distribution and Communities

Figure 15.1.9-1 presents the distribution and relative density of the population of Virginia. 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, 2015j).

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, 2010a; U.S. Census Bureau, 2010b). 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. Dispersed dots indicate dispersed population across the less densely settled areas of the state. The sparsely populated area on the state border with West Virginia is the Shenandoah National Park, much of which the state and federal government have protected. For more information about the Shenandoah National Park, see Section 15.1.7, Land Use, Recreation, and Airspace.

Table 15.1.9-4 provides the populations of the 10 largest population concentrations in Virginia, based on the 2010 census. It also shows the changes in population for these areas between the 2000 and 2010 censuses.[130] In 2010, the largest population concentration was the Virginia portion of the Washington area, which had over 2.2 million people. The second largest concentration was the Virginia Beach area with over 1.4 million people. The state had no other population concentrations over 1 million, although the Richmond area was close, with over

[130]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.

950,000 people. All other areas were considerably smaller. The smallest of these 10 population concentrations was the Winchester area, with a 2010 population of 69,449. The two fastest growing areas, by average annual rate of change from 2000 to 2010, were the Blacksburg and Fredericksburg areas, with annual growth rates of 4.46 and 3.82 percent, respectively. However, the high growth rate for the Blacksburg area may have been due mostly to a considerable enlargement of its boundary. Also, Loudoun County, Virginia, which is part of the northern Virginia/Washington DC area (VA portion in Table 15.1.9-4) is one of the fastest growing counties in the nation. Most areas experienced growth rates of over 1.00 percent during this period, with the exception of the Virginia Beach area (0.32 percent) and the Roanoke area (0.62 percent).

Table 15.1.9-4 also shows that the top 10 population concentrations in Virginia accounted for 67.8 percent of the state's population in 2010. Further, population growth in those 10 areas from 2000 to 2010 amounted to 90.5 percent of the entire state's growth.

Table 15.1.9-4: Population of the 10 Largest Population Concentrations in Virginia

Area	Population				Population Change 2000 to 2010	
	2000	2010	2009–2013	Rank in 2010	Numerical Change	Rate (AARC)[a]
Blacksburg[b]	57,236	88,542	89,596	8	31,306	4.46%
Charlottesville	81,449	92,359	93,673	7	10,910	1.26%
Fredericksburg	97,102	141,238	145,739	5	44,136	3.82%
Lynchburg	98,714	116,636	119,246	6	17,922	1.68%
Richmond	818,836	953,556	963,521	3	134,720	1.53%
Roanoke	197,442	210,111	211,395	4	12,669	0.62%
Virginia Beach	1,394,439	1,439,666	1,447,320	2	45,227	0.32%
Washington (DC/VA/MD) (VA Portion)	1,789,227	2,235,884	2,293,206	1	446,657	2.25%
Williamsburg[c]	NA	75,689	76,653	9	NA	NA
Winchester	53,559	69,449	70,028	10	15,890	2.63%
Total for Top 10 Population Concentrations	4,588,004	5,423,130	5,510,377	NA	835,126	1.69%
Virginia	7,078,515	8,001,024	8,100,653	NA	922,509	1.23%
Top 10 Total as Percentage of State	64.8%	67.8%	68.0%	NA	90.5%	NA

Sources: (U.S. Census Bureau, 2010a; U.S. Census Bureau, 2015u; U.S. Census Bureau, 2015v)

[a] AARC = Average Annual Rate of Change
[b] The large population increase from 2000 to 2010 reflects a large change in the area definition for the Blacksburg urbanized area, from 26 sq. mi. in 2000 to 51 sq. mi. in 2010. Thus, much of the "growth" was due to expansion of the area's Census Bureau boundary to take in existing development/population.
[c] The Census Bureau did not define a "Williamsburg" urban area in 2000.

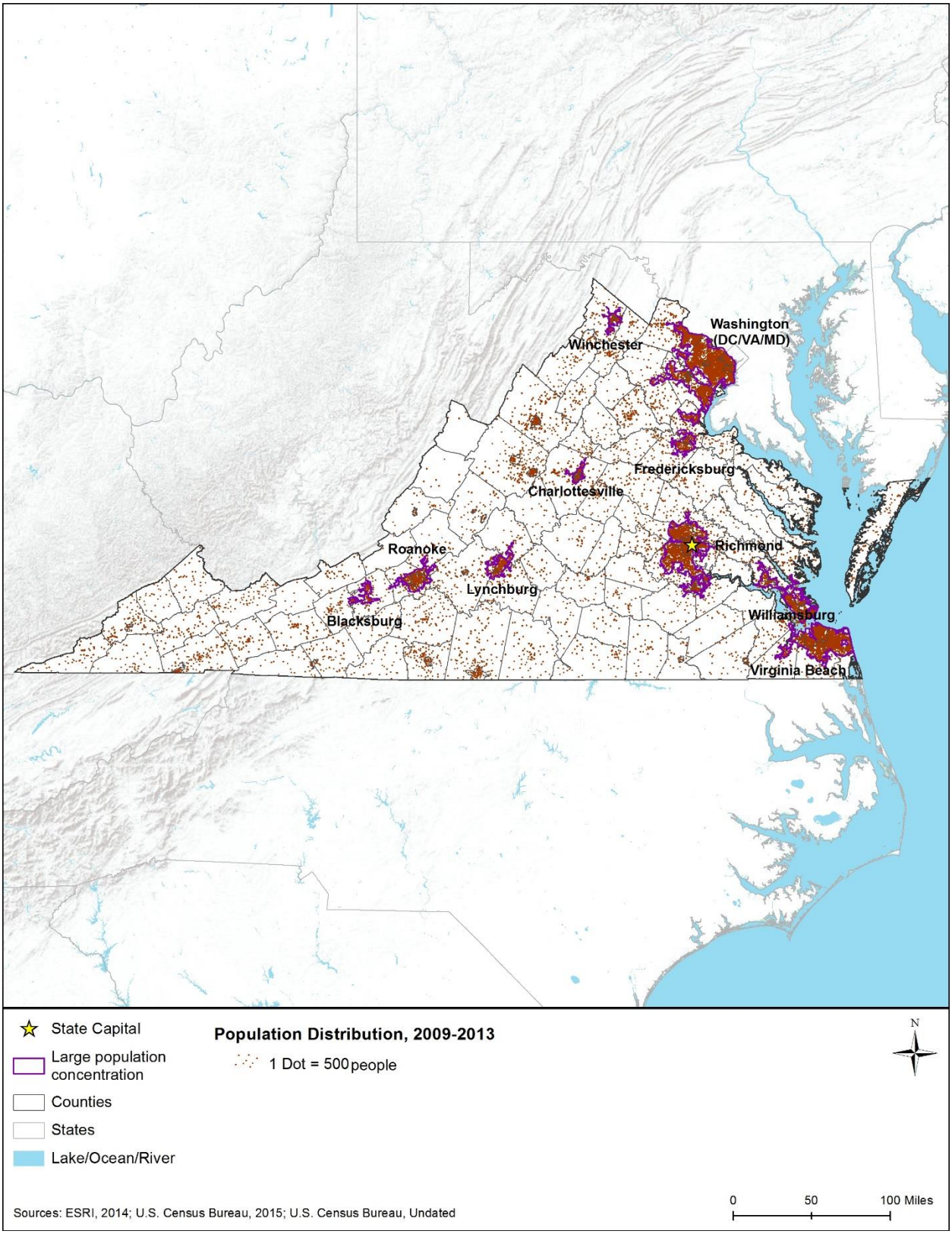


Figure 15.1.9-1: Population Distribution in Virginia, 2009–2013

15.1.9.4. 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 emergency medical services and facilities. This PEIS addresses public services in Section 15.1.1, Infrastructure. Project-level NEPA analyses may need to examine other institutions, depending on specific locations and specific types of actions.

Economic Activity

Table 15.1.9-5 compares several economic indicators for Virginia to the East region and the nation. The table presents two indicators of income[131] – per capita and median household – as income is a good measure of general economic health of a region.

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 15.1.9-5, the per capita income in Virginia in 2013 ($33,145) was $293 higher than that of the region ($32,852), and $4,961 higher 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 15.1.9-5 shows that in 2013, the MHI in Virginia ($62,745) was $2,241 higher than that of the region ($60,504), and $10,495 higher than 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 15.1.9-5 compares the

[131] 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, 2015h)

unemployment rate in Virginia to the East region and the nation. In 2014, Virginia's statewide unemployment rate of 5.2 percent was lower than the rate for both the region (6.0 percent) and the nation (6.2 percent).[132]

Table 15.1.9-5: Selected Economic Indicators for Virginia

Geography	Per Capita Income 2013	Median Household Income 2013	Average Annual Unemployment Rate 2014
Virginia	$33,145	$62,745	5.2%
East Region	$32,852	$60,504	6.0%
United States	$28,184	$52,250	6.2%

Sources: (BLS, 2015a; U.S. Census Bureau, 2015a; U.S. Census Bureau, 2015o; U.S. Census Bureau, 2015i)

Figure 15.1.9-2 and Figure 15.1.9-3 show how MHI in 2013 (U.S. Census Bureau, 2015a) and unemployment in 2014 (BLS, 2015a) varied by county across the state. These maps also incorporate the same population concentration data as Figure 15.1.9-1 (U.S. Census Bureau, 2010a; U.S. Census Bureau, 2010b). Following these two maps, Table 15.1.9-6 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 Virginia.

Figure 15.1.9-2 shows that, in general, counties with the highest MHI values were located in the northeastern portion of the state. Other counties with MHI levels above the national average were distributed through Virginia, with the exception of southwest Virginia and most of the southern portion of the state. Many of the counties that encompass the top 10 population concentrations had MHI levels above the national average, although the central cities of some of those areas, which are considered county equivalents, had MHI values below the national average. Most of the remaining counties of the state had MHI levels below the national average, some considerably so, including many in the south and southwest of the state. Table 15.1.9-6 is mostly consistent with those observations. It shows that the Williamsburg area, the Fredericksburg area, and the Virginia portion of the Washington area had MHI levels above the 2009–2013 state average ($63,907). All other areas had MHI levels below the state average. MHI was lowest in the Blacksburg area, which is the second smallest of the areas shown in the table. The smallest area, Winchester, had a considerably higher MHI compared to Blacksburg, probably reflecting its proximity to the high-income Washington area (Virginia portion).

Figure 15.1.9-3 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 located in the northern and eastern portions of the state, with a few exceptions. Most counties in the south and southwestern portions of Virginia had

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

unemployment rates above the national average. For the top 10 population concentrations, Table 15.1.9-6 shows that all 10 areas had unemployment rates within 2.2 percentage points of the state average (7.2 percent). Only the Virginia portion of the Washington area (5.3 percent), the Williamsburg area (6.1 percent) and the Charlottesville area (5.0 percent) had 2009–2013 unemployment rates below the state average. The unemployment rate was highest in the Lynchburg area (9.4 percent).

Detailed employment data provides useful insights into the nature of a local, state, or national economy. Table 15.1.9-7 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 was slightly lower in Virginia than in the East region and the nation. The percentage of government workers was considerably higher in the state than in the region and nation. The percentage of self-employed workers was slightly lower in the state compared to both the region and the nation.

By industry, Virginia has a mixed economic base and some notable figures in the table are as follows. Virginia in 2013 had a considerably higher percentage of persons working in "professional, scientific, management, administrative, and waste management services" and "public administration" than did the region or the nation. It had a lower percentage of workers in "manufacturing" and "educational services, and health care and social assistance" than the region or nation. The rest of the state figures were very similar (approximately within one percentage point) compared to the region.

Table 15.1.9-6: Selected Economic Indicators for the 10 Largest Population Concentrations in Virginia, 2009–2013

Area	Median Household Income	Average Annual Unemployment Rate
Blacksburg	$39,237	7.6%
Charlottesville	$51,910	5.0%
Fredericksburg	$73,460	7.6%
Lynchburg	$43,275	9.4%
Richmond	$57,121	8.8%
Roanoke	$48,143	7.2%
Virginia Beach	$57,535	8.7%
Washington (DC/VA/MD) (VA Portion)	$105,133	5.3%
Williamsburg	$72,060	6.1%
Winchester	$56,142	7.1%
Virginia (statewide)	$63,907	7.2%

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

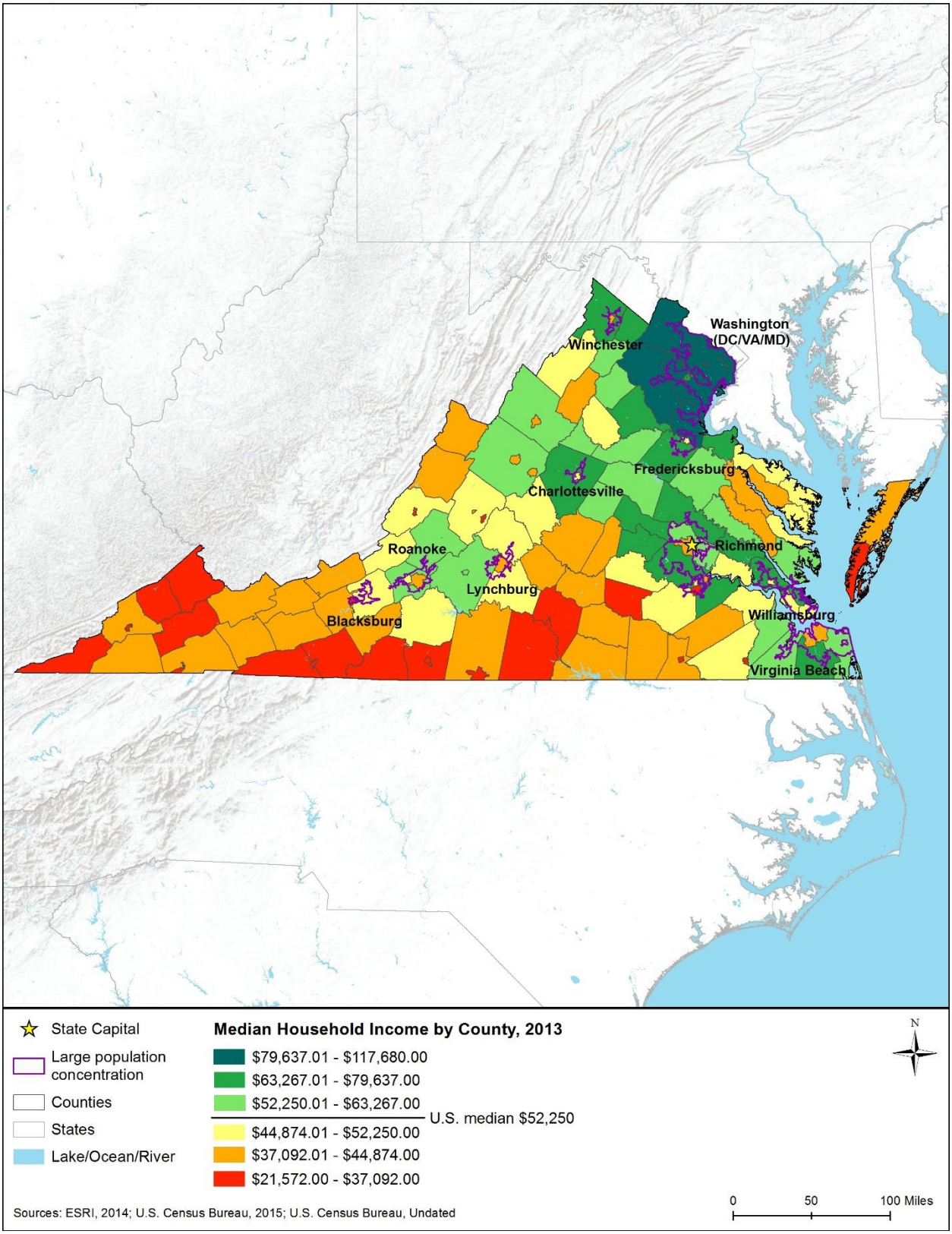


Figure 15.1.9-2: Median Household Income in Virginia, by County, 2013

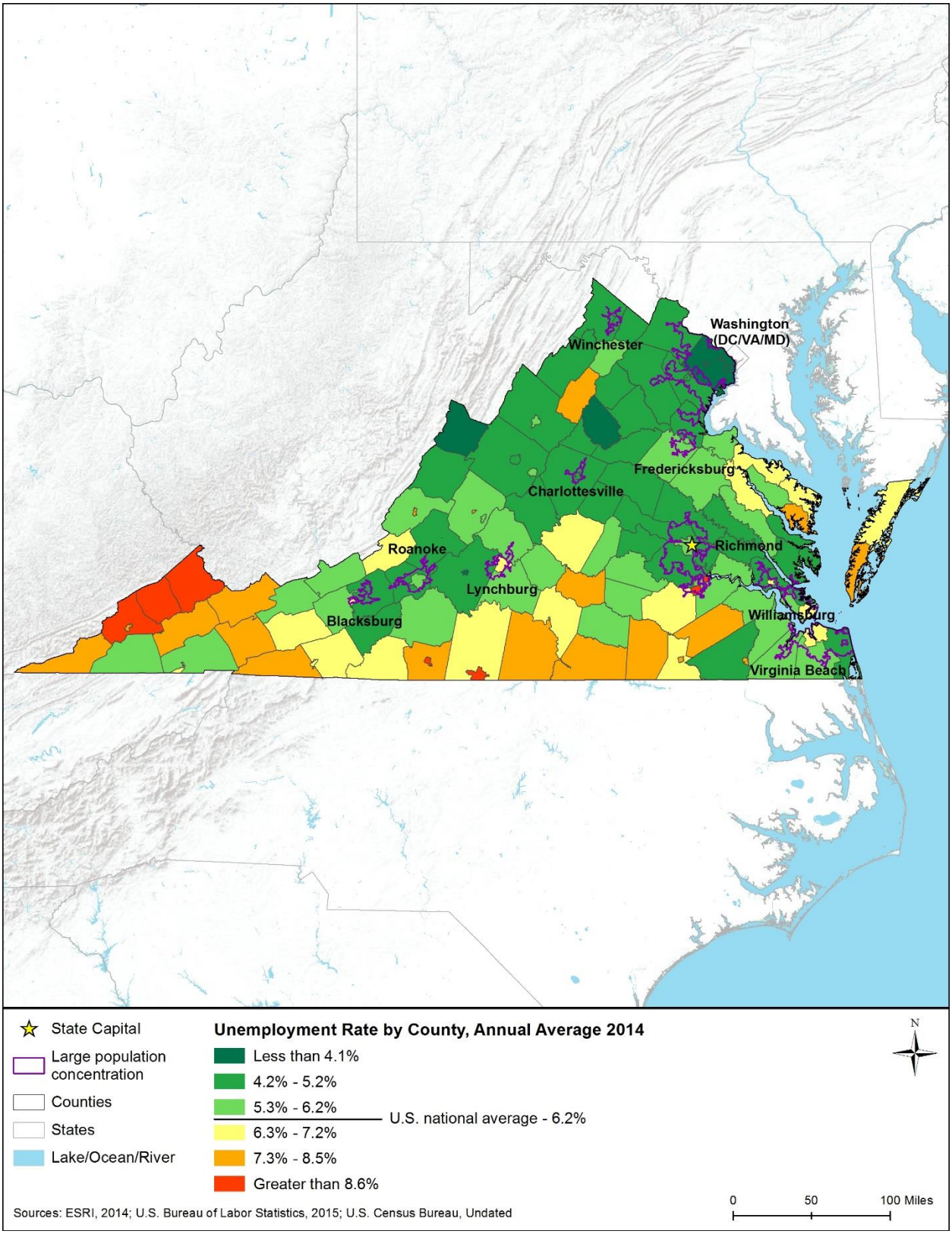


Figure 15.1.9-3: Unemployment Rates in Virginia, by County, 2014

Table 15.1.9-7: Employment by Class of Worker and by Industry, 2013

Class of Worker and Industry	Virginia	East Region	United States
Civilian Employed Population 16 Years and Over	3,986,665	35,284,908	145,128,676
Percentage by Class of Worker			
Private wage and salary workers	75.0%	79.3%	79.7%
Government workers	20.0%	15.1%	14.1%
Self-employed in own not incorporated business workers	4.9%	5.4%	6.0%
Unpaid family workers	0.1%	0.1%	0.2%
Percentage by Industry			
Agriculture, forestry, fishing and hunting, and mining	1.1%	0.9%	2.0%
Construction	6.2%	5.8%	6.2%
Manufacturing	7.2%	8.5%	10.5%
Wholesale trade	1.9%	2.5%	2.7%
Retail trade	11.1%	11.1%	11.6%
Transportation and warehousing, and utilities	4.1%	4.6%	4.9%
Information	2.1%	2.3%	2.1%
Finance and insurance, and real estate and rental and leasing	6.2%	7.3%	6.6%
Professional, scientific, management, administrative, and waste management services	14.8%	12.3%	11.1%
Educational services, and health care and social assistance	21.9%	25.6%	23.0%
Arts, entertainment, and recreation, and accommodation and food services	9.1%	8.9%	9.7%
Other services, except public administration	5.3%	4.9%	5.0%
Public administration	8.8%	5.5%	4.7%

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

Table 15.1.9-8 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 15.1.9-7 for 2013.

Table 15.1.9-8: Employment by Relevant Industries for the 10 Largest Population Concentrations in Virginia, 2009–2013

Area	Construction	Transportation and Warehousing, and Utilities	Information	Professional, Scientific, Management, Administrative and Waste Management Services
Blacksburg	2.6%	1.6%	1.7%	9.2%
Charlottesville	4.8%	2.0%	2.1%	13.0%
Fredericksburg	6.3%	4.0%	1.8%	12.6%
Lynchburg	5.1%	3.7%	1.6%	8.1%
Richmond	5.6%	4.7%	1.7%	11.8%
Roanoke	5.0%	5.8%	1.5%	8.6%
Virginia Beach	6.3%	4.2%	2.0%	11.4%
Washington (DC/VA/MD) (VA Portion)	5.9%	3.2%	3.1%	23.6%
Williamsburg	4.7%	2.1%	1.7%	12.1%
Winchester	6.3%	4.6%	2.6%	10.2%
Virginia	6.5%	4.1%	2.2%	14.7%

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

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 15.1.9-9 compares Virginia to the East region and nation on several common housing indicators.

As shown in Table 15.1.9-9, in 2013 Virginia had a slightly higher percentage of housing units that were occupied (89.5 percent) than the region (88.4 percent) or nation (87.5 percent). Of the occupied units, Virginia had a somewhat higher percentage of owner-occupied units (65.6 percent) compared to the region (62.8 percent) and nation (63.5 percent). The owner-occupied rate is also consistent with the percentage of detached single-unit housing (also known as single-family homes) in Virginia in 2013 (61.5 percent), which is higher than that of the region (52.7 percent) and matched the nation's percentage (61.5 percent). The vacancy rate among rental units was higher in Virginia (6.4 percent) than in the region (5.5 percent) and nearly matched the nation's rate (6.5 percent).

Table 15.1.9-10 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. As shown in Table 15.1.9-10, during this period the percentage of occupied housing units ranged between 87.6 to 94.0 percent across these population concentrations, which is consistent with the state percentage (89.4 percent).

Table 15.1.9-9: Selected Housing Indicators for Virginia, 2013

Geography	Total Housing Units	Housing Occupancy & Tenure				Units in Structure
		Occupied Housing	Owner-Occupied	Homeowner Vacancy Rate	Rental Vacancy Rate	1-Unit, Detached
Virginia	3,412,577	89.5%	65.6%	1.5%	6.4%	61.5%
East Region	31,108,124	88.4%	62.8%	1.6%	5.5%	52.7%
United States	132,808,137	87.5%	63.5%	1.9%	6.5%	61.5%

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

Table 15.1.9-10: Selected Housing Indicators for the 10 Largest Population Concentrations in Virginia, 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
Blacksburg	35,353	89.9%	45.5%	2.1%	4.2%	43.0%
Charlottesville	40,321	89.5%	45.2%	1.6%	8.9%	42.1%
Fredericksburg	53,629	93.7%	66.1%	1.6%	5.7%	66.9%
Lynchburg	49,770	91.1%	60.3%	2.1%	5.8%	60.7%
Richmond	407,552	90.2%	62.7%	1.9%	9.8%	65.2%
Roanoke	96,313	92.1%	64.8%	2.6%	5.9%	68.5%
Virginia Beach	585,597	91.2%	60.3%	2.2%	7.0%	58.0%
Washington (DC/VA/MD) (VA Portion)	870,701	94.0%	65.3%	1.2%	4.5%	44.2%
Williamsburg	33,522	87.6%	70.3%	2.5%	11.5%	63.4%
Winchester	28,941	91.0%	63.6%	3.5%	8.1%	61.0%
Virginia	3,381,332	89.4%	67.3%	1.8%	6.7%	62.1%

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

Property Values

Property values have important relationships to both the wealth and affordability of communities.

Table 15.1.9-11 provides indicators of residential property values for Virginia and compares these values to values for the East 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, 2015h).

The table shows that the median value of owner-occupied units in Virginia in 2013 ($239,300) was lower than the corresponding value for the East region ($249,074) and higher than the nation's value ($173,900).

Table 15.1.9-11: Residential Property Values in Virginia, 2013

Geography	Median Value of Owner-Occupied Units
Virginia	$239,300
East Region	$249,074
United States	$173,900

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

Table 15.1.9-12 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 value of owner-occupied housing was highest in the Virginia portion of the Washington area ($424,800), which was considerably higher than the state median value ($244,600). The areas of Lynchburg ($160,000), Roanoke ($167,200), and Blacksburg ($186,400) had property values considerably below the state value. These three areas also had the lowest median household incomes (Table 15.1.9-6).

Table 15.1.9-12: Residential Property Values for the 10 Largest Population Concentrations in Virginia, 2009–2013

Area	Median Value of Owner-Occupied Units
Blacksburg	$186,400
Charlottesville	$287,500
Fredericksburg	$257,500
Lynchburg	$160,000
Richmond	$215,100
Roanoke	$167,200
Virginia Beach	$235,300
Washington (DC/VA/MD) (VA Portion)	$424,800
Williamsburg	$322,400
Winchester	$214,100
Virginia	$244,600

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

Government Revenues

State and local governments obtain revenues from many sources. FirstNet 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 15.1.9-13 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 15.1.9-13 shows that state and local governments in Virginia received less total revenue in 2012 on a per capita basis than their counterpart governments in the region and nation. Virginia state and local governments also had lower levels of intergovernmental revenues[133] from the federal government. The Virginia state government obtained less revenue per capita from property taxes compared to its regional and national counterparts. Local governments in Virginia obtained lower levels of property taxes per capita than local governments in the region did, and similar levels to local governments in the nation. General sales taxes were lower on a per capita basis for Virginia state and local governments compared to their counterparts in the region and nation. Compared to counterparts in the region and nation, selective sales taxes, and public utility taxes specifically, on a per capita basis, were lower for the Virginia state government, and higher for local governments. Individual income tax revenues, on a per capita basis, were lower for the Virginia state government compared to other states in the region, and higher compared to other states in the nation. Corporate income tax revenues, on a per capita basis, were lower for the Virginia state government compared to state governments in both the region and nation. Local governments in Virginia did not report any individual or corporate income tax revenues.

[133] Intergovernmental revenues are those revenues received from the Federal government or other government entities such as shared taxes, grants, or loans and advances.

Table 15.1.9-13: State and Local Government Revenues, Selected Sources, 2012

Type of Revenue		Virginia		Region		United States	
		State Govt. Amount	Local Govt. Amount	State Govt. Amount	Local Govt. Amount	State Govt. Amount	Local Govt. Amount
Total Revenue	($M)	$43,138	$34,916	$522,354	$431,898	$1,907,027	$1,615,194
	Per capita	$5,270	$4,265	$7,132	$5,897	$6,075	$5,145
Intergovernmental from Federal	($M)	$9,278	$1,503	$135,435	$20,289	$514,139	$70,360
	Per capita	$1,133	$184	$1,849	$277	$1,638	$224
Intergovernmental from State	($M)	$0	$10,366	$0	$120,274	$0	$469,147
	Per capita	$0	$1,266	$0	$1,642	$0	$1,495
Intergovernmental from Local	($M)	$506	$0	$9,810	$0	$19,518	$0
	Per capita	$62	$0	$134	$0	$62	$0
Property Taxes	($M)	$34	$11,305	$2,215	$144,319	$13,111	$432,989
	Per capita	$4	$1,381	$30	$1,971	$42	$1,379
General Sales Taxes	($M)	$3,487	$1,069	$49,123	$15,874	$245,446	$69,350
	Per capita	$426	$131	$671	$217	$782	$221
Selective Sales Taxes	($M)	$2,373	$1,386	$38,070	$5,996	$133,098	$28,553
	Per capita	$290	$169	$520	$82	$424	$91
Public Utilities Taxes	($M)	$151	$580	$4,314	$2,261	$14,564	$14,105
	Per capita	$18	$71	$59	$31	$46	$45
Individual Income Taxes	($M)	$10,216	$0	$102,813	$18,838	$280,693	$26,642
	Per capita	$1,248	$0	$1,404	$257	$894	$85
Corporate Income Taxes	($M)	$839	$0	$14,112	$6,733	$41,821	$7,210
	Per capita	$102	$0	$193	$92	$133	$23

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

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

15.1.10. Environmental Justice

15.1.10.1. Definition of the Resource

E.O. 12898, 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 E.O. The fundamental principle of environmental justice as stated in the E.O. 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" (Executive Office of the President, 1994). Under the E.O., 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 E.O., the Department of Commerce developed an Environmental Justice Strategy in 1995, and published an updated strategy in 2013 (U.S. Department of Commerce, 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 requirements of the E.O. (CEQ, 1997). Additionally, the USEPA's Office of Environmental Justice (USEPA, 2015g) offers guidance on Environmental Justice issues and provides an "environmental justice screening and mapping tool," EJSCREEN (USEPA, 2015e).

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).
- 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)
- In 2014, the USEPA issued the Policy on Environmental Justice for Working with Federally Recognized Tribes and Indigenous Peoples, which establishes principles to ensure that achieving environmental justice is part of the USEPA's work with federally recognized tribes and Indigenous Peoples in all areas of the U.S. and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands, and others living in Indian country. The policy, which is based on Executive Order 12898 as well as USEPA strategic plan and policy documents, contains 17 principles pertaining to the policy's four focus areas. These four focus areas are:
  - Direct implementation of federal environmental programs in Indian country, and throughout the U.S.;
  - Work with federally recognized tribes/tribal governments on environmental justice;
  - Work with Indigenous Peoples (state recognized tribes, tribal members, etc.) on environmental justice; and
  - Coordinate and collaborate with federal agencies and others on environmental justice issues of tribes, Indigenous Peoples, and others living in Indian country.
- The policy includes accountability for the implementation of the policy, a definitions section, and an appendix that contains a list of implementation tools available (USEPA, 2014a).

15.1.10.2. Specific Regulatory Considerations

Multiple agencies of the Commonwealth of Virginia address environmental justice matters directly or indirectly. For instance, the Virginia Department of Environmental Quality (VDEQ) addresses minority community concerns in the siting and management of solid and hazardous waste facilities. VDEQ also has developed a Community Involvement Policy. The Department of Planning and Budget in 2008 developed Model Public Participation Guidelines that were adopted by many state agencies. (University of California, Hastings College of Law, 2010)

The Virginia Department of Transportation (VDOT) explicitly addresses environmental justice in transportation-related projects. It has established guidelines for ensuring the involvement of minority/low-income communities in the project development process. These guidelines help decision-makers assess the impacts of transportation-related projects on affected communities. The guidelines apply to all types of projects requiring evaluation under the National Environmental Policy Act. They provide a consistent framework for both preparing an environmental justice analysis and developing an effective public involvement strategy. An environmental justice analysis is required for each build alternative. VDOT seeks to inform decision makers about the important issues concerning environmental justice populations and makes demographic maps available to be considered in determining project location, design and mitigation. These maps show percentages of specific population segments relating to race, age, economic status, and other factors. (Virginia Department of Transportation, 2015a; Virginia Department of Transportation, 2015b)

15.1.10.3. Environmental Setting: Minority and Low-Income Populations

Table 15.1.10-1 presents 2013 data on the composition of Virginia's population by race and by Hispanic origin. The state's population has a higher percentage of individuals who identify as Black/African American (19.3 percent) than the populations of the East region (14.4 percent) and the nation (12.6 percent). The state's percentage of persons identifying as White (69.3 percent) is somewhat smaller than that of the East region (72.1 percent) or the nation (73.7 percent).

The percentage of the population in Virginia that identifies as Hispanic (8.6 percent) is considerably smaller than in the East region (12.2 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. Virginia's All Minorities population percentage (36.5 percent) is roughly similar to the region and nation – it is higher than that of the East region (34.0 percent) and slightly lower than that of the nation (37.6 percent).

Table 15.1.10-2 presents the percentage of the population living in poverty in 2013, for the state, region, and nation. The figure for Virginia (11.7 percent) is lower than that for the East region (13.3 percent) and considerably lower than that for the nation (15.8 percent).

Table 15.1.10-1: 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		
Virginia	8,260,405	69.3%	19.3%	0.2%	5.9%	0.1%	2.0%	3.3%	8.6%	36.5%
East Region	73,558,794	72.1%	14.4%	0.3%	5.8%	0.0%	4.8%	2.7%	12.2%	34.0%
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, 2015x)

[a] "All Minorities" is defined as all persons other than Non-Hispanic White.

Table 15.1.10-2: Percentage of Population (Individuals) in Poverty, 2013

Geography	Percent Below Poverty Level
Virginia	11.7%
East Region	13.3%
United States	15.8%

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

15.1.10.4. 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 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. (See footnote 131 in Socioeconomics for further information on how data was calculated.)

Figure 15.1.10-1 visually portrays the results of the environmental justice population screening analysis for Virginia. The analysis used block group data from the Census Bureau's American Community Survey 2009-2013 5-Year Estimates (U.S. Census Bureau, 2015j; U.S. Census Bureau, 2015k; U.S. Census Bureau, 2015l; U.S. Census Bureau, 2015n) and Census Bureau urban classification data (U.S. Census Bureau, 2010a) (U.S. Census Bureau, 2010b).

Figure 15.1.10-1 shows that Virginia has many areas with High Potential for environmental justice populations. The distribution of these High Potential areas is fairly even across the state, and occurs both within and outside of the 10 largest population concentrations. The distribution of areas with Moderate Potential for environmental justice populations is also fairly even across the state.

It is important to understand how the data behind Figure 15.1.10-1 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 may 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 15.1.10-1 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.

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 15.2) addresses the potential for disproportionately high and adverse environmental or human health impacts on environmental justice populations.

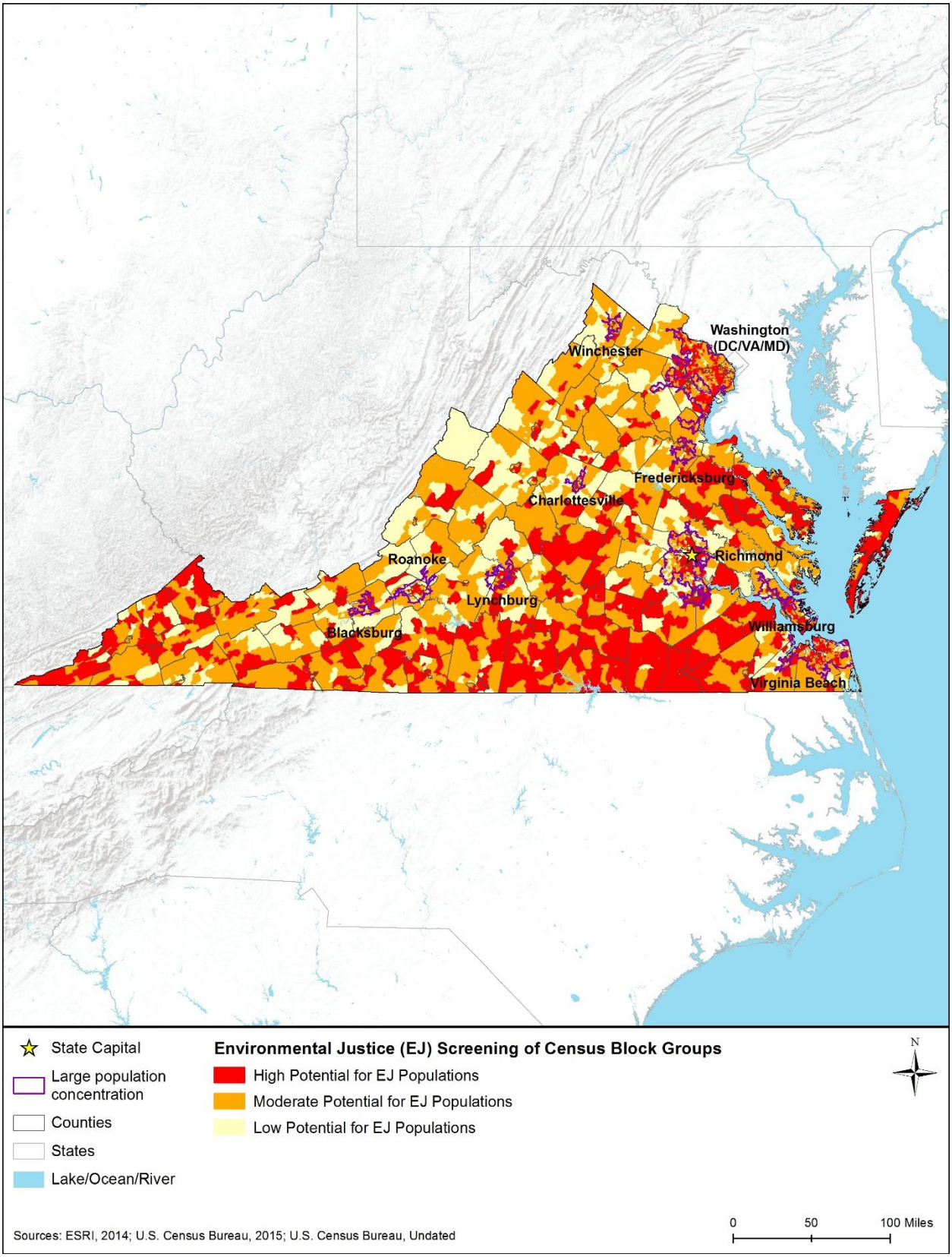


Figure 15.1.10-1: Potential for Environmental Justice Populations in Virginia, 2009–2013

15.1.11. Cultural Resources

15.1.11.1. Definition of the 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 U.S.C. 470a(d)(6)(A) (now 54 U.S.C. 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 U.S.C. 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 U.S.C. 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, 2015ad); 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).

15.1.11.2. Specific Regulatory Consideration

Applicable federal laws and regulations that apply to Cultural Resources include the NHPA, the American Indian Religious Freedom Act (AIRFA), ARPA, and NAGPRA. Appendix C summarizes these pertinent federal laws.

Virginia has a state law that is similar to NEPA and the NHPA (refer to Table 15.1.11-1). However, federal laws and regulations supersede this law. 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 15.1.11-1: Relevant Virginia Cultural Resource Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Virginia Environmental Impacts Report Act (§ 10.1-1188 Code of Virginia)	Virginia Department of Environmental Quality (DEQ), Virginia Department of Historic Resources (DHR) (SHPO)	This Act requires the DEQ to "provide comments on the environmental impacts of all major state projects," and the State Historic Preservation Office (SHPO) "is invited to submit comments to the Department of Environmental Quality when an environmental impact report describes a project that might affect historic properties or archaeological sites." (Virginia Department of Historic Resources, 2011)
Permit Required for the Archaeological Excavation of Human Remains (§ 10.1-2305 Code of Virginia)	SHPO	There are multiple laws that deal with discovery, disturbance, excavation, removal, transportation, and prosecution/damages related to human remains, graves, and cemeteries. The main law that applies to discocvery and/or excavation of human remains, which integrates the various other laws, is the permit process that is required from the SHPO. The intent of the protocol is to protect unmarked human remains from construction, agriculture and other ground disturbing activities. If a burial is uncovered during development or construction, work must stop immediately in the area and local law enforcement should be notified. Following determination that the site does not constitute a crime scene and the remains are a prehistoric or historic human burial, the SHPO may assist the project proponent, developer, and/or landowner in contacting appropriate parties, considering options to avoid the burial(s), and advising on the legal process for potentially moving the remains.

Sources: (Virginia Department of Historic Resources, 2011) (Virginia Law, 2017g)

15.1.11.3. Cultural Setting

Virginia has been inhabited by human beings for 12,000 years (Cantwell & diZerega Wall, 2001; Haynes, Johnson, & Stafford, 1999; Pauketat, 2012); however, due to a relatively wet climate that degrades and moves artifacts, the state's archaeological record is less reliable than that of more arid parts of the United States (Ritchie, 1969). The majority of early human habitation evidence in the state 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 171 archaeological sites and archaeological districts listed on the NRHP in Virginia (NPS, 2014d).

Archaeologists typically divide large study areas into regions. As shown in Figure 15.1.11-1, Virginia occupies two physiographic regions: Appalachian Highlands and Atlantic Plain. The Appalachian Highlands region is further divided into four provinces. The Appalachian Plateaus province is in the southwest corner of the state. The Valley and Ridge province spans the full length of the state between the Tennessee border in the southwest and West Virginia in the north. The Blue Ridge province is a chain of mountains that parallels the Valley and Ridge province, and contains the Blue Ridge and Shenandoah Mountains. The Piedmont is the largest physiographic province in Virginia, covering the central portion of the state, between the North Carolina border in the south to and Maryland in the north. The Atlantic Plain physiographic

region has only a single province in Virginia, the Coastal Plain, which includes the Tidewater area and Eastern Shore of the state.

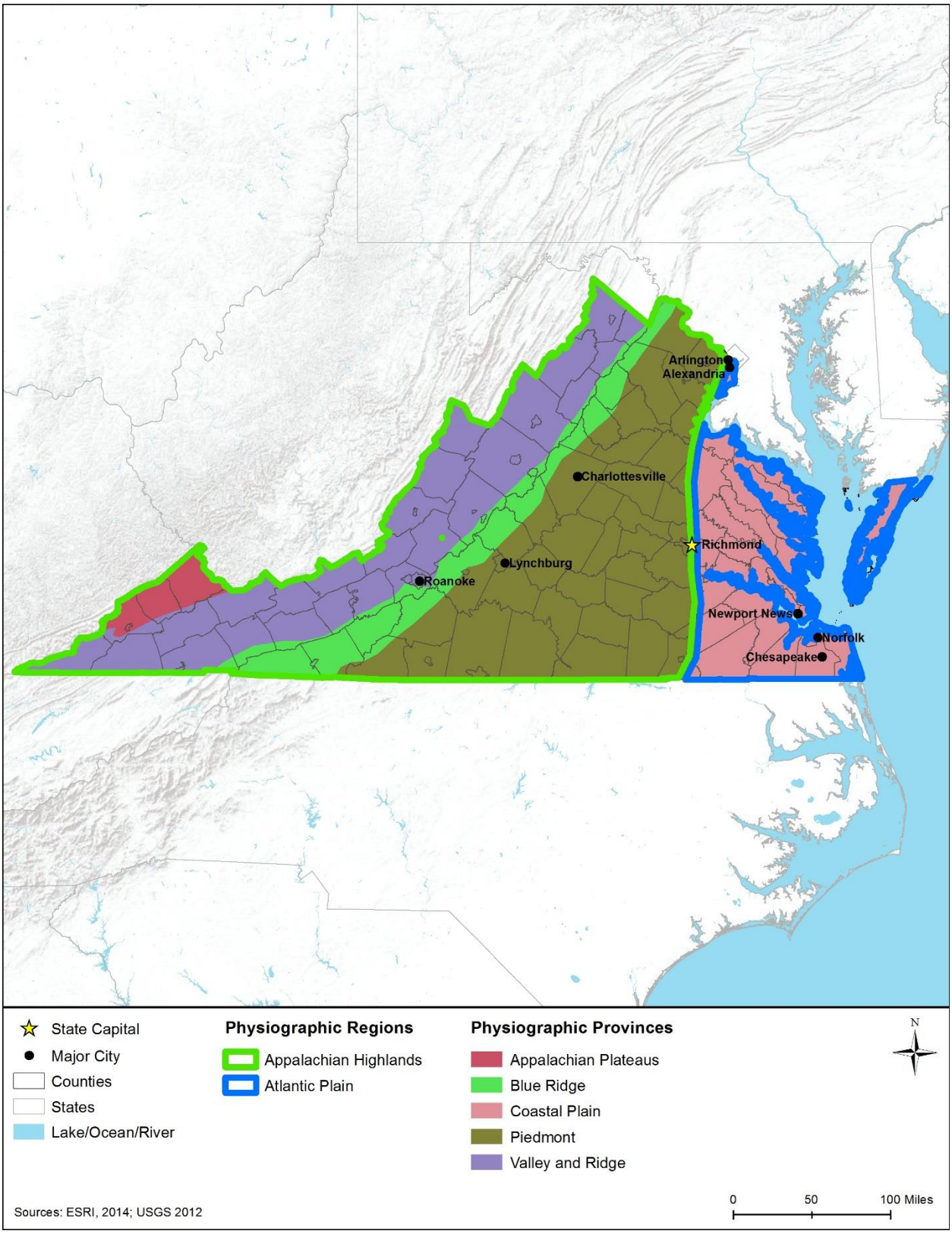
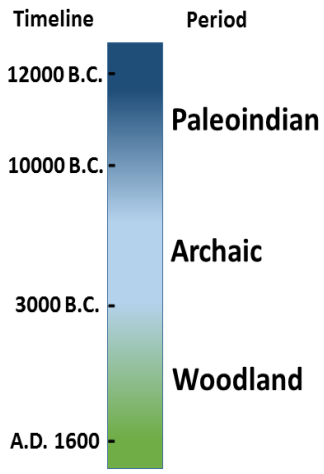


Figure 15.1.11-1: Virginia Physiographic Regions

15.1.11.4. Prehistoric Setting

There are three distinct periods associated with the prehistoric human populations that inhabited present day Virginia and the greater Northeast geography of North America: The Paleoindian period (12,000 to 10,000 B.C.), Archaic (10,000 to 3,000 B.C.), and Woodland (3,000 B.C. to A.D. 1600) (Pauketat, 2012; Institute of Maritime History, 2015; Holiday, Johnson, & Stafford, 1999). Figure 15.1.11-2 shows a timeline representing these periods of early human habitation in North America, including present day Virginia. It is important to note that there is potential for undiscovered archaeological remains representing every prehistoric period throughout the state. Evidence of human occupation have been discovered throughout the state. During early archaeological research, there was often no clear distinction between prehistoric periods in the archaeological record, due to overlaps between phases of cultural development (Ritchie, 1969). With advancements in radiocarbon dating techniques, dates of each period in the archaeological record have been increasingly more accurate, and there is less overlap in the timeline of human occupation in North America (Pauketat, 2012). Radiocarbon dating techniques and associating artifacts discovered with similar ones previously assigned to a particular range of the archaeological record continue to become increasingly accurate (Pauketat, 2012; Haynes, Donahue, Jull, & Zabel, 1984; Haynes, Johnson, & Stafford, 1999).



Source: (Institute of Maritime History, 2015; Pauketat, 2012)

Figure 15.1.11-2: Timeline of Prehistoric Human Occupation

The Paleoindian Period represents the earliest human habitation of Virginia and the Mid-Atlantic United States. The earliest people to occupy the state were small groups of nomadic hunters and gatherers that used chipped-stone tools, including the "fluted javelin head" arrow and spear points, also referred to as the Clovis fluted point. Early hypotheses in American archaeology

suggested that the Clovis fluted point was not invented until prehistoric people reached North America and began hunting the large game of that period (Ritchie, 1969). However, studies that are more recent show that such technology was prevalent in northeastern Asia, the Arabian Peninsula, and Spain prior to human arrival into North America (Charpentier & Inizan, 2002). Archaeologists hypothesize that the people of this period ranged across Virginia in small bands in pursuit of migratory game. Early Paleoindian settlers used the Clovis fluted-point technology to hunt large game, such as mastodon, horse, caribou, stag-moose, and giant beaver (Laub, 2000).

Paleoindian camps appear to have been occupied seasonally, with some sites that may have formed the basis for more permanent settlements. No skeletal remains of these people have been identified to date in the state. This group of hunters and gatherers were related to a population of inhabitants that spread into North America via a land bridge at the Bering Strait during the latter part of the last ice age (Late Pleistocene epoch) (Ritchie, 1969; Laub, 2000; Robinson, 2011; West Virginia Division of Culture and History, 2015).

By the end of the Pleistocene, the climate of Virginia started getting warmer and drier. Rising sea levels caused the coastal plain of Virginia to be inundated by water, forming what we now know as Chesapeake Bay. With the gradually rising sea, people of the Archaic Period moved inland to the tidewater grasslands and interior pine, oak, and hickory forests of the state. Then as large game such as the mastodon became extinct, subsistence patterns changed to the hunting of smaller animals such as deer, elk, bear, turkey, rabbit, and fox. In general, the forests of Virginia had an increasing abundance of flora and fauna during the Early Archaic Period, thus allowing for an expansion in diet that included nuts, berries, and other foods. Correspondingly, the people of this period expanded on their ability to make stone tools, manufacturing stone spear points, knives, scrapers, gravers, and drills (Virginia Department of Historic Resources, 2015a).

During the Middle Archaic Period, the people of the region became increasing proficient at adjusting their skills on the seasons (Virginia Department of Historic Resources, 2015b). Archaeologists have discovered many seasonal campsites throughout the state from this period, which has been interpreted as a period of substantial population growth. Tools such as the atlatl javelin[134] have been recovered throughout the state, indicating that Middle Archaic people were developing more sophisticated hunting practices (Bolton, 1971; Ritchie, 1969; Virginia Department of Historic Resources, 2015b). Other stone implements, such as projectile points (arrowheads), axes, and hammerstones have been documented for this period (Virginia Department of Historic Resources, 2015b).

Archaeological sites of the Late Archaic Period are well documented throughout Virginia. Hardwood forests dominated the region and the subsistence base for inhabitants included white tail deer, black bear, small game animals, and aquatic and wild vegetable food sources. The warmer climate, and abundance and variety of food sources, led to population increases, by new migration of groups from outside the region, increases of indigenous populations, or both.

[134] The atlatl javelin was a spear-throwing device with a stone weight. The weight was placed on a narrow board, which works like a lever, and the device projected out behind the throwing hand, permitting the javelin resting into its end to be hurled with greater force and precision (Bolton, 1971; Ritchie, 1969).

Archaeological evidence suggests the Late Archaic Period was a time of substantial population growth, with a total state population in the tens of thousands. As exploitation of food sources intensified, and bands began to settle along riverbanks and floodplains (Ritchie, 1969; Levine, 2004; Virginia Department of Historic Resources, 2015b).

Societies during this period in Virginia became much more sophisticated. People were beginning to live in small villages, which were a more permanent base that led to a more egalitarian society with leaders and distinct stratification of duties. The institution of marriage was also established during this period (Virginia Department of Historic Resources, 2015c).

During the Early Woodland Period in Virginia clay cooking and storage vessels were first developed. Archeological research of Early Woodland sites also show the first period when people began to live in permanent houses, which suggests that their lifestyle was becoming less nomadic and more sedentary. (Virginia Department of Historic Resources, 2015d) However, the main technology that differentiates the Woodland Period from the Archaic Period is the development and use of pottery, which originated in the Southeastern United States during the late Archaic Period and spread northward to Virginia and elsewhere (Sassaman, 1998).

By the Middle Woodland period, large and diverse tribes were settling along major rivers of the state. Social structures became more complex and sophisticated, with people beginning to participate in ranked cultures. Technological advances were also made — the bow and arrow began to replace spears, and axes were designed for more effective woodworking. This period also saw an increase in artistic expression, often through decoration of tobacco pipes. (Virginia Department of Historic Resources, 2015e)

By the Late Woodland Period, populations were living in large and sometimes palisaded settlements across the region. These villages provided safety and stability for the inhabitants, and fostered the development of complex political, social, and economic structures. Innovations of increasing craftsmanship included the development of needles, fishhooks, and ceremonial objects. Populations of this period also become more reliant on intensive gardening as a primary source for food. (Virginia Department of Historic Resources, 2015f)

15.1.11.5. Federally Recognized Tribes of Virginia

According to the Bureau of Indian Affairs and the National Conference of State Legislators, there is one federally recognized Tribe in Virginia: the Pamunkey Indian Tribe (National Conference of State Legislators, 2015; GPO, 2015). The Pamunkey Indian Tribe, once part of the Powhatan Confederacy, owns a small reservation, as described in Section 15.1.7. Figure 15.1.11-3 depicts the general historic location of officially federally-recognized tribes that were known to exist in this region of the United States, but are no longer present in the state.

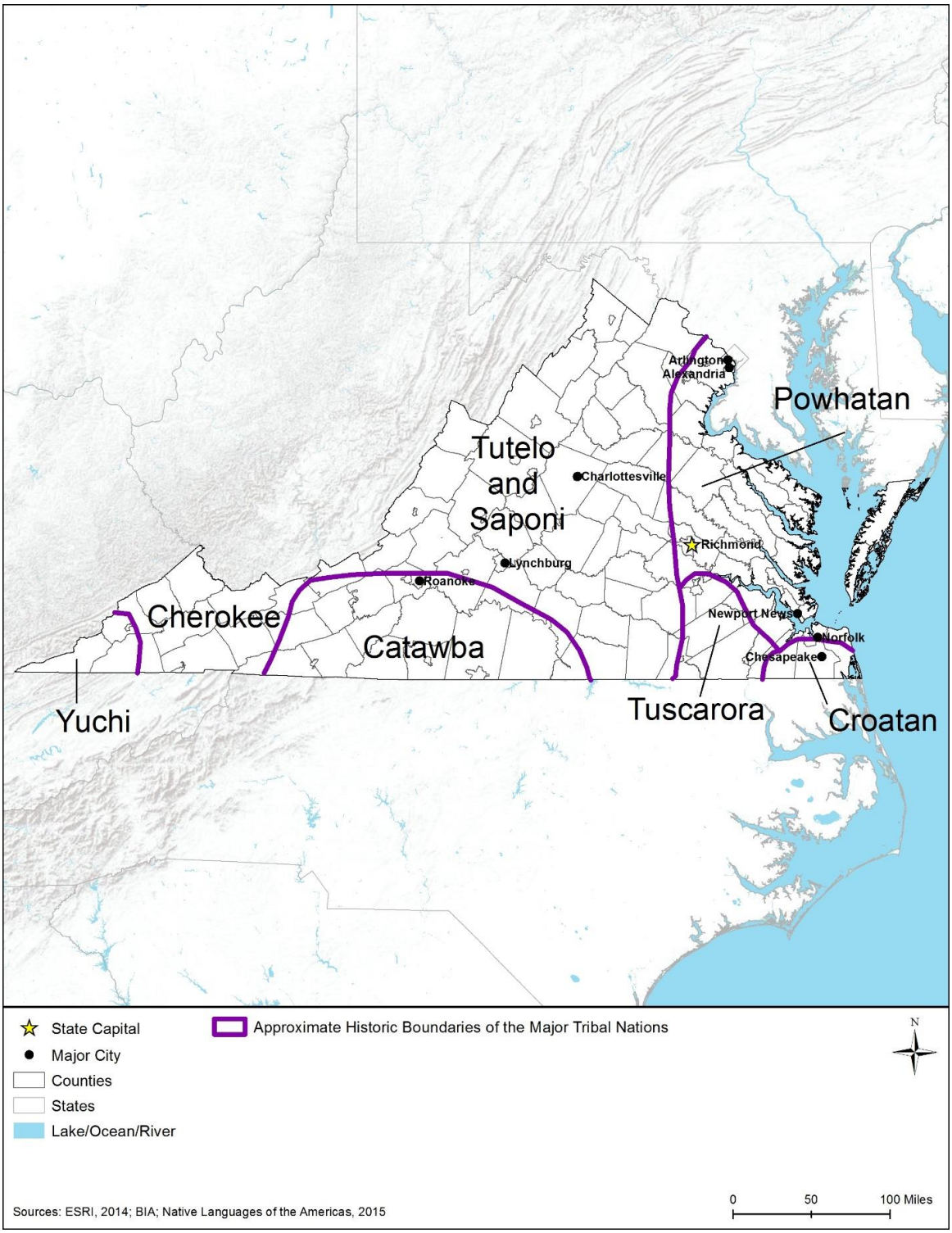


Figure 15.1.11-3: Federally Recognized Tribes in Virginia[135]

[135] Figure 15.1.11-3 is provided for context and is not intended to be exact as the various sources that were consulted contain varying ancestral territory boundaries. Instead, this figure and corresponding ancestral territory boundaries are provided to show that the historic ancestral territories and the current ancestral interests of a given tribe within a given state are often times complex as ancestral territory boundaries shifted and overlapped over time.

15.1.11.6. Significant Archaeological Sites of Virginia

There are 171 archaeological sites in Virginia listed on the NRHP. Table 15.1.11-2 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. A current list of NRHP sites can be found on the NPS NRHP website at http://www.nps.gov/nr/ (NPS, 2014e).

Virginia State Cultural Resources Database and Tools

Virginia Cultural Resources Information System (VCRIS)

The Virginia Cultural Resource Information System (VCRIS) serves as the Virginia Department of Historical Resources' (DHR) online cultural resource inventory. The system provides access to information in the DHR's Archives about properties, sites, and historic districts. It streamlines data entry and reporting, and offers enhanced functionality for responding to a user's data requests. A link to the system homepage can be found here: http://www.dhr.virginia.gov/archives/archiv_vcrisHome.htm (VRE, 2015)

Council of Virginia Archaeologists (CoVA)

The Council of Virginia Archaeologists is Virginia's professional archaeology organization. CoVA was founded in 1975 as an organization dedicated to the preservation and study of Virginia's archaeological resources. The council maintains multiple resources on their website (http://cova-inc.org) including artifact databases (Culture Embossed), publications, and links to related organizations. (CoVA, 2015)

Table 15.1.11-2: Archaeological Sites on the National Register of Historic Places in Virginia

Closest City	Site Name	Type of Site
Alexandria (Independent City)	Alexandria Canal Tide Lock	Historic
Altavista	Leesville Dam Archeological Site (44PY30)	Prehistoric
Arlington	Fort C. F. Smith Historic District	Historic - Military
Arvonia	Seven Islands Archeological and Historic District	Prehistoric
Austinville	Cornett Archeological Site (44WY1)	Prehistoric
Barboursville	Hampstead Farm Archeological District	Historic, Prehistoric
Berryville	Cool Spring Battlefield	Historic - Military
Blacksburg	Kentland Farm Historic and Archeological District	Historic, Prehistoric
Blacksburg	Kentland Farm Historic and Archeological District (Boundary Increase)	Historic, Prehistoric
Blackstone	Little Mountain Pictograph Site	Prehistoric
Boissevain	Moore, Capt. James, Homestead	Historic
Boones Mill	Early, Jubal A., House	Historic - Military
Boydton	Rudd Branch Ridge--Complexes #1 and #2	Historic
Broad Run	Thoroughfare Gap Battlefield	Historic - Military

Closest City	Site Name	Type of Site
Brooke	Potomac Creek Site	Historic - Aboriginal
Brookneal	Indian Jim's Cave	Historic, Prehistoric
Buchanan	Looney Mill Creek Site	Historic, Prehistoric
Buffalo Junction	Buffalo Springs Historical Archeological District	Historic
California	Rockbridge Alum Springs Historic District	Historic
Capeville	Arlington Archeological Site	Historic, Historic - Aboriginal, Prehistoric
Carson	Conover Archaeological Site	Prehistoric
Castle Heights	Elm Hill Archaeological Site	Prehistoric
Chancellor	Tubal Furnace Archeological Site	Historic, Military
Charles City	Fort Pocahontas	Historic - Military
Charles City	Hilton, Aaron, Site	Historic
Charles City	Weyanoke	Historic, Historic - Aboriginal, Prehistoric, Military
Charlottesville (Independent City)	Jefferson School, Carver Recreation Center, and School Site	Historic
Chesapeake (Independent City)	Great Bridge Battle Site	Historic - Military
Chester	Dale's Pale Archeological District	Historic, Historic - Aboriginal, Prehistoric
Clarksville	Sydnor, Patrick Robert, Log Cabin	Historic
Colonial Heights (Independent city)	Conjurer's Field Archeological Site (44CF20)	Prehistoric
Colonial Heights (Independent City)	Conjurer's Neck Archeological District	Historic, Prehistoric
Colonial Heights (Independent City)	Fort Clifton Archeological Site	Historic - Military
Columbia	Point of Fork Arsenal	Historic - Military
Croaker	Croaker Landing Archaeological Site (44JC70)	Prehistoric
Culpepper	Germanna Site	Historic - Military
Davis Wharf	Scarborough House Archaeological Site (44AC4)	Historic
Dinwiddie	Williamson Site	Prehistoric
Dublin	Spring Dale	Historic, Military
Dumfries	Leesylvania Archeological Site (44PW7)	Historic
Dungannon	Flanary Archeological Site (44SC13)	Prehistoric
Dutch Gap	Henrico	Historic
Eagle Rock	Bessemer Archaeological Site (44 BO 26)	Historic - Aboriginal, Prehistoric
Elliston	Madison Farm Historic and Archeological District	Historic, Prehistoric
Emporia	Green, John, Archaeological Sites	Historic, Historic - Aboriginal, Prehistoric
Farmville	Sayler's Creek Battlefield	Historic - Military
Ferrum	Otter Creek Archaeological Site (44FR31)	Prehistoric
Fincastle	Bowyer--Holladay House	Historic

Closest City	Site Name	Type of Site
Fort Chiswell	Fort Chiswell Site	Historic - Military
Fosters Falls	Martin Site	Prehistoric
Fredericksburg	Ferry Farm Site	Historic
Fredericksburg	Washington, George, Boyhood Home Site	Historic
Fredericksburg (Independent City)	Fredericksburg Gun Manufactory Site	Historic
Front Royal	Flint Run Archeological District	Prehistoric
Gala	Gala Site	Prehistoric
Garysville	Flowerdew Hundred Plantation	Historic, Historic - Aboriginal, Prehistoric
Gloucester	Cappahosic House	Historic
Gloucester	Gloucester Point Archaeological District	Historic - Military
Gloucester	Rosewell	Historic
Gloucester	Werowocomoco Archeological Site	Historic - Aboriginal, Prehistoric
Hague	Jones, Morgan, 1677 Pottery Kiln	Historic
Hampton (Independent City)	Chesterville Plantation Site	Historic
Harrisburg	Cove, The	Historic - Aboriginal, Prehistoric
Hayes	Shelly Archeological District	Historic, Historic - Aboriginal, Prehistoric
Highgate	Walnut Valley	Historic
Hopewell	Eppes Island	Historic, Historic - Aboriginal, Prehistoric
Hopewell	Hatch Archeological Site (44PG51)	Historic, Historic - Aboriginal, Prehistoric
Hopewell (Independent City)	Kippax Plantation Archeological Site	Historic
Jamestown	Governor's Land Archeological District	Historic
Jamestown	Jamestown National Historic Site	Historic
Kelly	Mount Athos	Historic
King and Queen Courthouse	Newington Archaeological Site	Historic, Prehistoric
Lanesville	Pamunkey Indian Reservation Archaeological District	Historic, Prehistoric
Lawrenceville	Fort Christanna	Historic - Military
Lebanon	Daugherty's Cave and Breeding Site	Prehistoric
Leesburg	Ball's Bluff Battlefield and National Cemetery	Historic - Military
Leesburg	Francis--Gulick Mill	Historic
Leesburg	Old Stone Church Archeological Site (44LD376)	Historic
Lexington	Anderson Hollow Archaeological District	Historic, Prehistoric
Lexington	Liberty Hall Site	Historic
Limeton	Thunderbird Archeological District	Prehistoric
Lorton	Taft Archeological Site #029-5411	Prehistoric

Closest City	Site Name	Type of Site
Luray	Archeological Site No. AU-154	Prehistoric
Luray	Big Meadows Site	Prehistoric
Luray	Big Run Quarry Site	Prehistoric
Luray	Blackrock Springs Site	Prehistoric
Luray	Cliff Kill Site	Prehistoric
Luray	Compton Gap Site	Prehistoric
Luray	Gentle Site	Prehistoric
Luray	Jeremey's Run Site	Prehistoric
Luray	Paine Run Rockshelter	Prehistoric
Luray	Robertson Mountain Site	Prehistoric
Madison Heights	Fort Riverview (44AH91 and 44AH195)	Historic - Military
Maiden Spring	Indian Paintings	Prehistoric
Manassas	Mayfield Fortification (44PW226)	Historic - Military
Manassas (Independent City)	Cannon Branch Fort	Historic - Military
Manassas Park	Louisiana Brigade Winter Camp	Historic - Military
Manassas Park	Mitchell's Ford Entrenchments	Historic - Military
Manassas Park	Orange and Alexandria Railroad Bridge Piers	Historic
Marine Corps Base, Quantico	Camp French	Historic - Military
Marine Corps Base, Quantico	Rising Hill Camp	Historic - Military
Marine Corps Base, Quantico	Tennessee Camp	Historic - Military
Martinsville	Martinsville Fish Dam	Prehistoric
McMullin	Fox Farm Site	Prehistoric
Mechanicsville	Hanover Meeting House	Historic, Military
Mechanicsville	Hanover Town	Historic
Middletown	Cedar Creek Battlefield and Belle Grove	Historic - Military
Midland	Germantown Archeological Sites	Historic
Mockhorn Island	Upper Ridge Site	Prehistoric
Monroe Hall	Monroe, James, Family Home Site (Boundary Increase)	Historic
Montross	Chantilly	Historic
Newport News (Independent City)	Boldrup Plantation Archeological Site	Historic
Newport News (Independent City)	Denbigh Plantation Site	Historic
Newport News (Independent City)	First Denbigh Parish Church Archeological Site	Historic
Newport News (Independent City)	Fort Crafford	Historic - Military
Newport News (Independent City)	Queen Hith Plantation Complex Site	Historic, Prehistoric

Closest City	Site Name	Type of Site
Newport News (Independent City)	Richneck Plantation Site	Historic
Newport News (Independent City)	Skiffes Creek Sand Spit Site	Prehistoric
Newport News (Independent City)	Southern Terminal Redoubt	Historic - Military
Oak Grove	Monroe, James, Family Home Site	Historic
Overall	Milford Battlefield	Historic - Military
Pamplin	Pamplin Pipe Factory	Historic
Petersburg	Five Forks Battlefield	Historic - Military
Petersburg	Petersburg Breakthrough Battlefield	Historic - Military
Petersburg (Independent City)	Pocahontas Island Historic District	Historic, Historic - Aboriginal
Port Conway	Millbank	Historic
Port Conway	Woodlawn Historic and Archeological District	Historic, Historic - Aboriginal, Prehistoric
Port Republic	Bogota	Historic
Port Royal	Camden	Historic - Aboriginal
Radford	Arnheim	Historic
Radford	Ingles Bottom Archeological Sites	Historic, Historic - Aboriginal, Prehistoric
Randolph	Wade Archeological Site (44CH0062)	Prehistoric
Richmond	Falling Creek Ironworks Archeological Site	Historic
Richmond	Richmond National Battlefield Park	Historic - Military
Rose Hill	Ely Mound	Historic - Aboriginal, Prehistoric
Rushmere	Basses Choice--Days Point Archeological District	Historic, Prehistoric
Saltville	Saltville Battlefields Historic District	Historic, Military
Scotland	Swann's Point Plantation Site	Historic
Selden	Site 44GL103--Quest End	Historic
Simonson	Indian Banks	Historic
Smithfield	Fort Boykin Archaeological Site (44IW20)	Historic - Military
South Boston	Reedy Creek Site	Historic - Aboriginal
Stafford	Accokeek Furnace Archeological Site (44ST53)	Historic
Stafford	Public Quarry at Government Island	Historic, Historic - Aboriginal, Prehistoric
Stafford	Redoubt #2	Historic - Military
Stony Creek	Nottoway Archeological Site (44SX6, 44SX7, 44SX98, 44SX162)	Prehistoric
Studley	Patrick Henry's Birthplace Archeological Site	Historic
Suffolk (Independent City)	Dumpling Island Archeological Site	Historic - Aboriginal, Prehistoric
Suffolk (Independent City)	Knotts Creek--Belleville Archeological Site	Historic, Prehistoric

Closest City	Site Name	Type of Site
Surry	Second Southwark Church Archeological Site (44SY65)	Historic
Surry	Smith's Fort	Historic
Tazewell	Big Crab Orchard Site	Historic, Historic - Aboriginal, Prehistoric, Military
Tazewell	Bull Thistle Cave Archeological Site (44TZ92)	Prehistoric
Toano	Chickahominy Shipyard Archeological Site	Historic - Military
Toano	Moysonec	Historic, Prehistoric
Toano	Stone House Site	Historic
Varina	Varina Plantation	Historic, Military
Walkerton	Fort Mattapony	Historic - Military
Warm Springs	Hidden Valley Rock Shelter (44BA31)	Prehistoric
Weems	Corotoman	Historic
White Marsh	Fairfield Site	Historic
White Marsh	Point Lookout Archaeological Site	Historic
Williamsburg	Archeological Site No. 44JC308	Historic, Historic - Aboriginal, Prehistoric
Williamsburg	Bruton Parish Poorhouse Archeological Site	Historic
Williamsburg	Bryan Manor	Historic
Williamsburg	Whitaker's Mill Archeological Complex	Historic, Military
Williamsburg (Independent City)	College Landing	Prehistoric
Winchester (Independent City)	Fort Loudoun Site	Historic - Military
Yorktown	Gooch, William, Tomb and York Village Archeological Site	Historic, Military
Yorktown	Gooch, William, Tomb and York Village Archeological Site (Boundary Decrease)	Historic, Military
Yorktown	Yorktown Wrecks	Shipwreck, Military

Source: (NPS, 2015ac)

15.1.11.7. Historic Context

European settlement attempts in Virginia occurred in the late 16th century with the formation of the Roanoke colony; however, England soon after became involved in a war with Spain, and the Roanoke colony was effectively abandoned, resulting in its disappearance. Spain had attempted a settlement in Virginia prior to Roanoke, but the mission they built was destroyed by Indians in 1571. In 1607, England attempted another settlement in the area, named Jamestown, which was successful and became the first permanent English settlement in America. Jamestown was established by the Virginia Company of London, and was meant to rival Spain's claims to the south. Captain John Smith emerged as a leader of the colony and helped ensure its success (Heinemann, Kolp, Parent Jr., & Shade, 2007).

The Virginia settlement soon expanded beyond Jamestown, with tobacco becoming an important export, and by the middle of the 17th century Virginia was a stable colony. Large planters came

to hold a majority of the power, with indentured servants, and eventually enslaved Africans, performing most of the work on these plantations. This power system bred resentment and there were several unsuccessful attempted uprisings. In 1693, the College of William and Mary was charted, and in 1698, the capital of the colony was moved from Jamestown to Middle Plantation, which was soon renamed Williamsburg (Heinemann, Kolp, Parent Jr., & Shade, 2007).

During the French and Indian War, fighting occurred in Virginia relating to control over the Ohio River Valley. Later in the century, Virginians such as George Washington, Thomas Jefferson, Patrick Henry, and James Madison had key roles in the politics leading to the American Revolution. During the American Revolution, the capital was moved from Williamsburg to Richmond for fear of a British attack; however, Richmond was still sacked and burned during the conflict. Ultimately, with the help of French forces, the British were defeated at Yorktown in 1781, and the Treaty of Paris was signed on September 3, 1783 ending the war (Heinemann, Kolp, Parent Jr., & Shade, 2007).

Virginia supplied four of the first five presidents, and the historic estates of these leaders draw visitors today. Virginia ceded a portion of the land that would become the District of Columbia, including Alexandria; however, this portion was retroceded to the state in 1847 (D.C. Historic Preservation Office, 2013). Prior to the outbreak of the Civil War, Virginia was at first reluctant to involve itself in the conflict, but ultimately chose to secede on April 17, 1861. It was at this time that West Virginia broke away and aligned itself with the Union. During the war, Richmond served as the capital of the Confederacy, and General Robert E. Lee's Army of Northern Virginia heralded from the state. Numerous battles and critical events occurred on Virginia soil, including Manassas, which marked the beginning of the conflict here, and Lee's eventual surrender at Appomattox on April 9, 1865 (Heinemann, Kolp, Parent Jr., & Shade, 2007).

During the late 19th century, tobacco continued to be grown, and although it was grown by sharecroppers rather than slaves, worker conditions had not changed dramatically. While the state prospered during this time, northern "carpetbaggers" owned much of the state's economy. Urbanization was also common during the late 19th and early 20th centuries, as African Americans sought better living conditions by moving into cities. During World War I (WWI), thousands of Virginians served abroad and, and following the war, the New Deal programs of the Great Depression were implemented in the state. Despite this, the state remained averse to the programs and contributed little of the required matching relief money (Heinemann, Kolp, Parent Jr., & Shade, 2007).

During World War II (WWII), Virginians again served in the military, and the conflict helped pull the economy out of the Great Depression. The state experienced significant growth as a result of the accompanying military buildup and long-term growth of the federal government and military, including construction of the Pentagon in Arlington, VA. Suburbanization related to this growth continues to occur today, particularly around Washington, D.C., Richmond, Norfolk, and other large cities and military installations (Heinemann, Kolp, Parent Jr., & Shade, 2007).

Virginia has 2,993 National Register of Historic Places (NRHP) listed sites, as well as 120 National Historic Landmarks (NHL) (NPS, 2014f). Virginia contains two National Heritage

Areas, the Shenandoah Valley Battlefields National Historic District, and the Journey through Hallowed Grounds National Heritage Area, the latter of which is shared with Maryland (NPS, 2015y). Figure 15.1.11-4 shows the locations of NHA and NRHP sites within the state of Virginia.[136]

15.1.11.8. Architectural Context

European architecture in Virginia predates the 17th century. The first structures were built in Roanoke (now part of North Carolina), and while little is known about the settlement, palisades and fortification would have been common. Early "Virginia houses" were earthfast structures (post-in-ground), and were made of wood. These houses replicated building types brought from England and were usually 1-room structures lacking a wooden floor, sometimes without windows, and exterior end chimneys. Walls were usually wattle and daub and roofs were covered with wood or thatch; brick was sometimes used for foundations or chimneys (Wilson R. G., 2002) (Carson & Lounsbury, 2013). Tobacco production allowed certain farmers to amass great wealth, who in turn built substantial and impressive dwellings. Bacon's Castle is an example of a surviving 17th century brick house and can illustrate how wealthier colonists lived (Preservation Virginia, 2015).

In the late 17th century, following the chartering of the College of William and Mary, the capital was moved to Williamsburg (Wilson R. G., 2002). Buildings exhibited Georgian characteristics, with the Wren Building (1700) being an example that still exists today (The Colonial Williamsburg Foundation, 2015b). In the 20th century, additional Colonial Era buildings in Williamsburg were rehabilitated or reconstructed and the town now serves as a tourist destination. Georgian architecture continued to be popular up until the American Revolution, and features details such as decorative cornices, symmetrical window placement, and multi-pane sash windows (Carson & Lounsbury, 2013). Mount Airy (1758 to 1764), in Richmond County, is an excellent example of a high-style 5-part plan house from this period (Mount Airy Plantation, 2015).

Examples of public architecture exist as well, such as St. Luke's Church, Isle of Wight County (17th century), the oldest existing church in Virginia; several pre-revolutionary courthouses also exist (Wilson R. G., 2002). These public works appeared later in western and southern portions of the state, as development lagged behind that of the Tidewater and Piedmont regions. Architecture in the western portion of Virginia remained focused around security, from both the French and Indians, and included fortifications to protect English assets. Major settlement west of the Piedmont remained delayed until after the American Revolution (Lee, et al., 2015).

[136] See Section 15.1.7 for a more in-depth discussion of additional historic resources as they relate to recreational resources.

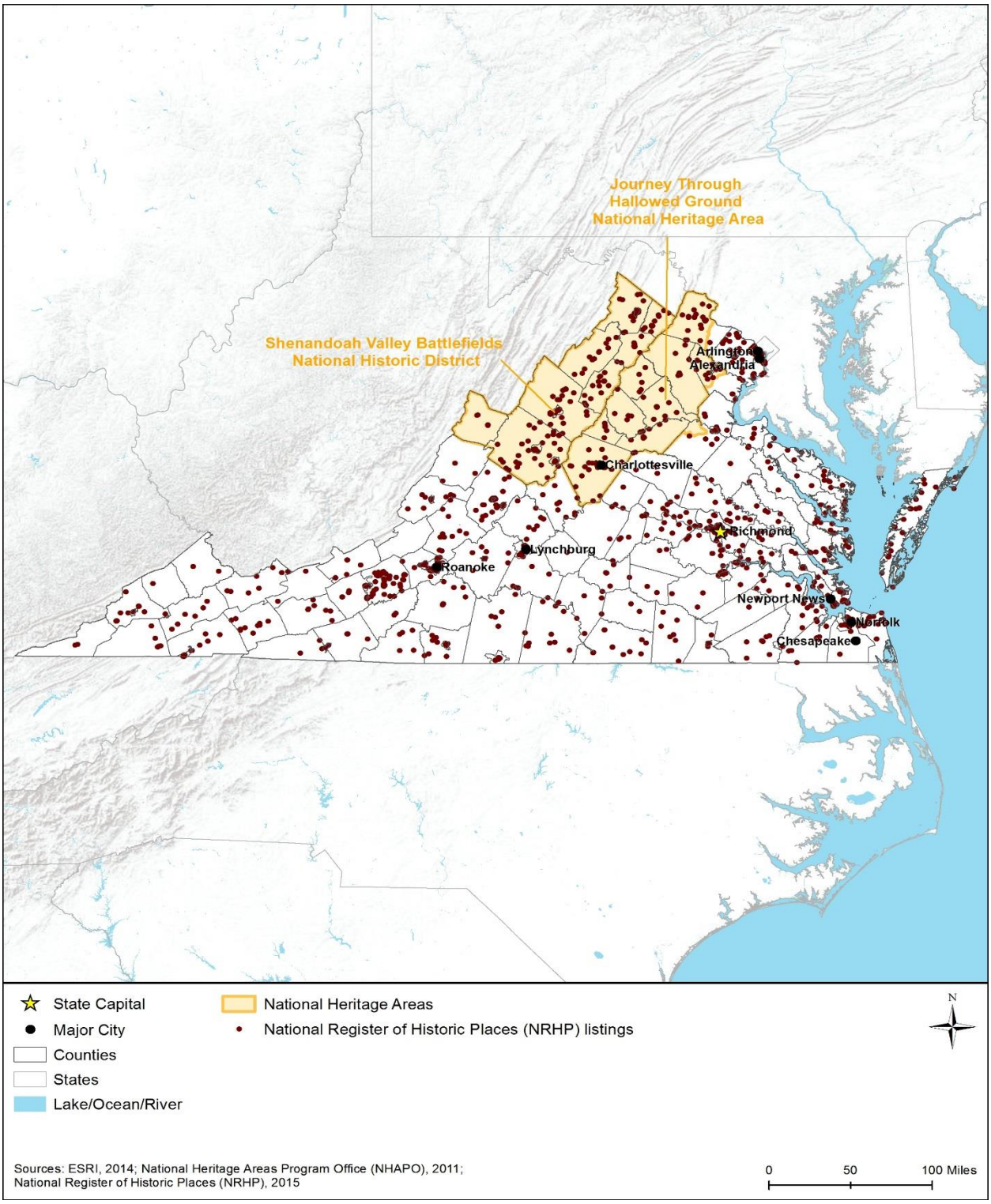


Figure 15.1.11-4: National Heritage Area (NHA) and National Register of Historic Places (NRHP) Sites in Virginia[137]

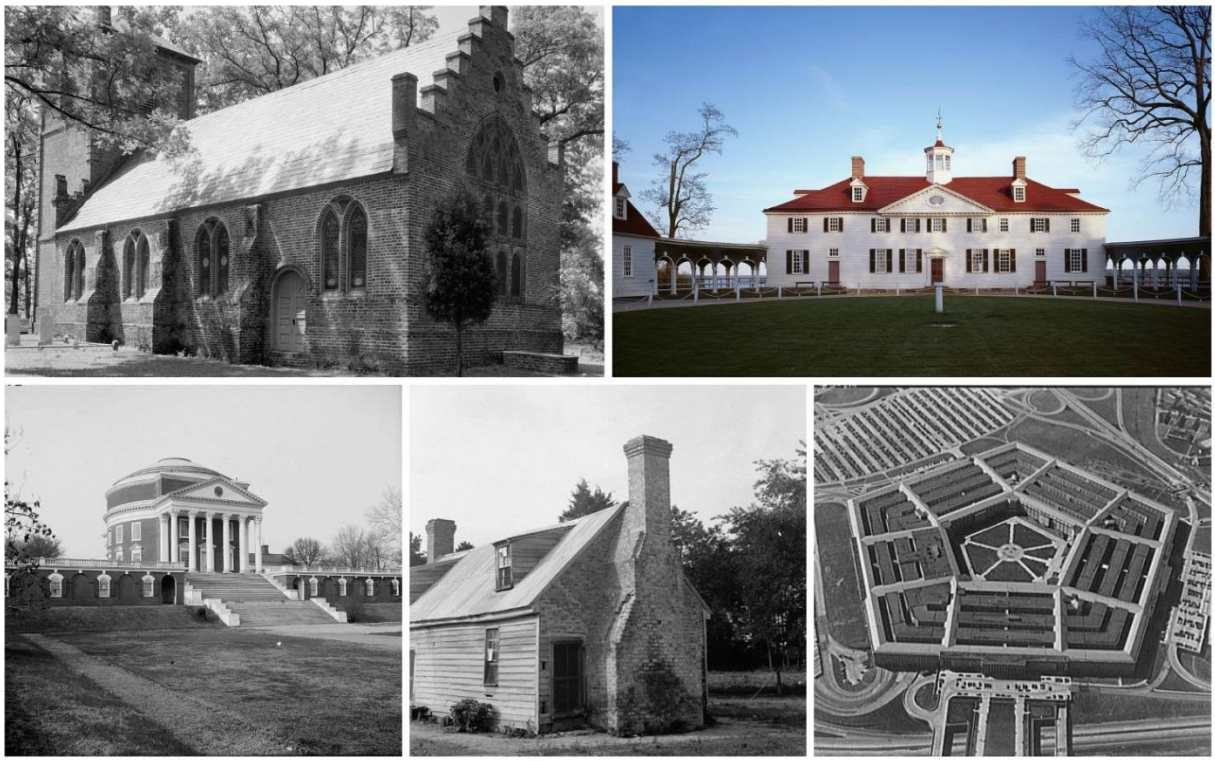
[137] The oddly shaped polygons in this figure are artifacts of available data of NRHP district listings. The accuracy of the location data for these resources varies, resulting in variations in the appearance of each resource.

The Federal style grew in popularity following the American Revolution. Houses became taller and more ornate, with details becoming lighter and more refined. I-houses, which are generally two story central passage houses with exterior end chimneys, became popular for domestic residences. Greek Revival came into style during the second quarter of the 19th century and can be linked to the earlier Classical Revival movement. Railroad architecture began to appear in the second quarter of the 19th century, as did tracks and other associated rail resources. Historic agricultural buildings are common as well, particularly tobacco barns (Wilson R. G., 2002). The James River and Kanawha Canal, an engineering feat which sought to link the Potomac River with the Ohio River, was not completed before it was outmoded by railroad transportation (Lee, et al., 2015).

The Civil War had a devastating effect on Virginia, which suffered a great degree of destruction. Virginia began losing its regional architectural distinction following the war as nationwide trends spread to the state (Wilson R. G., 2002). Wealthy northerners purchased southern estates and revamped them with popular national styles (Lee, et al., 2015). Gothic Revival and Italianate houses, along with later Victorian Era houses styles such as Second Empire, Stick, and Queen Anne were constructed with the help of mail-order plan books (Lee, et al., 2015).

The Colonial Revival movement of the late 19th and early 20th centuries was popular in Virginia, aided by iconic estates such as George Washington's Mount Vernon, and Thomas Jefferson's Monticello and Poplar Forest (Wilson R. G., 2002) (Lee, et al., 2015). Educational facilities were constructed (universities and public schools), and many that still exist illustrate the popularity of Colonial Revival in this sector. Virginia Tech (originally Virginia Agricultural and Mechanical College) is an example of the movement to expand educational opportunities into rural areas. The formation of Colonial Williamsburg, which was funded by John D. Rockefeller Jr., was one of the most significant historic preservation actions of the early 20th century (Wilson R. G., 2002)

Prior to WWII, residential styles ranged "from Chateauesque to Tudor, Italian Renaissance, and, especially Colonial Revival" (Lee, et al., 2015). Following WWII, suburban development began to increase around the larger cities and Washington, D.C. The growth of the federal government and military has resulted in the formation of entirely new planned suburban communities such as Crystal City, Pentagon City, and Reston. These areas are generally characterized by sprawling automobile oriented development. While some of the larger buildings do exhibit Modernism, Stripped Classicism, and Post-Modernism, Virginia continues to remain architecturally conservative (Wilson R. G., 2002).



Top Left – St. Luke's Church (Isle of Wight County, VA) – (Johnston, 1930)
Top Right – Mount Vernon (Mount Vernon ,VA) – (Highsmith, 1980)
Bottom Left – University of Virginia Rotunda (Charlottesville, VA) – (Detroit Public Company, 1890)
Bottom Middle – Hudgins House (London Bridge, VA) – (Historic American Building Survey, 1933)
Bottom Right – The Pentagon (Arlington County, VA) – (Horydczak, 1920)

Figure 15.1.11-5: Representative Architectural Styles of Virginia

15.1.12. Air Quality

15.1.12.1. Definition of the Resource

Air Quality in a geographic area is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography[138] 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)[139] or micrograms per cubic meter (µg/m3) determined over various periods of time (averaging time).[140] This section discusses the existing air quality in Virginia. The USEPA designates areas within the United States as attainment,[141]

[138] Topography: The unique features and shapes of the land (e.g., valleys and mountains).
[139] Equivalent to 1 milligram per liter (mg/L)
[140] 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, 2015c)
[141] Attainment areas: Any area that meets the national primary or secondary ambient air quality standard for the pollutant. (USEPA, 2015o)

nonattainment,[142] maintenance,[143] or unclassifiable[144] 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.

15.1.12.2. 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, nitrogen dioxide(NO_2), particulate matter ($PM_{2.5}$ and PM_{10}), ozone (O_3), and sulfur dioxide (SO_2). The NAAQS establish various standards, either primary[145] or secondary,[146] 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, Air Quality.

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, 2017a). HAPs can have severe adverse impacts on human health and the environment, including increased risk of cancer, reproductive issues, or birth defects. HAPs are 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. (USEPA, 2015h) Appendix E, Air Quality presents a list of federally regulated HAPs.

In conjunction with the federal NAAQS, Virginia maintains its own air quality standards, the Virginia Ambient Air Quality Standards (VAAAQS). Table 15.1.12-1 presents an overview of the VAAAQS as defined by Virginia Department of Environmental Quality (DEQ).

[142] 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, 2015o).
[143] 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, 2015o)
[144] 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, 2015o)
[145] 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, 2014b)
[146] 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, 2014b)

Table 15.1.12-1: Virginia Ambient Air Quality Standards (VAAAQS)

Pollutant	Averaging Time	Primary Standard		Secondary Standard		Notes
		µg/m³	ppm	µg/m³	ppm	
CO	8-hour	10,000	9	-	-	Not to be exceeded more than once per year
	1-hour	40,000	35	-	-	
Lead	3-month (rolling)	0.15	-	Same as Primary		Rolling 3-Month Average
	(average)	1.5	-	Same as Primary		Quarterly Average
NOx	1-hour	-	0.1	-	-	Uses nitrogen dioxide as the indicator.
	Annual	-	0.053	Same as Primary		Annual (Arithmetic Average)
PM_{10}	24-hour	150	-	Same as Primary		
$PM_{2.5}$	Annual	12	-	-	15	Annual (Arithmetic Average)
	24-hour	35	-	Same as Primary		98th percentile 24-hour concentration
O_3 (2008 Standard)	8-hour	-	0.075	Same as Primary		3-year average of the annual fourth-highest daily maximum 8-hour average ozone concentration
O_3 (1997 Standard)	8-hour	-	0.08	Same as Primary		Average of the annual fourth-highest daily maximum 8-hour average ozone concentration
O_3	1-hour	235	0.12	Same as Primary		
SOx	Annual	80	0.03	1300	0.5	Uses SO_2 as the indicator Annual (Arithmetic Average). Secondary is based on 3-hour
	24-hour	365	0.14	-	-	Maximum 24-hour concentration not to be exceeded more than once per calendar year
	1-hour	-	0.075	-	-	Three-year average of the annual (99th percentile) of the daily maximum 1-hour average concentrations

Source: (VDEQ, 2013)

Title V Operating Permits/State Operating Permits

The Commonwealth of Virginia 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, 2015m). The overall goal of the Title V program is to "reduce violations of air pollution laws and improve enforcement of those laws" (USEPA, 2015m). Virginia regulation 9VAC5-80-60 describes the applicability of Title V operating permits (VDEQ, 2013). Virginia 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 15.1.12-2). The permit issued to a facility contains both state and federal portions and incorporates a reporting schedule (USEPA, 2017b).

Table 15.1.12-2: Major Air Pollutant Source Thresholds

Pollutant	Tons per Year (TPY)
Any Pollutant	100
Single Hazardous Air Pollutant (HAP)	10
Total/Cumulative HAPs	25

Source: (USEPA, 2017b)

Exempt Activities

The Virginia DEQ issues multiple types of permits: General Permits, Major New Source Review (NSR) Permits, State Operating Permits, New and Reconstructed Major Sources of Hazardous Air Pollutants (Article 7 Permits), Federal Operating permits, Minor NSR Permits, and State Major Permits. General Permits were developed for "facilities that will emit regulated air pollutants above the exemption thresholds listed in 9VAC5801105 of state regulations but less than 100 tons per year (9VAC5, Chapter 80, Article 6)." (Commonwealth of Virginia, 2015b) If a major new emission source is constructed in a nonattainment area, a nonattainment permit is also required.

The construction or modification of any stationary source (including engine generators) and/or project including an emissions unit requires an NSR Permit. Virginia regulations (9VAC5-80-1105) list permit exemptions from the NSR Permit for the following stationary sources or emission units:

- "Engines and turbines that are used for emergency purposes only and that do not individually exceed 500 hours of operation per year at a single stationary source as follows. All engines and turbines in a single application must also meet the following criteria to be exempt.
  - Gasoline engines with an aggregate rated brake (output) horsepower of less than 910 hp and gasoline engines powering electrical generators having an aggregate rated electrical power output of less than 611 kilowatts.
  - Diesel engines with an aggregate rated brake (output) horsepower of less than 1,675 hp and diesel engines powering electrical generators having an aggregate rated electrical power output of less than 1125 kilowatts.
  - Combustion gas turbines with an aggregate of less than 10,000,000 Btu per hour heat input (low heating value)." (Virginia Law, 2017h)

In addition to the exemptions in 9VAC5-80-1105, a new stationary source is exempt from the NSR Permit if the uncontrolled emission rates are less than that in Table 15.1.12-3. "The uncontrolled emission rate of a new stationary source is the sum of the uncontrolled emission rates of the individual affected emissions units." (Virginia Law, 2017h)

Table 15.1.12-3: Exemptions for New Stationary Sources

Pollutant	Emissions Rate - Tons Per Year (TPY)
Carbon Monoxide	100
Nitrogen Oxides	40
Sulfur Dioxide	40

Pollutant	Emissions Rate - Tons Per Year (TPY)
Particulate Matter	25
Particulate Matter (PM_{10})	15
Particulate Matter ($PM_{2.5}$)	10
Volatile organic compounds	25
Lead	0.6
Fluorides	3
Sulfuric Acid Mist	6
Hydrogen Sulfide (H_2S)	9
Total Reduced Sulfur (including H_2S)	9
Reduced Sulfur Compounds (including H_2S)	9
Municipal waste combustor organics	3.5 x 10-6
Municipal waste combustor metals	13
Municipal waste combustor acid gases	35
Municipal solid waste landfill emissions	22

Source: (Virginia Law, 2017h)

For an engine generator to meet the emergency generator exemption of 9VAC5-80-1105, it must only run for maintenance, testing, and in emergency circumstances. Virginia defines an emergency as "a condition that arises from sudden and reasonably unforeseeable events where the primary energy or power source is disrupted or disconnected due to conditions beyond the control of an owner or operator of a facility including a failure of the electrical grid, onsite disaster or equipment failure, public service emergencies such as flood, fire, natural disaster, or severe weather conditions, or an ISO [Independent System Operator]-declared emergency." (Virginia Law, 2017h)

Temporary Emission Sources Permits

The Commonwealth of Virginia exempts certain temporary emission sources from obtaining permits if they adhere to the following conditions:

- "The operational period of the temporary facility (the period from the date that the first pollutant-emitting operation is commenced to the date of shutdown of the temporary facility) is 12 months or less.
- The uncontrolled emissions rate of any regulated air pollutant that would be emitted from the temporary facility during the operational period does not exceed the applicable exempt emission rate as set forth in 9VAC5-80-1105 C (exemption rates for new stationary sources) or 9VAC5-80-1105 D (exemption rates for projects). The uncontrolled emission rate may be calculated based upon the total number of hours in the operational period instead of 8760 hours. All temporary facilities that will be co-located at a stationary source shall be considered in the aggregate when calculating the uncontrolled emissions rate under this subdivision." (Virginia Law, 2017h)

State Preconstruction Permits

The Virginia DEQ issues construction and operating permits for all emission-generating sources unless they meet an exemption. There are four types of construction and operating permits offered by the Virginia DEQ: the Article 6 Permit (Major NSR), the Article 7 Permit (New and Reconstructed Major Sources of Hazardous Air Pollutants), the Article 8 Permit (Major Stationary Sources and Major Modifications Located in Prevention of Significant Deterioration Areas), and the Article 9 Permit (Major Stationary Sources and Major Modifications Located in Nonattainment Areas) (Commonwealth of Virginia, 2015b). FirstNet deployment activities in Virginia could require one type of permit; consultation with Virginia DEQ could be necessary.

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, 2013). 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. The estimated pollutant emissions are compared to de minimis levels. These values are the minimum thresholds for which a conformity determination must be performed (see Table 15.1.12-4). Some Virginia counties lie in the Ozone Transport Region (OTR). As a result, lower *de minimis*[147] thresholds for VOCs and NOX could apply depending on the attainment status of a county.

Table 15.1.12-4: *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)	Marginal and Moderate Nonattainment inside an OTR	100
	Maintenance	100
Ozone (VOC)	Marginal and Moderate Nonattainment inside an OTR	50
	Maintenance within an OTR	50
	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, 2010)

[147] Small amount or minimal.

If an action does not result in an emissions increase above the *de minimis* levels in Table 15.1.12-4, 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 15.1.12-4, 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 cause a new violation of the NAAQS. To demonstrate conformity[148], 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 Virginia SIP is composed of many related actions to ensure ambient air concentrations of the six criteria pollutants comply with the NAAQS. Virginia's SIP is a conglomeration of separate actions taken for each of the pollutants. All of Virginia's SIP actions are codified under 40 CFR Part 52 Subpart HH. A list of all SIP actions for all six criteria pollutants can be found on Virginia DEQ's website[149] (VDEQ, 2015r).

15.1.12.3. 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 15.1.12-1 and Table 15.1.12-5, below, present the current nonattainment areas in Virginia as of January 30, 2015. Table 15.1.12-5 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 USEPA promulgated the AAS for that pollutant. Unlike Table 15.1.12-5, Figure 15.1.12-1 does not differentiate between standards for the same pollutant. Additionally, given that particulate matter is the criteria pollutant of concern, PM_{10} and $PM_{2.5}$ are merged in the figure and presented as a single pollutant.

[148] Conformity: Compliance with the State Implementation Plan.
[149] http://www.deq.virginia.gov/

Air Quality Monitoring and Reporting

The Virginia DEQ measures air pollutants at 40 sites across the state as part of the National Air Monitoring Stations Network and the State and Local Air Monitoring Stations Network. Virginia DEQ compiles the Annual State Ambient Air Quality Reports, containing pollutant data summarized by region. The Virginia DEQ reports real-time pollution levels of O_3 on their website to inform the public, as O_3 is the main pollutant of concern in Virginia (VDEQ, 2015s).

Throughout 2013 (the most recent period with a full set of data), O_3 measurements exceeded the state and federal standard of 0.075 ppm twice in Richmond and once in Northern Virginia. $PM_{2.5}$ exceeded the 24-hour state and federal standard of 35 $\mu g/m_3$ in Frederick County. No other criteria pollutants exceed state and federal standards. (Commonwealth of Virginia, 2014)

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). 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).

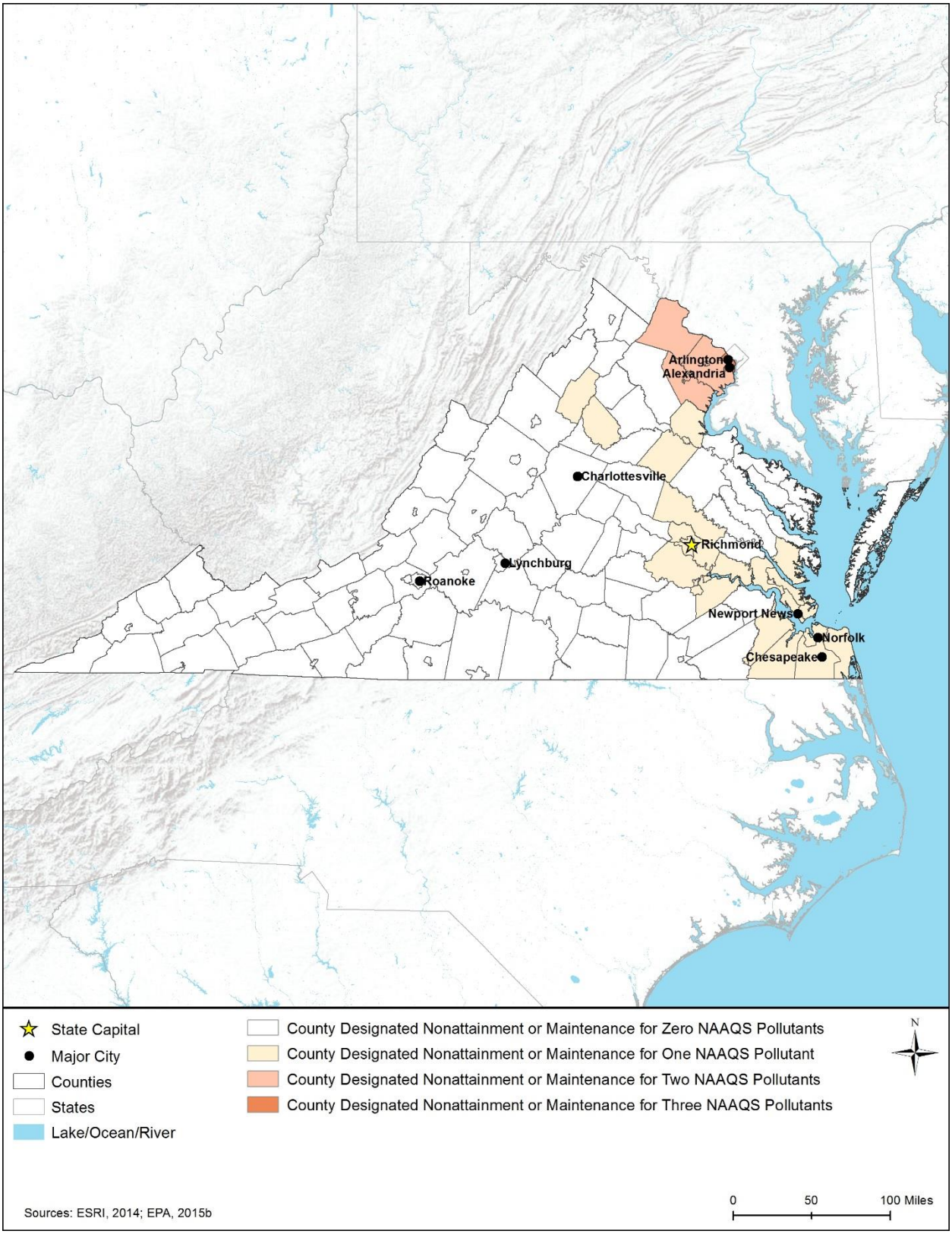


Figure 15.1.12-1: Nonattainment and Maintenance Counties in Virginia

Table 15.1.12-5: Virginia Nonattainment and Maintenance Areas by Pollutant Standard and County

County	Pollutant and Year USEPA Implemented Standard										
	CO	Lead		NO_2	PM_{10}	$PM_{2.5}$		O_3		SO_2	
	1971	1979	2008	1971	1987	1997	2006	1997	2008	1971	2010
Alexandria (City)	M					M		X-4	X-5		
Arlington	M					M		X-4	X-5		
Charles City								M			
Chesapeake (City)								M			
Chesterfield								M			
Colonial Heights (City)								M			
Fairfax (City)						M		X-4	X-5		
Fairfax						M		X-4	X-5		
Falls Church (City)						M		X-4	X-5		
Fredericksburg (City)								M			
Gloucester								M			
Hampton (City)								M			
Hanover								M			
Henrico								M			
Hopewell (City)								M			
Isle of Wight								M			
James City								M			
Loudoun						M		X-4	X-5		
Madison								M			
Manassas (City)						M		X-4	X-5		
Manassas Park (City)						M		X-4	X-5		
Newport News (City)								M			
Norfolk (City)								M			
Page								M			
Petersburg (City)								M			
Poquoson (City)								M			
Portsmouth (City)								M			
Prince George								M			
Prince William						M		X-4	X-5		
Richmond (City)								M			
Spotsylvania								M			
Stafford								M			
Suffolk (City)								M			
Virginia Beach (City)								M			
Williamsburg (City)								M			
York								M			

Source: (USEPA, 2015d)

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

In a 1979 USEPA memorandum, the Assistant Administrator for Air, Noise, and Radiation (Hawkins, 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[150] 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 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[151] (the normal useful range of EPA-approved Gaussian plume models" (Seitz, 1992).

Virginia contains two federal Class I areas; the rest of the land within the state is classified as Class II (USEPA, 2012c). If an action is considered major source and consequently subject to PSD requirements, the air quality impact analysis need only to analyze the impacts to air quality within 100 kilometers from the source (USEPA, 1992). West Virginia and North Carolina have Class I areas where the 100-kilometer buffer intersects Virginia counties. Any PSD-applicable action within these counties would require FLMs notification from the appropriate Regional Office. Figure 15.1.12-2 provides a map of Virginia 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 15.1.12-2 correspond to the numbers and Class I areas listed in Table 15.1.12-6.

Table 15.1.12-6: Relevant Federal Class I Areas

#	Area	Acreage	State
1	Shenandoah NP	190,535	VA
2	James River Face Wilderness	8,703	VA
3	Otter Creek Wilderness	20,000	WV
4	Dolly Sods Wilderness	10,215	WV
5	Linville Gorge Wilderness	7,575	NC

Source: (USEPA, 2012c)

[150] The memorandum and associated guidance use kilometers. 100 kilometers is equal to about 62 miles.
[151] The memorandum and associated guidance use kilometers. 50 kilometers is equal to about 31 miles.

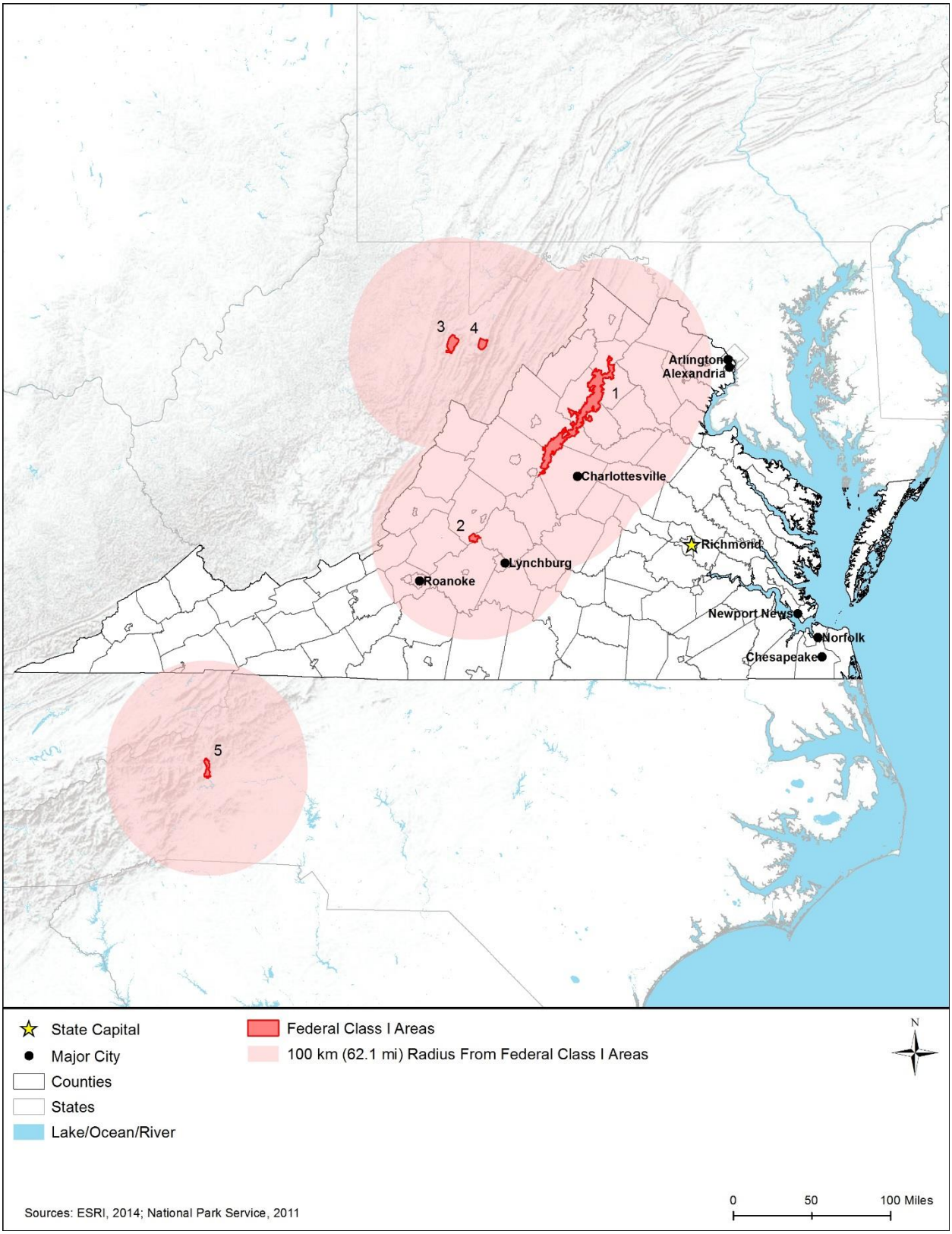


Figure 15.1.12-2: Federal Class I Areas with Implications for Virginia

15.1.13. Noise and Vibration

This section presents a discussion of a basic understanding of environmental noise, background/ambient noise levels, noise standards, and guidelines.

15.1.13.1. 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, 2012d). 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.

Ground-borne vibrations, which in many instances can be caused by tools or equipment that generate noise, can also result from roadway traffic, rail traffic, and industrial activities as well as from some construction-related activities such as blasting, pile-driving, vibratory compaction, demolition, and drilling. Unlike noise, most ground-borne vibrations are not typically experienced every day by most people because the existing environment does not include a significant number of perceptible ground-borne vibration events.

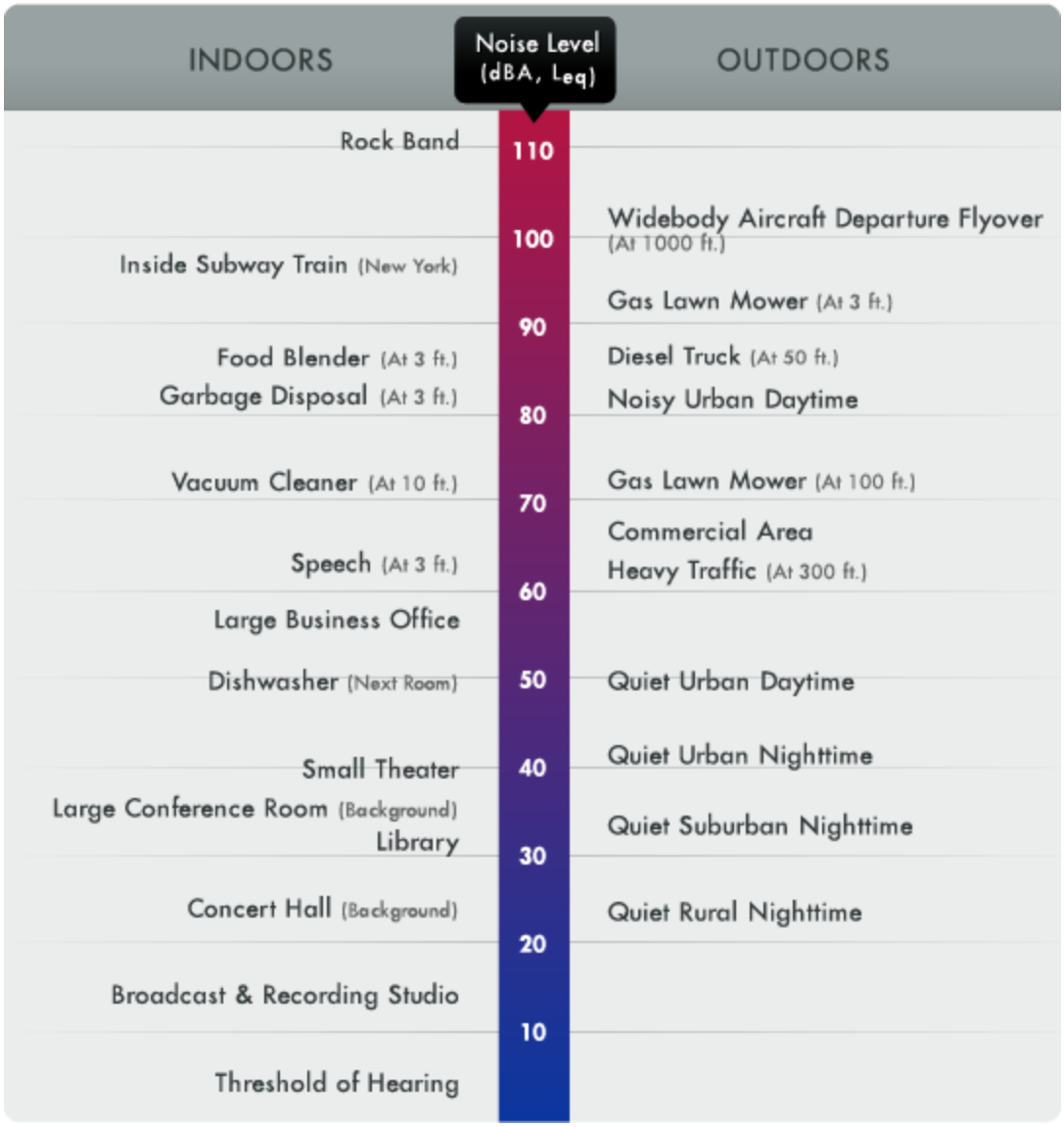
Fundamentals of Noise and Vibration

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"). The normal audible frequency range is approximately 20 Hz to 20 kHz (FAA, 2015i). 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, 2013).

Measurements and descriptions of noise (i.e., sounds) are based on various combinations of the following factors (FTA, 2006):

- The vibration frequency characteristics of the sound, measured as sound wave cycles per second [Hertz (Hz)], determines the pitch of the sound.
- 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 (SPL) (the frequency characteristics and SPL combine to determine the loudness of a sound at a particular location).
- The duration of a sound.
- The changes in frequency characteristics or pressure levels through time.

Figure 15.1.13-1 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.



Source: (Sacramento County Airport System, 2015)
Prepared by: Booz Allen Hamilton, 2005.
Leq: Equivalent Continuous Sound Level

Figure 15.1.13-1: Sound Levels of Typical Sounds

Because of the logarithmic unit of measurement, sound levels cannot be added or subtracted linearly. However, several simple methods of estimating sound levels can be useful in determining approximate sound levels are useful in calculating 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.

Related to noise, vibration is a fluctuating motion described by displacement with respect to a reference point. Depending on the intensity, vibrations may create perceptible ground shaking and the displacement of nearby objects as well as rumbling sounds. Table 3.1.13-1 lists vibration source levels produced by typical construction machinery and activities at a distance of 25 feet in units of vibration decibels (VdB). The vibration thresholds for human perceptibility and potential building damage are 65 and 100 VdB, respectively (FTA, 2006).

Table 15.1.13-1: Vibration Source Levels for Select Construction Equipment (VdB)

Equipment[a]	VdB at 25 feet away
Pile Driver (impact type)	104-112
Pile Driver (sonic or vibratory type)	93-105
Vibratory Roller	94
Hoe Ram	87
Large Bulldozer	87
Caisson Drilling	87
Loaded Trucks	86
Jackhammer	79
Small Bulldozer	58

Source: (FTA, 2006)

VdB = vibration decibels

[a] The types of equipment listed in this table are included for reference purposes only. It is possible that not all equipment types listed here would be used in the deployment and operation of the Proposed Action.

15.1.13.2. 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.

Virginia has statewide laws that regulate noise. The Code of Virginia Titles 15.2, 45.1, and 46.2 provides regulatory guidance for noise limits from equipment and mobile vehicles that would apply to both fixed and deployable technology scenarios (Commonwealth of Virginia, 2015c). 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 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). Table 15.1.13-1 summarizes these Virginia noise statutes.

Table 15.1.13-1: Relevant Virginia Noise Laws and Regulations

State Law/Regulation	Agency	Applicability
15.2-1220	Commonwealth of Virginia	Regulates maximum noise levels in certain counties.
45.1-161.270	Commonwealth of Virginia	States that any mobile equipment should be equipped with an audible warning.
46.2-1049	Commonwealth of Virginia	Regulates the condition of use of an exhaust system to prevent unnecessary high noise levels.

Source: (Commonwealth of Virginia, 2015c)

15.1.13.3. Environmental Setting: Ambient Noise

The range and level of ambient noise in Virginia varies widely based on the area and environment. The population of Virginia can choose to live and interact in areas that are large cities, suburban neighborhoods, rural communities, and national and state parks. Figure 15.1.13-1 illustrates noise values for typical community settings and events that are representative of what the population of Virginia may experience on a day-to-day basis. These noise levels represent a wide range and are not specific to Virginia. As such, this section describes the areas where the population of Virginia 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) (U.S. Department of Interior, 2008). The urban areas that are likely to have the highest ambient noise levels in the state are Arlington, Alexandria, Fairfax (and other northern Virginia counties in and around the Washington, DC metro area), Virginia Beach, Norfolk, Chesapeake, and Richmond.
- **Airports:** Areas surrounding airports tend to have higher noise levels 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, 2012). 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 is in proximity to urban communities, resulting in noise exposure from aircraft operations (arrivals/departures) to the surrounding areas at higher levels and 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 Virginia, Washington Dulles International (IAD), Ronald Reagan Washington National (DCA), Richmond International (RIC), Norfolk International (ORF), Roanoke Regional/Woodrum Field (ROA), Newport News/Williamsburg International (PHF), Charlottesville-Albemarle airport (CHO), and Lynchburg Regional/Preston Glen Field (LYH) have combined annual operations of more than 1 million flights, with IAD accounting for approximately 314,000 annual flights and DCA accounting for approximately 287,000 annual flights (FAA, 2015h). These operations result in increased ambient noise levels in the surrounding communities. See Section 15.1.1, Infrastructure, 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 near those traffic corridors. 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 15.1.1, Infrastructure, 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 (FRA, 2015b). Virginia has multiple rail corridors with high levels of commercial and commuter rail traffic. Amtrak's Northeast Corridor hosts regular passenger rail services from Washington, DC to Lynchburg, Newport, Norfolk, and Richmond (DRPT, 2014b). See Section 15.1.1, Infrastructure, 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. National and state parks, historic areas, and monuments are protected areas, which are regions that are given legal safeguards in order to maintain biological diversity and natural resources (NPS, 2013). These areas typically have lower noise levels, as low as 30 to 40 dBA (NPS, 2014g). Virginia has one National Park, one National Seashore, two National Scenic Trails, five National Historic Trails, seven National Historic Parks, two National Parkways, three National Monuments, one National Military Park, one National Historic Site, three National Battlefields, and other affiliated locations managed by the NPS (National Parks Conservation Association, 2015) (NPS, 2015z). Visitors to these areas expect lower ambient noise conditions than the surrounding urban areas. See Section 15.1.8, Visual Resources for more information about national and state parks for Virginia.

15.1.13.4. Sensitive Noise and Vibration 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 and vibration 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 and towns in Virginia 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 Commonwealth of Virginia.

15.1.14. Climate Change

15.1.14.1. Definition of the Resource

Climate change, according to the Intergovernmental Panel on Climate Change (IPCC), is defined as "…a change in the state of 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, 2012e). 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)[152], which equalizes for the different global warming potential of each type of GHG. Where this document references emissions of CO_2 only, the units will be in MMT CO_2. Where the document references emissions of multiple GHGs, the units will be in MMT CO_2e.

The IPCC reports that "global concentrations of these four GHGs have increased significantly since 1750" with "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 concentrations 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 Section 15.2, 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).

[152] 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, 2015j)

15.1.14.2. 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. The Council on Environmental Quality (CEQ) published draft National Environmental Policy Act (NEPA) guidance on the consideration of the effects of climate change and greenhouse gas in February of 2010. Revised draft guidance was published in December 2014 and in August 2016 (after publication of the Draft PEIS) CEQ published its final guidance. This guidance is applicable to all federal agency actions and is meant to facilitate compliance within the legal requirements of NEPA. The CEQ guidance describes how federal agency actions should evaluate GHG and climate change effects in their NEPA reviews, using GHG emissions as a proxy for assessing a proposed action's potential effect on climate change. CEQ defines GHGs to include CO_2, CH_4, N_2O, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, which is in accordance with Section 19 (m) of *Executive Order 13693*. The final CEQ guidance suggests that agencies consider "(1) the potential effects of a proposed action on climate change as indicated by assessing GHG emissions (e.g. to include, where applicable, carbon sequestration); and (2) the effects of climate change on a proposed action and its environmental impacts." The final guidance recommends that agencies quantify an action's projected direct and indirect GHG emissions when data inputs are reasonably available to support calculations. The final guidance states that "agencies should be guided by the principle that the extent of the analysis should be commensurate with the quantity of the projected GHG emissions and take into account available data and GHG quantification tools that are suitable for and commensurate with the proposed agency action." In addition, CEQ recommends agencies evaluate project emissions and changes in carbon sequestration and storage, when appropriate, in assessing a proposed action's potential climate change impacts. The analysis should assess direct and indirect climate change effects of a proposed project including connected actions, the cumulative impacts of its proposed action, and reasonable alternatives. CEQ advises that climate change effects on the environmental consequences of a proposed action should be described based on available studies, observations, interpretive assessments, predictive modeling, scenarios, and other empirical evidence. The temporal bounds should be limited by the expected lifetime of the proposed project. Mitigation and adaptation measures should be considered in the analysis for effects that occur immediately and in the future.

Virginia has not established goals and regulations to reduce GHG emissions to combat climate change. However, Virginia has developed a couple of programs to address the effects of climate change.

The Virginia Coastal Zone Management (CZM) Climate Change Adaptation Program is taking steps to prepare for the effects of climate change specifically focused on sea level rise. Under the Virginia CZM the state has taken steps to improve coastal resiliency, such as assessing and mapping the potential impacts of sea-level rise and severe storm events to both developed and natural areas. The Program is helping the state move toward policy development, which will establish a framework for local response to these issues (VDEQ, 2015t).

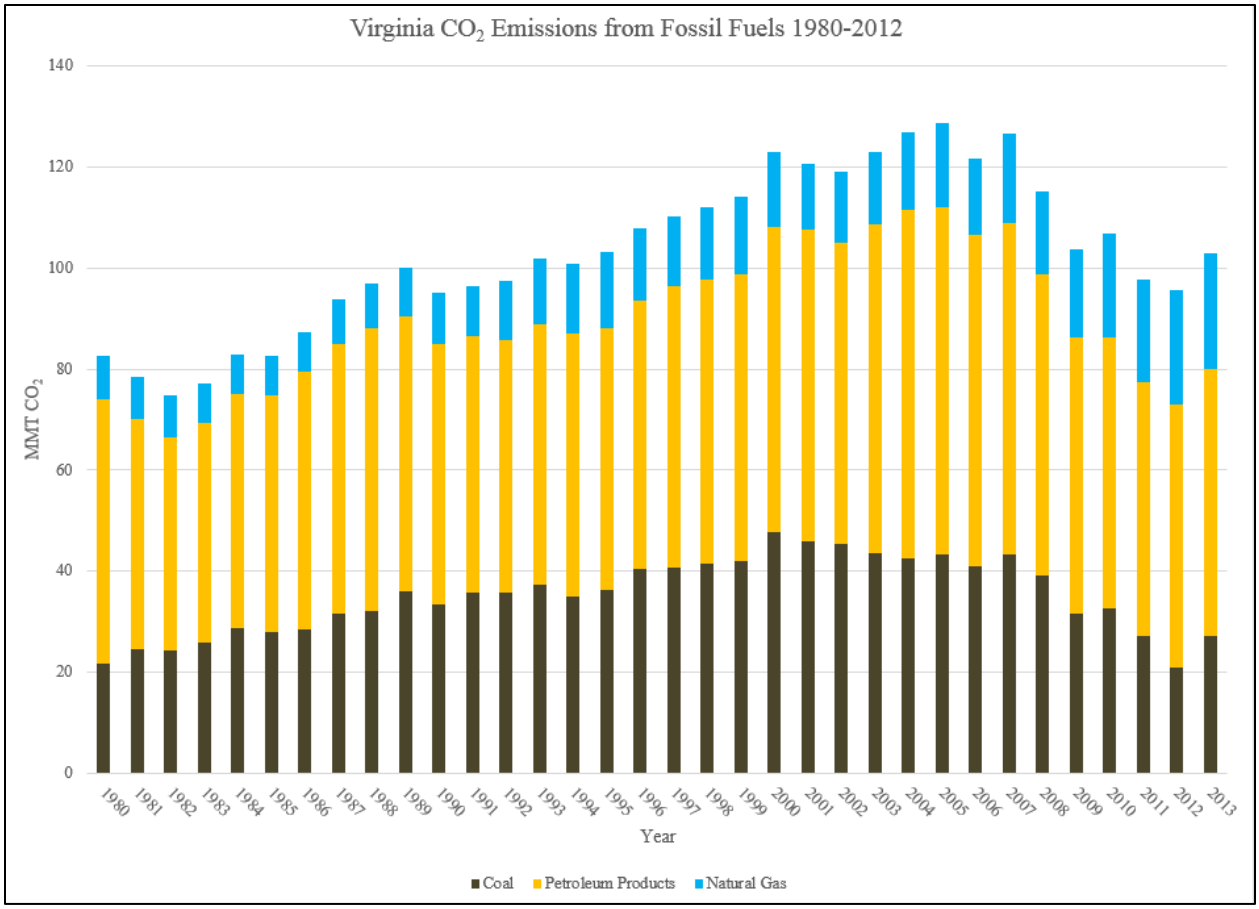
15.1.14.3. Virginia's Greenhouse Gas Emissions

According to the EIA, Virginia emitted a total of 104.0 MMT of CO_2 in 2014, with transportation being the highest emitter (Table 15.1.14-1) (EIA, 2014b). Annual emissions between 1980 and 2013 are represented in Figure 15.1.14-1. CO_2 emissions grew from 1980 to 2005 when they peaked at 129.2 MMT, from which they generally declined until 2012 before increasing to the 2013 level. Declines were driven largely by reductions in emissions from coal and petroleum products. (EIA, 2014b). In 2015, electricity generated from natural gas surpassed Virginia's generation from nuclear power for the first time. (EIA, 2015d). In 2014, Virginia is ranked 18th in the U.S. for total CO_2 emissions, and 38th for per capita CO_2 emissions (EIA, 2014c).

Table 15.1.14-1: Virginia CO_2 Emissions from Fossil Fuels by Fuel Type and Sector, 2014

Fuel Type (MMT)		Source (MMT)	
Coal	26.2	Residential	6.9
Petroleum Products	54.6	Commercial	5.3
Natural Gas	23.2	Industrial	12.6
		Transportation	48.9
		Electric Power	30.3
TOTAL	**104.0**	**TOTAL**	**104.0**

Source: (EIA, 2014b)



Source: (EIA, 2013b)

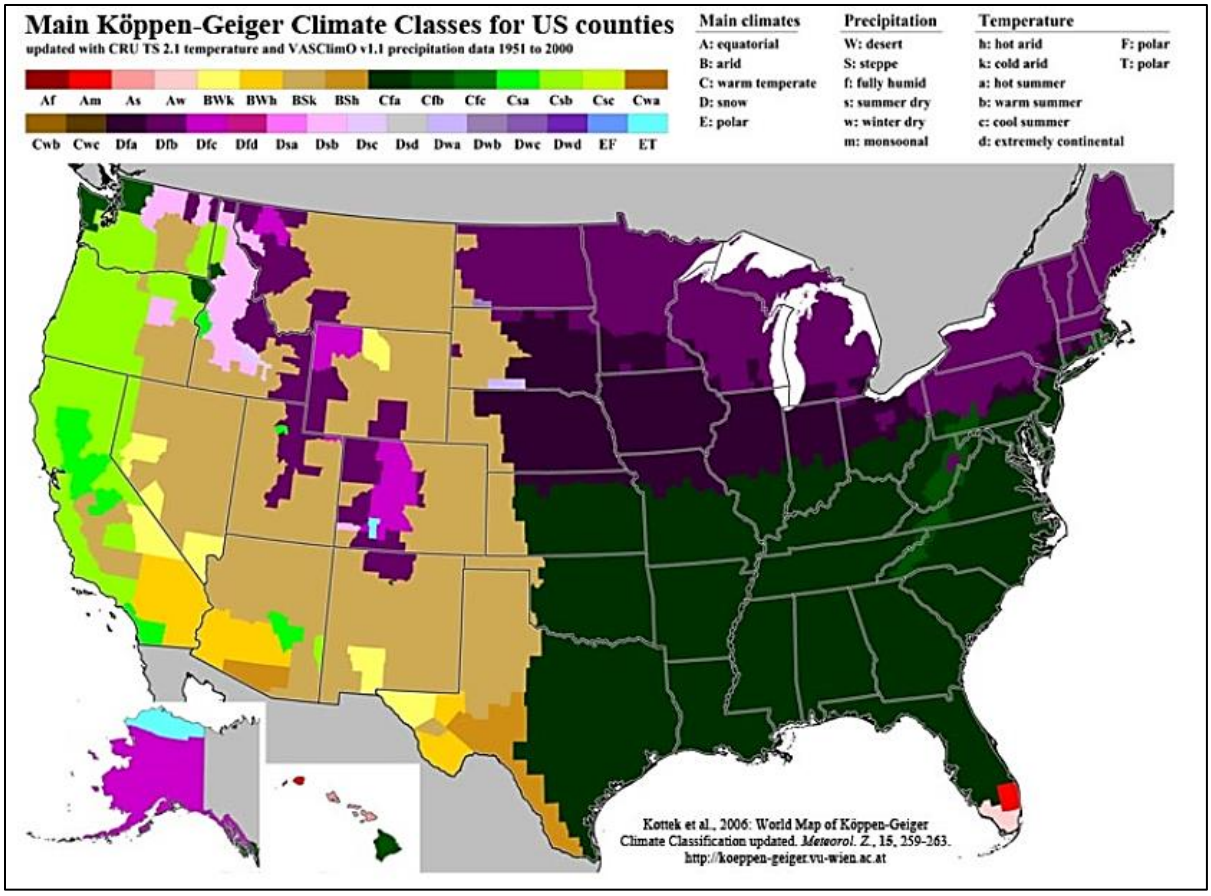
Figure 15.1.14-1: Virginia CO_2 Emissions from Fossil Fuels by Fuel Type 1980-2013

15.1.14.4. Environmental Setting: Existing Climate

The National Weather Service defines climate as "The composite or generally prevailing weather conditions of a region, throughout the year, averaged over a series of years. (NWS, 2009). 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, 2009). 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, 2006).

The entirety of Virginia falls into climate group (C) (see Figure 15.1.14-2). Climates classified as (C) are generally warm, with "humid summers and mild winters" (NWS, 2009). "During the winter, the main weather feature is the mid-latitude cyclone" (NWS, 2009). There are also frequent thunderstorms during summer months. Virginia has two sub-climate categories, which are described in the following paragraphs (NWS, 2009) (NWS, 2006).

Global weather patterns, coupled with topographic variations, dictate Virginia's climate. For example, statewide precipitation is strongly influenced by the Atlantic Ocean, which transports warm, Gulf Stream water along the coastline of the state. Warm, Gulf Stream water also influences storms that originate in the Atlantic, causing them to rapidly grow and resulting in "moisture-laden air" which passes over Virginia from the east to the northeast (Hayden & Michaels, 2015). In Virginia, the "eastern slopes and foothills of the Blue Ridge Mountains" are the primary receivers of this precipitation (Hayden & Michaels, 2015). The driest areas of Virginia are the New River and Shenandoah River Valleys due to the "high relief of the Appalachian and Blue Ridge Mountains" (Hayden & Michaels, 2015). "The third important local control on climate is the state's complex pattern of rivers and streams, which drain the precipitation that falls and modify the pattern of moist airflow from which the precipitation falls" (Hayden & Michaels, 2015).



Source: (Kottek, 2006)

Figure 15.1.14-2: Köppen-Geiger Climate Classes for US Counties

Cfa – The Köppen-Geiger climate classification system classifies Richmond, as well as the majority of Virginia, as Cfa. Cfa climates are generally mild, with no dry seasons and hot summers. Virginia's secondary classification indicates year-round rainfall, but it is highly variable; thunderstorms are dominant during summer months. The tertiary classification indicates mild, hot summers with average temperature of warm months over 72 °F. Average

temperatures of the coldest months are under 64 °F (Kottek, Grieser, Beck, Rudolf, & Rubel, 2006) (NWS, 2009) (NWS, 2006).

Cfb – Portions of southwestern Virginia, such as Blacksburg, are classified as Cfb. Climates classified as Cfb are generally mild, with no dry seasons and warm summers. Virginia's secondary classification indicates "year around equally spread rainfall" (NWS, 2006). Virginia's tertiary classification indicates that at least four months out of the year averaging above 50 °F (Kottek, Grieser, Beck, Rudolf, & Rubel, 2006) (NWS, 2009) (NWS, 2006).

This section discusses the current state of Virginia's climate with regard to air temperature, precipitation, sea level, and extreme weather events (e.g., tropical storms, tropical cyclones, and hurricanes) in Virginia's two climate regions, Cfa and Cfb.

Air Temperature

Virginia's climate is extremely diverse. Certain areas, such as Charlottesville, Lynchburg, and Warrenton, "have climate amenities such as long growing seasons and infrequent subzero temperature minimums, while winters on the northern Blue Ridge frequently produce bitterly cold temperatures like those of Chicago" (Hayden & Michaels, 2015). The highest temperature to occur in Virginia was on July 5 and July 7, 1900 and July 15, 1954, each with a record high of 110 °F (SCEC, 2015). The coldest temperature to occur in Virginia was on January 21, 1985 with a record low of negative 30 °F (SCEC, 2015). The average temperature in the state of Virginia is 54.8 °F (NOAA, 2015h).

Cfa – Richmond, the state capital, is located in central Virginia and within the climate classification zone Cfa. The average annual mean temperature for this area is approximately 58.9 °F; 39.9 °F during winter months; 77.4 °F during summer months; 57.7 °F during spring months; and 60.2 °F during autumn months. The average temperature throughout the entire eastern piedmont region is approximately 56.5 °F (NOAA, 2015h) (NOAA, 2015i).

Cfb – Blacksburg is located in southwestern Virginia and within the climate classification zone Cfb. The average annual mean temperature for this area is approximately 51.6 °F; 33.1 °F during winter months; 69.7 °F during summer months; 50.5 °F during spring months; and 52.9 °F during autumn months. The average temperature throughout the entire southwestern mountain region is approximately 52.3 °F (NOAA, 2015h) (NOAA, 2015i).

Precipitation

The majority of rainfall in Virginia is the result of storms "associated with warm and cold fronts" (Hayden & Michaels, 2015). In Virginia, storms typically move "parallel to the Appalachian or the Blue Ridge Mountains, the coastal zone, and the Gulf Stream" (Hayden & Michaels, 2015). Precipitation patterns and varying topography result in annual rainfall totals that "can vary form a sparse 33 inches typical of the Shenandoah Valley to more than 60 inches in the mountains of southwestern Virginia" (Hayden & Michaels, 2015). The heaviest rainfall in Virginia generally falls in southeastern Virginia. During the month of September, "anywhere from 10 to 40 percent of Virginia's rainfall comes from hurricanes and tropical storms" (Hayden & Michaels, 2015).

The highest 24-hour precipitation accumulation to occur was in Williamsburg, on September 16, 1999 with a record total of 14.28 inches of rainfall (SCEC, 2015).

In addition to heavy snowfall, Virginia typically experiences abundant snowfall due to the movement of cold air from the west and northwest leading to frontal storms and subsequent heavy snowfalls (Hayden & Michaels, 2015). Although "heavy snowstorms are common in the Piedmont region, the average winter does not have a major coastal snowstorm, and heavy winter snows are usually confined to the mountainous areas of the state" (Hayden & Michaels, 2015). The highest 24-hour snowfall accumulation to occur was in Luray, on March 3, 1994 with a record total of 33.5 inches of snowfall (SCEC, 2015).

Cfa – Richmond, the state capital, is located in central Virginia and within the climate classification zone Cfa. The average annual precipitation accumulation for this area is approximately 43.60 inches; 9.06 inches during winter months; 13.10 inches during summer months; 11.09 inches during spring months; and 10.35 inches during autumn months. The average annual precipitation throughout the entire eastern piedmont region is approximately 43.08 inches (NOAA, 2015h) (NOAA, 2015i).

Cfb – Blacksburg, located in southwestern Virginia, and within the climate classification zone Cfb. The average annual precipitation accumulation for this area is approximately 40.89 inches; 8.84 inches during winter months; 11.85 inches during summer months; 11.45 inches during spring months; and 8.75 inches during autumn months. The average annual precipitation throughout the entire southwestern mountain region is approximately 44.37 inches (NOAA, 2015h) (NOAA, 2015i).

Sea Level

Virginia has approximately 3,315 miles of coastal and tidal shoreline. Virginia's coastal zone "includes the state's 29 coastal counties and encompasses salt marshes, wetlands, beaches, transition and inter-tidal areas, and islands" (NOAA, 2014b). In Virginia, approximately 149,000 people, 72,000 homes, and 278,000 acres of land are at risk due to future sea level rise. Cities with the largest total populations at risk are Virginia Beach, Chesapeake, Norfolk, Hampton, Poquoson, Portsmouth, Newport News, Chincoteague, Suffolk, and Belle Haven. In Portsmouth, relative sea level is rising at a rate of 0.1504 inches per year (USEPA, 2014c). Portsmouth and Norfolk are also home to the world's largest naval base, which is situated on low-lying, sinking land. Cities such as Virginia Beach and Ocean City are "vulnerable to the most dramatic, direct effects of sea-level rise such as having structures being swept away by ocean waves" (USEPA, 2014c). In Virginia, three specific factors have combined to "make current sea level rise in Virginia's Chesapeake area close to the fastest in the nation" (Climate Central, 2015). Factors include: "global sea level rise; land still sinking due to the retreat of the glaciers across North America from the last ice age; and land still sinking in connection with the Chesapeake Bay Impact crater" (Climate Central, 2015). In addition, data predicts, "shifting Atlantic currents will speed Virginia sea level rise further" (Climate Central, 2015).

Table 15.1.14-2: Historical Sea Level Rise in Virginia

Water Level Station	Measured Historic Sea Level Rise	
	Inches of Rise	Period of Record
Washington – Potomac River (D.C.)	10	1924 – 2006
Kiptopeke – Chesapeake Bay	8	1951 – 2006
Lewisetta – Potomac River	6	1974 – 2006
Sewells Point – Hampton Roads	14	1927 – 2006
Chesapeake Bay Bridge Tunnel	8	1975 – 2006

Source: (Climate Central, 2015)

Severe Weather Events

Currently, hurricanes and tropical storms in Virginia are relatively common, with an average of one occurrence per year. During an earlier period in Virginian history, from 1905 to 1920, "a hurricanes stuck, on average, only one year in every five" (Hayden & Michaels, 2015). This frequency began to steadily increase over the years, "to above three hurricanes in a five-year period, before decreasing again in the 1960s and 1970s" (Hayden & Michaels, 2015).

Hurricanes and tropical storms in Virginia are generally "formed within the deep, moist layers of air over warm, tropical waters" (Hayden & Michaels, 2015). In comparison to heavy snowstorms, which "derive much of their energy from the great temperatures contrasts on either side of the fronts, hurricanes and tropical storms derive most of their energy from the warm ocean surface" (Hayden & Michaels, 2015). In Virginia, tropical storms generally moved in a "northeasterly track," intensifying further as they move along the route. "Those storms that reach an intensity indicated by sustained winds of at least 72 miles an hour are classified as hurricanes" (Hayden & Michaels, 2015). Hurricanes and tropical storms in Virginia occur most frequently in early August and September, rarely occurring before June or after November. "When Hurricane Camille, Virginia's most notable hurricane of recent times, passed through the state in 1969, upwards of 840 millimeters (33 inches) of rain fell on the eastern slopes of the Blue Ridge in Nelson County and caused record floods along the James River" (Hayden & Michaels, 2015).

Severe thunderstorms are also common throughout Virginia. Although they can occur during any month of the year, they "are most common in the deep, moist, warm air of tropical origin that is typical of summer" (Hayden & Michaels, 2015). Over the last 200 years, Virginia "has averaged one thunderstorm day per decade in January, compared with nine thunderstorm days a month in July" (Hayden & Michaels, 2015). Northern Virginia experiences the fewest thunderstorms of the state, while thunderstorms are most frequent in southern and far southwestern areas of the state. "Thunderstorms are most likely to occur during the warmest part of the day, with 4:00 p.m. the most probably time of occurrence" (Hayden & Michaels, 2015). For example, in Roanoke, "thunderstorms occur ten times more frequently at 4:00 p.m. than at 10:00 a.m., and five times more frequently at 4:30 p.m. than at 7:00 p.m." (Hayden & Michaels, 2015). In Norfolk, thunderstorms also occur most frequently at 4:00 p.m., "remaining common there until about midnight" (Hayden & Michaels, 2015).

Flooding, due to heavy rainstorms, tropical storms, hurricanes, and snowmelt is very common to Virginia, particularly within low-lying areas of the state. For example, Hurricane Fran, which occurred September 5 to 8, 1996 led to record flooding along the Shenandoah River Basin. This storm resulted in between three to seven inches of precipitation throughout much of the state, and between seven to 15 inches across the Shenandoah River Basin. As a result, many rivers in the area "recorded all time record river levels" (NWS, 2015a). In total, Virginia suffered nearly $350 million in damages (NWS, 2015a).

Another historical and severe flooding event occurred due to Hurricane Agnes, between June 21 and 24, 1972. This storm resulted in rainfall accumulations between five and 15 inches "across much of central and western Virginia" (NWS, 2015a). This rainfall led to flooding throughout the Potomac River Basin, the James River Basin, and portions of the Roanoke River Basin. "At the peak of the flooding, over 600 miles of highways were under water" (NWS, 2015a). In total, Virginia suffered approximately $222 million in damages along with 13 fatalities (NWS, 2015a).

15.1.15. Human Health and Safety

15.1.15.1. 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 general 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 implementation 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) emissions or, vehicular traffic and, or the transportation of hazardous materials and wastes. RF is evaluated in Section 2.4, Radio Frequency Emissions. Vehicle traffic and the transportation of hazardous materials and wastes are evaluated in Section 15.1.1, Infrastructure.

There are unique infectious diseases throughout the continental U.S. Because of the great variety of diseases, as well as the variables associated with contracting them, this PEIS will not be evaluating infectious diseases. For information on Infectious Diseases, please visit the Centers for Disease Control and Prevention website at www.CDC.gov.

15.1.15.2. Specific Regulatory Considerations

Federal organizations, such as the U.S. Occupational Safety and Health Administration (U.S. OSHA), USEPA, the U.S. Department of Health and Human Services, and others protect human health and the environment. In Virginia, public sector occupational safety is regulated by the

Virginia Department of Labor and Industry (VDOLI), and the Virginia Department of Environmental Quality (VDEQ) regulates waste and environmental pollution. Federal OSH regulations apply to workers through either OSHA, or stricter state-specific plans, which must be approved by OSHA. Virginia has an OSHA-approved "State Plan," which allows VDOLI to enforce public sector occupational safety and health regulations for Virginia state and local employees, through the Virginia Occupational Safety and Health (VOSH) Compliance Program. Federal employees, as well as most private sector programs in Virginia are enforced by OSHA. Health and safety of the general public is regulated by the Virginia Department of Health (VDH).

Federal laws relevant to protect occupational and public health and safety are summarized in Appendix C. Table 15.1.15-1 below summarizes the major Virginia laws relevant to the state's occupational health and safety, hazardous materials, and hazardous waste management programs.

Table 15.1.15-1: Relevant Virginia Human Health and Safety Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Virginia Administrative Code, Title 16, Agency No. 15	Virginia Department of Labor and Industry (VDOLI)	Sets Virginia-specific occupational health and safety standards for General Industry, Construction, Agriculture, and the Public Sectors.
Virginia Administrative Code, Title 59.1, Chapter 30	VDOLI	Describes conditions under which work or an activity can be carried out safely, and provides guidance for protection and safety arrangements for workers near overhead high voltage lines.
Virginia Voluntary Protection Program (VPP)	VDOLI	The VPP promotes effective safety and health management through leadership and employee involvement, worksite analysis, hazard prevention, and training.
Virginia Administrative Code, Title 10.1, Chapter 12.1	Virginia Department of Environmental Quality (VDEQ)	Sets state regulations for remediation of contaminated sites to protect public health and promote economic development.
Virginia Administrative Code, Title 9, Chapter 81	VDEQ	Sets state regulations for solid waste management, disposal, and permit requirements.
Virginia Administrative Code, Title 9, Chapter 60	VDEQ	Sets state regulations for hazardous waste management, disposal, and permit requirements.
Virginia Administrative Code, Title 9, Chapter 110	VDEQ	Sets state regulations for hazardous waste and hazardous radioactive materials transportation permit process.
Code of Virginia, Title 45.1, Chapter 14.2	Virginia Department of Mines, Minerals, and Energy (VDMME)	Sets safety, training, and rescue regulations for underground mines.

Sources: (Virginia Law, 2015b) (Virginia General Assembly Legislative Information System, 2017) (VDOLI, 2017)

15.1.15.3. 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 are often performed at dangerous heights, inside trenches or confined spaces, 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, 2016). A summary description of the health and safety hazards present in the telecommunication occupational work environment is listed below.

Health and Safety Hazards

Working from height, overhead work, and slip, trips, and 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, 2015a). 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, as well as to the general public who may be observing the work or transiting the area.

Trenches and confined spaces – Installation of underground utilities, building foundations, and work in utility manholes[153] 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.

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.

[153] 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.

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.

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 easily 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 (e.g., manholes) 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 decibels (dB) per 8-hour time weighted average (TWA) (see Section 15.1.13, 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.

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 treatments, such as pesticide application. Secondary hazardous materials, like exhaust fumes, may be a greater health risk than the primary hazardous material (i.e., 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 (exterior and interior) paint at outdoor structures or asbestos tiles and insulation in equipment sheds. The general 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.

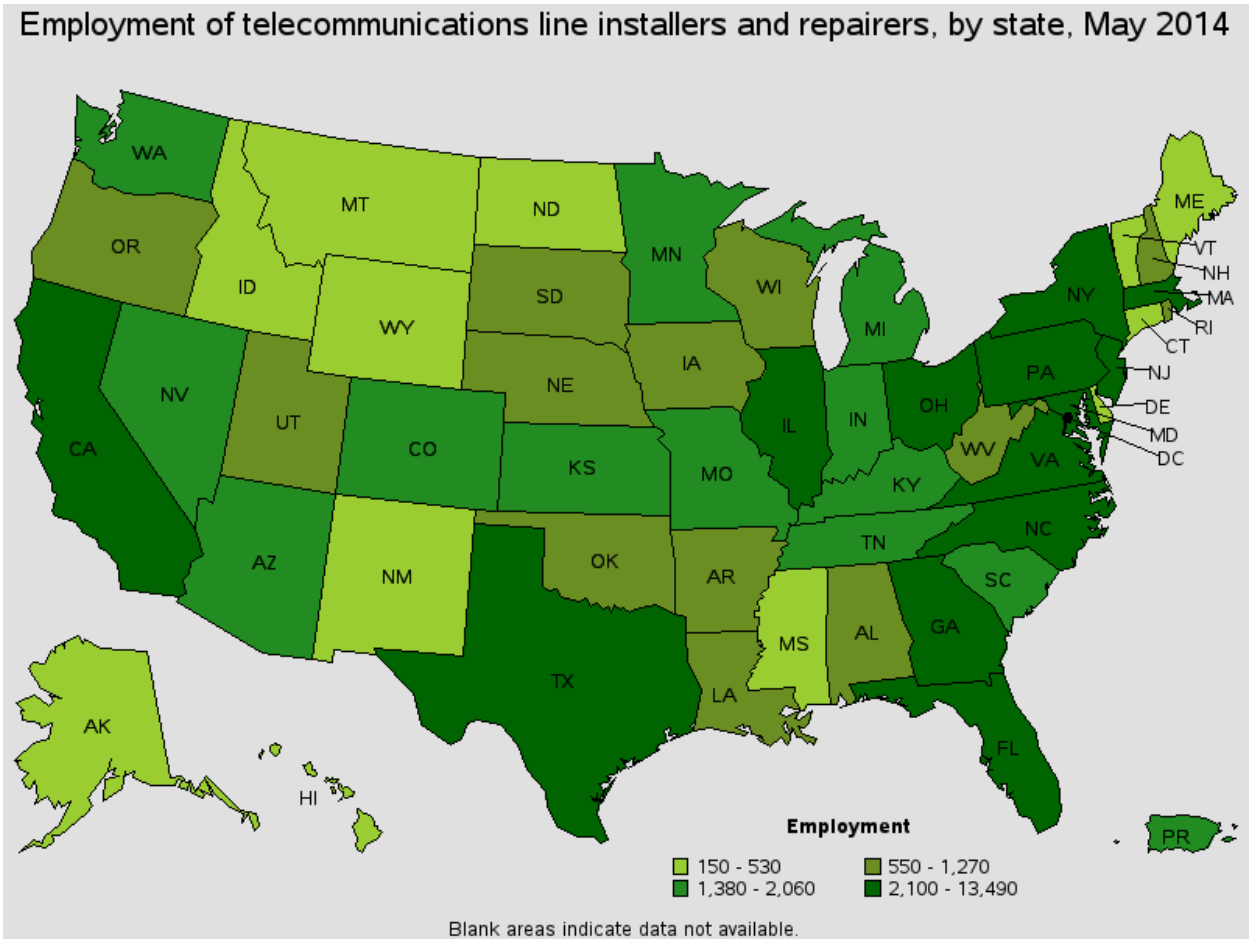
Aquatic environments – Installation of telecommunication lines may include laying, burying, or boring lines under waterways and wetlands, such as lakes, rivers, ponds, or streams. Workers responsible for these activities operate heavy equipment from soft shorelines, boats, barges, and other unstable 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.

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.

Telecommunication Worker Occupational Health and Safety

The Bureau of Labor Statistics (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).



Source: (USDOC, 2013a)

Figure 15.1.15-1: Number of Telecommunication Line Installers and Repairers Employed per State, May 2014

As of May 2014, Virginia employed 7,360 telecommunication line installers and repairers, and 3,990 telecommunication equipment installers and repairers (BLS, 2015b). In 2013, the most recent year that data are available, Virginia had approximately 0.4 reportable cases of nonfatal occupational injuries and illnesses in the telecommunications industry per 100 full-time workers (BLS, 2013a). By comparison, there were 2.1 nonfatal occupational injuries and illnesses reported nationwide per 100 full-time workers in the telecommunications industry (BLS, 2014b).

Nationwide in 2013, there were 18 fatalities reported across the telecommunications industry (including 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). Since 2003, Virginia has reported three line installers and repairers (SOC code 49-9052) fatalities, which occurred in 2004 (BLS, 2015c). In the broader installation, maintenance, and repair occupations (SOC code 49-0000), there were 78 total fatalities in Virginia between 2003 and 2010, with the highest fatality years being 2004 and 2005, with 13 fatalities each (BLS, 2015c).

Public Health and Safety

The general public are not likely to encounter occupational hazards at telecommunication sites, due to limited access. Virginia has not recorded incidents of injuries from the public to these sites. Among the general public, trespassers entering telecommunication sites would be at the greatest risk for exposure to the health and safety hazards.

15.1.15.4. Environmental Setting: Contaminated Properties 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 site occupants at telecommunication sites, prior to creation of 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 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.

In Virginia, the Department of Environmental Quality (DEQ)'s Division of Land Protection and Revitalization assists the EPA's Superfund program by performing activities in accordance with

the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (VDEQ, 2015u). As of September 2015, Virginia had 117 RCRA Corrective Action sites,[154] 126 brownfields, and 31 proposed or final Superfund/NPL sites (USEPA, 2015n). Based on a September 2015 search of USEPA's Cleanups in My Community (CIMC) database, two Superfund sites still exist in Virginia where contamination has been detected at an unsafe level, or a reasonable human exposure risk exists (Atlantic Wood Industries, Inc. and Arrowhead Associates Inc.) (USEPA, 2015n). Brownfield sites in Virginia are enrolled in the Brownfields/Land Renewable Program, designed to remediate contaminated properties and bring them back into economic production (VDEQ, 2015v). Section 90, Chapter 16 of 9 Virginia Administrative Code, "Voluntary Remediation Regulations," describes remediation levels that must be met to achieve safe reuse of a contaminated site (Virginia Administrative Code, 2014).

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, Virginia had 427 TRI reporting facilities. According to the USEPA, in 2013, the most recent data available, Virginia released 46,228,572 pounds of toxic chemicals through onsite and offsite disposal or other releases. This accounted for 1.12 percent of total nationwide TRI releases, ranking Virginia 19 of 56 U.S. states and territories. (USEPA, 2014d)

Another USEPA program is the National Pollutant Discharge Elimination System (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.

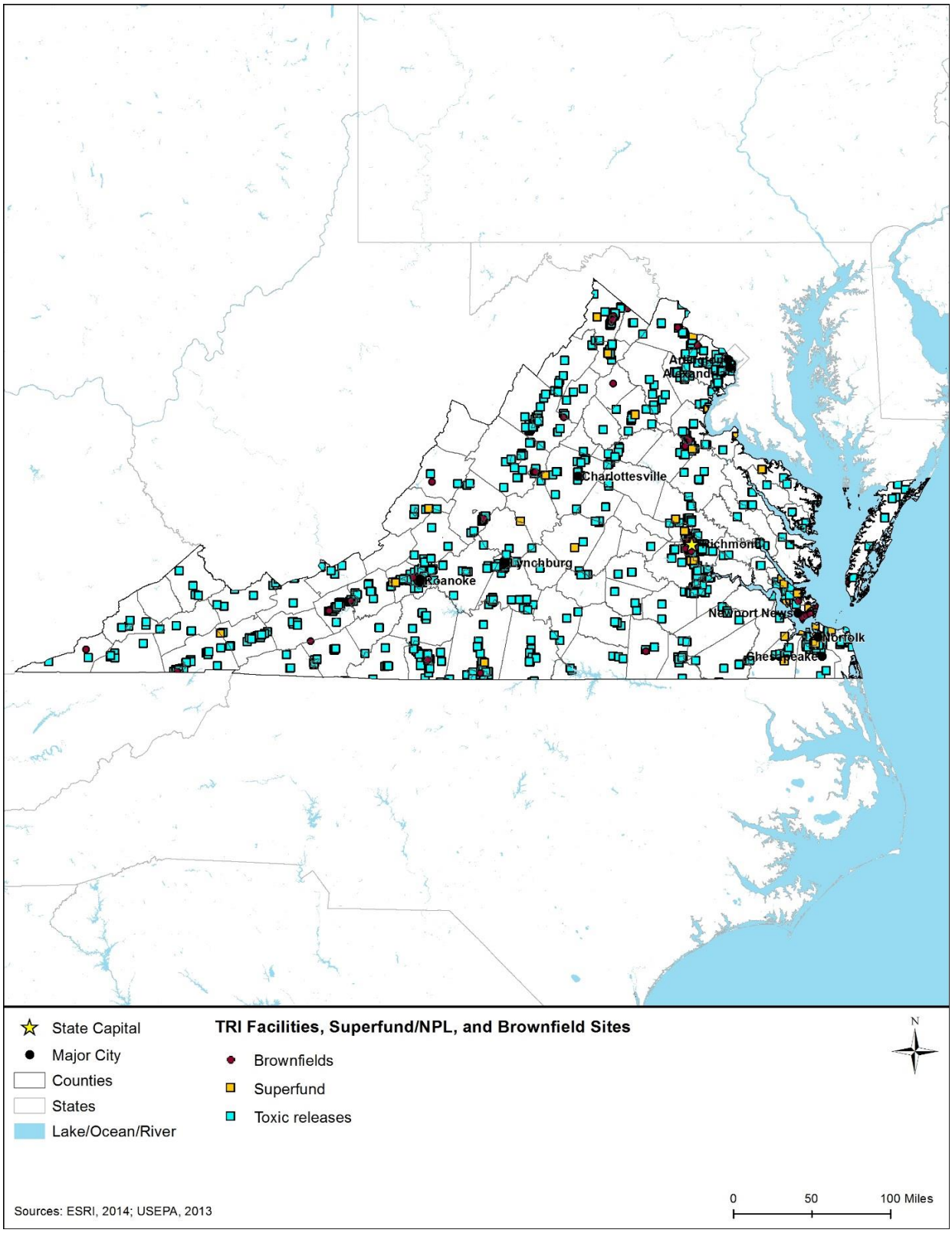
The National Institute of Health (NIH), U.S. National Library of Medicine, provides an online mapping tool called TOXMAP, which allows users to "visually explore data from the USEPA's TRI and Superfund Program" (NIH, 2015a). Figure 15.1.14-2 provides an overview of potentially hazardous sites in Virginia.

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

[154] Data gathered using the U.S. Environmental Protection Agency's Cleanups in My Community (CIMC) search on September 27, 2015, for all sites in the State of Virginia, where cleanup type equals 'RCRA Hazardous Waste – Corrective Action,' and excludes sites where cleanup phase equals 'Construction Complete' (i.e., no longer active).

over water bodies. Indoor air quality may be impacted from vapor intrusion infiltrating indoors from contaminated soil or groundwater that are present beneath a building's foundation. Since 2003, Virginia has reported three line installers and repairers (SOC code 49-9052) fatalities, which occurred in 2004 (BLS, 2015c). Within the broader installation, maintenance, and repair occupations (SOC code 49-0000), Virginia reported four occupational fatalities resulting from exposure to harmful substances or environments in 2012, three in 2006, four in 2004, and four in 2003 (BLS, 2013c). By comparison, the Bureau of Labor Statistics (BLS) reported three fatalities in 2011 and three preliminary fatalities in 2014 nationwide within the telecommunications industry (NAICS code 517), due to exposure to harmful substances or environments (BLS, 2015d). In 2014, BLS also reported four preliminary fatalities within the telecommunications line installers and repairers occupation (SOC code 49-9052), and no fatalities within the telecommunications.



Source: (NIH, 2015b)

Figure 15.1.15-2: TOXMAP Superfund/NPL and TRI Facilities in Virginia (2013)

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 general 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. The Virginia Department of Public Health is responsible for collecting public health data resulting from exposure to environmental contamination, and provides publicly available health assessments and consultations for documented hazardous waste sites (Virginia Department of Public Health, 2013).

15.1.15.5. Environmental Setting: Abandoned Mine Lands at or near Telecommunications Sites

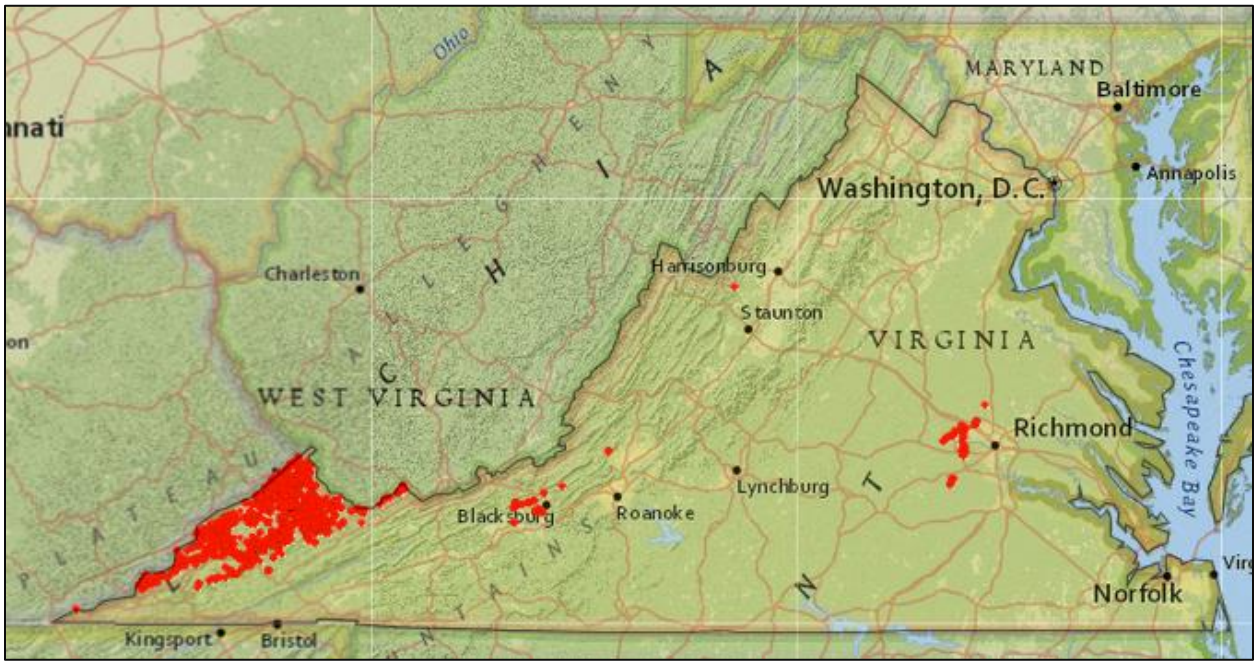
Another health and safety hazard in Virginia includes surface and subterranean mines. In 2015, the Virginia mining industry ranked 23rd for non-fuel minerals (primarily crushed stone, Portland cement, sand and gravel, lime, and zirconium concentrates), generating a value of $1.16 billion (USGS, 2016). In 2013, the most recent data available, coal production in Virginia ranked 4th in the United States, behind Kentucky, West Virginia, and Pennsylvania, with 118 coal mining operations (68 underground and 50 surface) (EIA, 2013c).

Health and safety hazards known at active mines and abandoned mine lands (AMLs) 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, 2015a). Gradual settling or sudden sinking of the Earth's surface, also known as subsidence, presents additional risks and is further discussed in Section 15.1.3.8, Geologic Hazards.

The Virginia Department of Mines Minerals and Energy (VADMME), Division of Mined Land Reclamation administers the Virginia Abandoned Mine Land program, and is responsible for managing AML health and safety hazards resulting from pre-1977 coal mining operations (Virginia Department of Mines Minerals and Energy, 2012a). As of 2015, there were 2,000 abandoned mines in Virginia (Federal Mining Dialogue, 2015b). Figure 15.1.15-3 shows the distribution of AMLs in Virginia.

Telecommunication Worker Occupational Health and Safety

Telecommunications sites may be at or near AMLs or coal mine fires, potentially presenting occupational exposure risks from fire, toxic gases, and subsidence during FirstNet deployment, operation, and maintenance activities. The U.S. Department of Labor, Mine Safety and Health Administration (MSHA) is responsible reporting occupational fatalities related to mining operations. As of September 22, 2015, Virginia has reported a total of 12 coal mining fatalities since 2004, with the highest number of fatalities reported in 2004 (3 total) (MSHA, 2015a). Between January 1 and September 24, 2015, MHSA reported 24 mining fatalities nationwide (9 fatalities in the coal mining industry and 15 in metals/nonmetals industry) (MSHA, 2015b). Because the locations of many abandoned mines are unknown or hidden, these mines pose a risk to telecommunications workers because they may be encountered during new construction operations.



Source: (OSMRE, 2015)

Figure 15.1.15-3: Abandoned Mine Lands in Virginia (2015)

15.1.15.6. Environmental Setting: Natural & Manmade Disaster Sites

Public Health and Safety

Natural and manmade disaster events can create health and safety risks, as well as present unique hazards, to telecommunication workers and the general public. Telecommunications, including public safety communications, can be knocked out (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.). Floodwaters are often

contaminated by hazardous chemicals and sanitary wastes, 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, and 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. Currently, VDOLI and US Bureau of Labor 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. During Hurricane Irene, several incidents involved ruptured transformers and associated spills, including an incident involving high winds that knocked a transformer from an electrical utility pole and spilled possibly hazardous transformer oil (USCG, 2011). Such incidents present unique, hazardous challenges to telecommunication workers responding during natural disasters.

Public Health and Safety

Hazards present during natural and manmade disasters are often ubiquitous, affecting large geographic areas and affecting all populations living within the area. Similar to telecommunication workers, the general public faces risks during these types of disasters, such as compromised transportation infrastructure and utilities and potential for exposure to unknown chemical and biologic hazards. In 2014, Virginia experienced 49 weather related injuries and seven fatalities (NWS, 2015b). For comparison, in 2011, the year Hurricane Irene affected the northeast, there were 20 weather related fatalities, and 116 weather related injuries in Virginia (NWS, 2012).

Spotlight on Virginia Natural Disaster Sites: Hurricane Isabel

In September 2003, Hurricane Isabel became the costliest disaster in Virginia, casing 32 fatalities, damages to more than 9,000 homes, and $1.9 billion in property damage (VDGIF, 2015a) (VDEM, 2011). Hurricane Isabel caused serious public health and safety concerns, including water and sewage pump failures and mosquito-borne diseases, prompting the Virginia Department of Health to issue 231 boil water advisories. More than 6.4 million pounds of ice and 1.5 million gallons of water were distributed to residents of affected areas (VDEM, 2011).

High winds and floods from the hurricane caused catastrophic damage to the state's telecommunications network, especially on the wireless networks. Verizon Virginia and Verizon South replaced more than 1,800 telecommunication poles and repaired more than 3,800 spans of cable. Cox Virginia Telecom reported damages or breakage in 13,000 of its individual customer connections and reported "6,000 spans of cable (150 miles) were either damaged or lying on the ground," costing the company nearly $20 million (Commonwealth of Virginia, 2004). Customers of local power companies also suffered significant power outage: nearly 2 million Dominion Virginia Power customers and more than two-thirds of Potomac Electric Power Company customers lost power (VDEM, 2011).

Source: (VDEM, 2011)

Figure 15.1.15-4: Downed Trees and Power Lines in Colonial Beach, VA

15.2. ENVIRONMENTAL CONSEQUENCES

15.2.1. Infrastructure

15.2.1.1. Introduction

This section describes potential impacts to infrastructure in Virginia associated with construction, deployment, and operation of the Proposed Action and alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.1.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on infrastructure were evaluated using the significance criteria presented in Table 15.2.1-1. The categories of impacts are defined at the programmatic level as *potentially significant, less than significant with BMPs and mitigation measures 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 15.2.1-1: Impact Significance Rating Criteria for Infrastructure at the Programmatic Level

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

15.2.1.3. 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., departments of transportation, airport authorities, railway companies, and harbormasters) to ensure proper coordination during deployment. Based on the impact significance criteria presented in Table 15.2.1-1, such impacts would be *less than significant* due to the temporary nature of the deployment activities, even if such impacts would be realized at one or more isolated locations. Such 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* at the programmatic level 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 – and that is 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 first responders 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 15.2.1-1, such potential negative and positive impacts would be *less than significant* at the programmatic level.

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 15.2.1-1, any potential impacts would be *less than significant* at the programmatic level 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 compliment such practices and SOPs in a positive manner; therefore, only beneficial or complimentary impacts would be anticipated. Public safety communication capabilities and response times would be expected to also experience such beneficial impacts through enhanced communications abilities. It is possible that FirstNet would be upgrading physical telecommunications infrastructure, thus such 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.

Effects to Commercial Telecommunication Systems, Communications, or Level of Service

Commercial telecommunication systems, communications, or level of service would experience *no impacts*, as such commercial assets would be using a different spectrum for communications. 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.[155] Such capacity would then have *less than significant* positive impacts at the programmatic level on commercial telecommunication systems, communications, or level of service, per the impact significance criteria presented in Table 15.2.1-1.

Effects to Utilities, including Electric Power Transmission Facilities, and Water and Sewer Facilities

The activities proposed by FirstNet would have *less than significant impacts* at the programmatic level 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.

15.2.1.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

[155] 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 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 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* at the programmatic level depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts at the Programmatic Level

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* at the programmatic level 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* to infrastructure resources because there would be no ground disturbance and no interference with existing utility, transportation, or communication systems.
  - New Build – Submarine Fiber Optic Plant: At the programmatic level, the installation of cables in or near bodies of water would have *no impacts* on infrastructure resources because there would be no local infrastructure to impact, other than harbor operations. Impacts to infrastructure resources associated with the construction of landings and/or facilities on shore or the banks of water bodies that accept the submarine cable are addressed below, and depend on the proximity of such infrastructure to the landing site.
  - 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 infrastructure at the programmatic level. The section below addresses potential impacts to infrastructure if construction of new boxes, huts, or other equipment is required near or adjacent to local infrastructure assets.
- 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 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 infrastructure resources, it is anticipated that this activity would have *no impact* to infrastructure resources.

Activities with the Potential to Have Impacts at the Programmatic Level

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)[156], huts, or other associated facilities or hand-holes[157] 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 poles requiring ground disturbance.
  - New Build – Submarine Fiber Optic Plant: As stated above, the installation of cables in limited nearshore or inland 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 shore to accept submarine cable, depending on the exact site location and proximity to existing infrastructure.
  - Installation of Optical Transmission or Centralized Transmission Equipment: As stated above, if installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to infrastructure. However, installation of transmission equipment could potentially impact infrastructure if small

[156] Points of Presence are connections or access points between two different networks, or different components of one network.
[157] A small hole typically large enough for one to insert a hand and arm into for inspection and maintenance activities.

boxes or huts, or access roads required ground disturbance. 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 can enhance public safety 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 result in localized impacts to that tower such as minor disruptions in services. As a result of collocation of equipment, the potential addition of power units, structural hardening, and physical security measures could potentially have beneficial impacts on existing infrastructure assets, depending on the site-specific plans.
- Deployable Technologies
  - Deployable technologies such as COWs, COLTs, and SOWs are comprised 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. Also, 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 negative and 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. See Chapter 17, BMPs and Mitigation Measures, for 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. 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 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 also 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.

15.2.1.5. Alternatives Impact Assessment

The following section assesses potential impacts to infrastructure associated with the Deployable Technologies Alternative and the No Action alternative.[158]

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 no 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 *less than significant impacts* at the programmatic level to infrastructure 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.

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 roads or utility ROWs, or if additional maintenance-related construction activities occur within public road and utility ROWs, *less than significant* impacts would likely still occur to

[158] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

transportation systems or utility services due to the limited amount of new infrastructure needed to accommodate the deployables.

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. Therefore, there would be *no impacts* to infrastructure as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 15.1.1, Infrastructure. The state also would not realize positive, beneficial impacts to infrastructure resources described above.

15.2.2. Soils

15.2.2.1. Introduction

This section describes potential impacts to soil resources in Virginia associated with construction/deployment and operation of the Proposed Action and alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.2.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on soil resources were evaluated using the significance criteria presented in Table 15.2.2-1. The categories of impacts are defined, at the programmatic level, as *potentially significant, less than significant with BMPs and mitigation measures 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 15.2.2-1: Impact Significance Rating Criteria for Soils at the Programmatic Level

Type of Effect	Effect Characteristic	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

15.2.2.3. Description of Environmental Concerns

Soil Erosion

Soil erosion is an environmental concern of 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 Virginia and other states with similar geography and weather patterns is the erosion of construction site soils to natural waterways, where the sediment can impair water and habitat quality, and potentially affect aquatic plants and animals (NRCS, 2000). Areas exist in Virginia that have steep slopes (i.e., greater than 20 percent) or where the erosion potential is medium to high, including locations with Aquents, Aquepts, Aquults, Saprists, Udalfs, Udepts, and Udults (see Section 15.1.2.4, Soil Suborders, and Figure 15.1.2-2).

Based on the impact significance criteria presented in Table 15.2.2-1, building of some of FirstNet's network deployment sites could cause, at the programmatic level, *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* at the programmatic level given the relatively small scale (less than an acre) and temporary duration of the construction activities.

To the extent practicable, FirstNet would attempt to avoid 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, BMPs and mitigation measures would, 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 17).

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 15.2.2-1, and due to the relatively small-scale (less than 1 acre) of most FirstNet project sites *less than significant* impacts from topsoil mixing is anticipated. BMPs and mitigation measures (see Chapter 17) could be implemented to further reduce potential impacts.

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 15.1.2.3, Soil Suborders). Heavy equipment can cause perceptible compaction and rutting of susceptible soils. Soils with the highest potential for compaction or rutting were identified by using the

STATSGO2[159] database (see Section 15.1.2.4, Soil Suborders). The most compaction susceptible soils in Virginia are hydric soils with poor drainage conditions, which include Aquents, Aquepts, Aquults, and Saprists. These suborders are found throughout the state in approximately ten percent of Virginia,[160] particularly in northeastern and southeastern areas of the state (see Figure 15.1.2-2). The potential for compaction or rutting impact would be generally low at FirstNet network deployment sites where other soil types predominate.

Based on impact significance criteria presented in Table 15.2.2-1, the risk of soil compaction and rutting resulting from FirstNet deployment activities would, at the programmatic level, be *less than significant*, due to the extent of susceptible soils in the state and the relatively small-scale (less than one acre) of most FirstNet construction projects. Potential impacts could be further reduced with implementation of BMPs and mitigation measures (see Chapter 17).

15.2.2.4. 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, 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, at the programmatic level, 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 at the Programmatic Level

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 would be through existing hand holes, pulling vaults, junction boxes, huts, and POP structures, and therefore would have *no impact* on soil resources because it would not produce perceptible changes to soil resources.
  - Collocation on Existing Aerial Fiber Optic Plant: Collocation of new aerial fiber optic plant on existing utility poles and other structures would have *no impact* on soils at the programmatic level because there would be no ground disturbance from pole/structure

[159] STATS2GO is the Digital General Soil Map of the United States developed by the National Cooperative Soil Survey and supersedes the State Soil Geographic (STATSGO) dataset; the U.S. General Soil Map is comprised of general soil association units and is maintained and distributed as a spatial and tabular dataset.
[160] This percentage was calculated by dividing the acres of soils that fall within the suborders listed above by the total soil land cover for the state.

installation. Heavy equipment use would typically be limited to bucket trucks operated from existing paved, gravel, or dirt roads. Impacts to soils associated with the construction of new poles to accept aerial fiber or on shore to accept submarine cable are addressed below.

- 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 ground disturbing activity, and therefore *no impacts* to soil resources at the programmatic level. 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 and would not require any ground disturbing activity. Impacts to soil resources associated with the construction of new poles to accept aerial fiber or on shore to accept submarine cable are addressed below, and depend on the proximity of such infrastructure to the landing site.
- New Build – Submarine Fiber Optic Plant: The installation of cables in or near bodies of water would have no impact on soil resources at the programmatic level because there would be no ground disturbance associated with this activity (see Section 15.2.4, Water Resources, for a discussion of potential impacts to water resources). Impacts to soil resources associated with the construction of landings or facilities on shore to accept submarine cable are addressed below.
- 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 soils at the programmatic level. The section below addresses potential impacts to soils if construction of new boxes, huts, or other equipment is required.

- Wireless Projects
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation is the mounting or installing of new equipment on existing structures (such as antennas on an existing tower). This activity would have *no impact* on soil resources at the programmatic level because there would be no ground disturbance. Potential impacts to soil resources from structural hardening, addition of power units, or security measures are addressed below
  - Deployable Technologies: Where technologies such as Cell on Wheels (COW), Cell on Light Trucks (COLT), or System on Wheels (SOW) are deployed on existing paved surfaces or dirt or gravel areas, there would be *no impacts* to soil resources at the programmatic level because there would be no ground disturbance. Potential impacts associated with paving of previously unpaved surfaces or other ground disturbing activities are addressed below.
- 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, or adding equipment to satellites launched for other purposes, would have *no impact* on soil resources at the programmatic level because those activities would not require ground disturbance.

- Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (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 soil resources, it is anticipated that this activity would have *no impact* to soil resources at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

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
  - 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: : As stated above, collocation with no ground disturbance would result in *no impacts* to soil resources at the programmatic level. However, 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.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: As stated above, lighting up of dark fiber in existing conduits or cables would have *no impact* on soil resources at the programmatic level, however, if installation of new huts or equipment we necessary, the activity could result in soil erosion and topsoil mixing during grading or excavation activities. This activity could also require the short-term use of heavy equipment for grading or other purposes, which could result in soil compaction and rutting.
  - New Build – Submarine Fiber Optic Plant: As stated above, the installation of cables in or near bodies of water would not impact soil resources at the programmatic level because there would be no soils to impact. However, 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 shore to accept submarine cable.[161] 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 deployment activity.

- Installation of Optical Transmission or Centralized Transmission Equipment: As stated above, if installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to soils at the programmatic level. However, 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, however, 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: As stated above, collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, would result in *no impacts* to soils. However, if 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: As stated above, if deployment occurred on paved surfaces or previously disturbed land, there would be *no impact* on soil resources, however, 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, or UAVs) 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. 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 those locations 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, where feasible. See Chapter 17, BMPs and Mitigation Measures, for 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.

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* to soil resources 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. 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. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.2.5. 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 no 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

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. See Chapter 17, BMPs and Mitigation Measures, for 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.

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 associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. At the programmatic level, 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 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. See Chapter 17, BMPs and Mitigation Measures, for 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.

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. Therefore, there would be *no impacts* to soil resources as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 15.1.2, Soils.

15.2.3. Geology

15.2.3.1. Introduction

This section describes potential impacts to Virginia geological resources associated with deployment and operation of the Proposed Action and alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.3.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on geological resources were evaluated using the significance criteria presented in Table 15.2.3-1. The categories of impacts are defined, at the programmatic level, as *potentially significant, less than significant with BMPs and mitigation measures 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 geological resources addressed in this section are presented as a range of possible impacts.

Table 15.2.3-1: Impact Significance Rating Criteria for Geology at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs 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 BMPs 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
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
Paleontological Resources impacts	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 BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	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

15.2.3.3. Description of Environmental Concerns

Environmental concerns regarding geology can be viewed as two distinct types, those that would potentially provide impacts on the project, such as seismic hazards and landslides, and those that could have impacts from the project, such as land subsidence, mineral and fossil fuel resources, paleontological resources, surface geology, bedrock, topography, physiography, and geomorphology. These concerns and their impacts on geological resources are discussed below.

Seismic Hazard

As discussed in Section 15.1.3.8, Virginia is not at risk for significant earthquake events. Based on the impact significance criteria presented in Table 15.2.3-1, seismic impacts from deployment or operation of the Proposed Action would have *no impact* on seismic activity at the programmatic level; however, seismic impacts to the Proposed Action could be *potentially significant* if FirstNet's deployment locations were within high-risk earthquake hazard zones. Equipment that is exposed to earthquake activity is subject to misalignment, alteration, or, in extreme cases, destruction; all of these activities could result in connectivity loss. Given the potential for minor earthquakes in or near Virginia, some amount of infrastructure could be subject to earthquake hazards, in which case BMPs and mitigation measures (see Chapter 17) could help avoid or minimize the potential impacts.

Volcanic Activity

Volcanoes were considered but not analyzed for Virginia, as they do not occur in Virginia; therefore, volcanoes 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.

As discussed in Section 15.1.3.8, Geologic Hazards, the majority of western Virginia is at moderate to high risk of experiencing landslide events. The highest potential for landslides in Virginia is found in the Valley and Ridge, Blue Ridge, and Appalachian Plateaus Physiographic Provinces, especially in locations with steep slopes. Based on the impact significance criteria presented in Table 15.2.3-1, potential impacts to landslides from deployment or operation of the Proposed Action would have *less than significant* impacts at the programmatic level 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. Where infrastructure is subject to landslide hazards, BMPs and mitigation measures, as discussed in Chapter 17, could help avoid or minimize the potential impacts.

To the extent practicable, FirstNet would avoid deployment in areas that are susceptible to landslide events. However, given that several of Virginia's major cities, including Alexandria, Charlottesville, Lynchburg, and Roanoke, are in areas that experience landslides with moderate

to high frequency, some amount of infrastructure could be subject to landslide hazards, in which case BMPs and mitigation measures (see Chapter 17) could help avoid or minimize the potential impacts.

Land Subsidence

Based on the impact significance criteria presented in Table 15.2.3-1, potential impacts to soil subsidence from deployment or operation of the Proposed Action would have *less than significant* impacts at the programmatic level. However, subsidence impacts could be *potentially significant* if FirstNet's deployment locations were within areas at high risk to karst topography, mine collapse, or inundation due to long-term 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[162] and inundation of equipment. All of these activities could result in connectivity loss. As discussed in Section 15.1.3.8, portions of Virginia are vulnerable to land subsidence due to karst topography. To the extent practicable, FirstNet would avoid deployment in known areas of karst topography, 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 landslide hazards, in which case BMPs and mitigation measures (see Chapter 17) could help avoid or minimize the potential impacts.

Mineral and Fossil Fuel Resource Impacts

As discussed in Section 15.1.3.7 and shown in Figure 15.1.3-7, widespread portions of Virginia contain mineral and fossil fuel resources. Equipment deployment near mineral and fossil fuel resources are not likely to affect these resources. Rather the new construction is only likely to, at most, temporarily limit access to extraction of these resources. To the extent practicable, FirstNet would avoid construction in areas where these resources exist. Chapter 17, 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.

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 15.2.3-1, impacts to paleontological resources could be *potentially significant* at the programmatic level if FirstNet's buildout/deployment locations uncovered paleontological resources during construction activities. As discussed in Section 15.1.3.7, fossils exist in/near Virginia. It is anticipated that potential impacts to specific areas known to contain paleontological resources would be avoided, minimized, or mitigated, and any

[162] 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." (USGS, 2015g)

potential impacts would be limited and localized thus potential impacts would be *less than significant* at the programmatic level. Site- specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. BMPs and mitigation measures could further help avoid or minimize the potential impacts. Chapter 17, 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 15.2.3-1, impacts could be *potentially significant* at the programmatic level if FirstNet's deployment were 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* at the programmatic level 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 measures (see Chapter 17) could be implemented to help avoid or minimize the potential impacts.

15.2.3.4. 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

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 have the potential to be impacted by geologic hazards, some activities could result in potential impacts to geological resources, and other activities would have *no impacts*. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result, at the programmatic level 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 at the Programmatic Level

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 geological 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. In most cases, there would be *no impacts* to geologic resources at the programmatic level since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes. The section below addresses potential impacts if entry/exit points are installed in coastal locations that are susceptible to land subsidence.
  - Collocation on Existing Aerial Fiber Optic Plant: Collocation of new aerial fiber optic plant on existing utility poles and other structures would have *no impact* on geologic resources at the programmatic level because there would be no ground disturbance for pole/structure installation, and heavy equipment use would be typically limited to bucket trucks operated from existing paved, gravel, or dirt roads. Impacts to geologic resources associated with the construction of new poles to accept aerial fiber or on shore to accept submarine cable are addressed below.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to geologic resources because there would be no ground disturbance at the programmatic level. The section below addresses potential impacts if ground disturbing activities associated with new huts or structures were to occur in locations that are susceptible to specific geologic hazards.
  - 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 geologic resources at the programmatic level. The section below addresses potential impacts if the boxes/huts are installed in locations that are susceptible to specific geologic hazards (e.g., land subsidence, landslides, or earthquakes).
- 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, which would result in *no impacts* to geologic resources at the programmatic level if no ground disturbance were associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact geologic resources if this activity did not require ground disturbance. The section below addresses potential impacts if ground disturbing activities occur in locations that are susceptible to specific geologic hazards.
  - Deployable Technologies: Where deployable technologies would be implemented on existing paved surfaces, there would be *no impacts* to/from geologic resources at the programmatic level because there would be no ground disturbance and mobile technologies could be moved to avoid geologic hazards. Potential impacts associated with site preparation for staging or landing areas is discussed below.
- Satellites and Other Technologies
  - Satellite -Enabled Devices and Equipment: In most cases, 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 would *not impact* geologic resources at the programmatic level because those activities would not require ground disturbance. The section below addresses potential impacts if ground disturbance activities occur in locations that are susceptible to specific geologic hazards.

- 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 geological resources, it is anticipated that this activity would have *no impact* on geological resources.

Activities with the Potential to Have Impacts at the Programmatic Level

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 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 specific geologic hazards, 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 specific geologic hazards, it is possible that equipment could be affected by that hazard.
  - Collocation on Existing Aerial Fiber Optic Plant: As stated above, if collocation does not require new utility poles or ground disturbance, there would be *no impacts* to geologic resources. However, 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 specific geologic hazards, it is possible that equipment could be affected by that hazard.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: As stated above, although lighting up of dark fiber would have *no impacts* to geologic resources at the programmatic level, installation of new associated huts or equipment, if required, could result in ground disturbance during grading or excavation activities.

Where equipment is installed in locations that are susceptible to specific geologic hazards, it is possible that equipment could be affected by that hazard.

- Use of Existing Conduit – New Buried Fiber Optic Plant: As stated above, disturbance associated with the installation of fiber optic cable in existing conduit have *no impacts* to geologic resources at the programmatic level. However, if fiber were installed in locations susceptible to landslides, earthquakes, or other geologic hazards, it is possible that the equipment could be affected by that hazard.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water is not expected to impact geologic resources, including marine paleontological resources. However, where landings and/or facilities for submarine cable are installed at locations that are susceptible to specific geologic hazards, it is possible that equipment could be affected by that hazard.
- Installation of Optical Transmission or Centralized Transmission Equipment: As stated above, if installation of equipment were to take place in existing facilities, there would be *no impact* to/from geologic resources. However, if installation of transmission equipment would occur in existing boxes or huts and require ground disturbance in locations that are susceptible to specific geologic hazards (e.g., land subsidence, landslides, or 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 perturbation of geologic resources. Where equipment is installed in locations that are susceptible to specific geologic hazards, it is possible that equipment could be affected by that hazard.
  - Collocation on Existing Wireless Tower, Structure, or Building: As stated above, collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in ground disturbance and therefore would have *no impact* on geologic resources. However, if 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 specific geologic hazards, it is possible that equipment could be affected by that hazard.
  - Deployable Technologies: As stated above, 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. However, 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, or UAVs) 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.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: As stated above, the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would have *no impact* on geologic resources at the programmatic level because those activities would not require ground disturbance. However, where equipment is permanently installed in locations that are susceptible to specific geologic hazards, such as earthquakes, it is possible that they 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 include minimal removal of bedrock or mineral and fuel resources, or adverse impacts to installed equipment resulting from geologic hazards (e.g., seismic hazards, 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. These potential impacts are expected to be *less than significant* at the programmatic level. See Chapter 17, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or its partners 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 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 geological resources 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.

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. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.3.5. 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 no 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 geological resources 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. See Chapter 17, BMPs and Mitigation Measures, for 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.

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 geologic resources (or from geologic hazards) associated with routine inspections of the Preferred Alternative.

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. See Chapter 17, BMPs and Mitigation Measures, for 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.

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. Therefore, there would be *no impacts* to geologic resources (or from geologic hazards) as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 15.1.3, Geology.

15.2.4. Water Resources

15.2.4.1. Introduction

This section describes potential impacts to water resources in Virginia associated with construction/deployment and operation of the Proposed Action and alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.4.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on water resources were evaluated using the significance criteria presented in Table 15.2.4-1. The categories of impacts are defined at the programmatic level as *potentially significant, less than significant with BMPs and mitigation measures 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 15.2.4-1: Impact Significance Rating Criteria for Water Resources at the Programmatic Level

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 BMPs and mitigation measures is *less than significant* at the programmatic level.	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		The impact is temporary, lasting no more than six months.	NA
Floodplain degradation*	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 BMPs and mitigation measures is *less than significant* at the programmatic level.	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		The 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 BMPs and mitigation measures is *less than significant* at the programmatic level.	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		The 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 BMPs and mitigation measures is *less than significant* at the programmatic level.	Minor or no consumptive use with negligible impact on discharge.	Activities do not impact discharge or stage of waterbody
	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 BMPs and mitigation measures is *less than significant* at the programmatic level.	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		Potential impact is temporary, not lasting more than six months.	NA

NA = Not Applicable

* - 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).

15.2.4.3. 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 Clean Water Act (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 (TMDL) or other strategy to reduce the input of the specific pollutant(s) restricting waterbody uses, in order to restore and protect such uses.

Most of Virginia's rivers, streams, lakes, and reservoirs are in poor condition and almost all (95 percent) of Virginia's estuaries and bays are impaired (see Table 15.1.4-2, Figure 15.1.4-4) (USEPA, 2015k). Low dissolved oxygen concentrations are a major cause of aquatic life impairment in Virginia. Nitrogen and phosphorous are carried to waterbodies via stormwater runoff and lead to the growth of excessive amounts of algae, which in turn leads to depletion of dissolved oxygen in the water column, suffocating fish and other aquatic life. Stormwater runoff can also carry pathogens into surface waters that originate in waste from livestock and pets. (VDEQ, 2014) Generally, the water quality of Virginia's aquifers is suitable for drinking and daily water needs (VDH, 2012).

Construction activities can contribute pollutants in a number of ways but the primary manner is increased sediment in surface waters. Vegetation removal on site exposes soils to rain and wind that can 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 can contaminate groundwater and surface waters if carried in runoff. Other water quality impacts could include changes in temperature, water volume flows, pH or 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 Virginia Pollutant Discharge Elimination System (VPDES) Construction General Permit (CGP) would be required. As part of the permit application for the CGP, a stormwater pollution prevention plan (SWPPP) 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 keep sediment and suspended solids from entering the waterways and ensure that effects on water quality during construction would not be adverse.

Construction 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, contaminated water runoff from these areas would have the potential to degrade surface water quality. Implementing BMPs and mitigation measures, where practicable and feasible, would reduce potential impacts to surface water quality.

The deployment activities would not violate applicable state, federal (e.g., CWA, and Safe Drinking Water Act), and locally required 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 15.2.4-1, water quality impacts would likely be *less than significant* at the programmatic level particularly if BMPs and mitigation measures were 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 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 Virginia dewatering requirements. Any groundwater extracted during dewatering activities or as required by a dewatering permit would be treated prior to discharge or disposed of at a wastewater treatment facility.

Due to average thickness of most Virginia aquifers, there is potential for groundwater contamination within a watershed or multiple watersheds. Thus, it is unlikely that the majority of FirstNet's deployment locations would result in a drinking quality violation, or otherwise substantially degrade groundwater quality or aquifer, and based on the impact significance criteria presented in Table 15.2.4-1, there would likely be *less than significant* impacts on groundwater quality at the programmatic level within most of the state. In areas where groundwater is close to the surface, such as along the coast, then site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Furthermore, BMPs and mitigation measures could be implemented to reduce further potential impacts. Chapter 17, 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.

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 humans, 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 15.2.4-1, floodplain degradation impacts would be *less than significant* at the programmatic level since the majority of FirstNet's likely deployment activities, on the watershed or subwatershed level, would likely occur inside the 500-year floodplain, use minimal fill, would not substantially increase impervious surfaces, would not impede or redirect flood flows or impact floodplain hydrology, and would not occur during flood events, except to use deployables to respond to a flood emergency. Additionally, any effects would be temporary, lasting no more than one season or water year,[163] or occur only during an emergency.

Examples of activities that would have *less than significant* impacts at the programmatic level 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.
- Limited clearing or grading activities.

BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented to help reduce the risk of additional impacts of floodplain degradation. Chapter 17, 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.

Drainage Pattern Alteration

Flooding and erosion from land disturbance can changes drainage patterns. Stormwater runoff causes erosion while construction activities and land clearing can 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 can be directed to stormwater drains, storage, and retention areas designed to slow water and allow sediments to settle out. Improperly handled drainage can cause increased erosion, changes in stormwater runoff, flooding, and damage to water quality. Existing drainage patterns can 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 15.2.4-1, 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* at the programmatic level.

[163] 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, 2014d)

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 off-site on other properties.
- Activities designed so that the amount of stormwater generated before construction is the same as afterwards.
- 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* at the programmatic level. BMPs, mitigation measures, and avoidance could be implemented to further reduce any impacts. Chapter 17, 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.

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 can 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 can 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 15.2.4-1. 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) basis are likely to have *less than significant* impacts on flow alteration at the programmatic level, on a watershed or subwatershed level. Examples of projects likely to have *less than significant* impacts at the programmatic level include:

- Construction of any structure in a 100-year or 500-year floodplain but is built above base flood 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 off site or into surface water bodies that have not received that volume of stormwater before.
- 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 at the programmatic level. BMPs, mitigation measures, and avoidance could be implemented to further reduce any impacts. Chapter 17, 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.

Changes in Groundwater or Aquifer Characteristics

As described in Section 15.1.4, approximately 2 million Virginia residents get their drinking water exclusively from wells (VDCR, 2015a). Generally, the water quality of Virginia's aquifers is suitable for drinking and daily water needs (VDH, 2012). Groundwater is an important natural resource used by industrial, commercial, agricultural, and residential uses for manufacturing, irrigation, and drinking water purposes. 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 any *potentially significant* impacts to water quality due to the small volume of fuels anticipated to be stored on site and the likelihood that any spilled material would be cleaned up promptly. Activities that may cause changes is groundwater or aquifer characteristics include:

- Excavation, mining, or dredging during or after construction.
- New or additional demand for water.
- Public, private, or commercial potable water source that will be added or impacted by the proposed project.
- Any liquid waste, including but not limited to wastewater, generation.
- Storage of petroleum or chemical products.
- Use of pesticides, herbicides, or insecticides during or after construction of a commercial, industrial, or recreational use.
- Commercial generation, treatment, storage, or disposal of hazardous wastes.

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* at the programmatic level 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 15.2.4-1, *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 17, 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.

15.2.4.4. Potential Impacts of the Preferred Alternative at the Programmatic Level

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operation activities.

Potential 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 could result in potential impacts to water resources and others would not. In addition, and as explained in this section, the various types of Preferred Alternative Infrastructure could result in a range of *no impacts* to *less than significant* impacts at the programmatic level 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 at the Programmatic Level

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 water resources at the programmatic level 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 at the programmatic level 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* to water resources at the programmatic level because there would be no ground disturbance.
  - *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 water resources at the programmatic level. The section below addresses potential impacts if construction of new boxes, huts, or other equipment is required.
- Satellites and Other Technologies
  - *Satellite-Enabled Devices and Equipment:* It is anticipated that the installation of permanent equipment on existing structures, equipment attached to satellites launched for

other purposes, or the use of portable devices that use satellite technology would not impact water resources because those activities would not require ground disturbance, construction in floodplains, or use of motorized equipment near streams.

- o *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 water resources, it is anticipated that this activity would have *no impact* on water resources at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential construction/deployment-related impacts to water resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground disturbance activities, including in-stream construction work, resulting primarily in sediments entering streams, but also potentially to near-shore or inland waters, as well as the potential for other impacts to water quality and floodplains. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to water resources include the following:

- Wired Projects
  - o *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 further reduce impact intensity.
  - o *New Build – Submarine Fiber Optic Plant:* The installation of cables in or near bodies of water could potentially impact water quality due to disruption of sediments on the floor of the waterbody. Impacts to water resources could also potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable. Sediments entering limited near-shore or inland waterbodies could potentially occur as result of grading, foundation excavation, or other ground disturbance activities. Construction of facilities in floodplains could potentially impact floodplain functionality and drainage patterns.
  - o *New Build – Aerial Fiber Optic Plant:* Soil exposure from installation of new poles or construction of new roads, POPs, huts, or other facilities near waterbodies could result in ground disturbance, potentially resulting in sediment deposition and increased turbidity in nearby waterbodies. The use of heavy equipment during the installation of new poles and cables could result in potential soil disturbance and the resulting potential sedimentation

impacts to streams, disturbance of riparian vegetation, leaching of PCPs, and accidental spills of fuels or lubricants to waterbodies.

- *Collocation on Existing Aerial Fiber Optic Plant:* Ground disturbance during the replacement of poles and structural hardening could result in potential soil erosion and sedimentation impacts to streams, particularly where this work would be done in proximity to waterbodies. Collocation on Existing Aerial Fiber Optic Plant projects could present a lower risk to water resources because of their relatively low degree of soil disturbance compared to the other types of projects.
- *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 at the programmatic level.

- 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 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.
  - *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 water resources because there would be no ground disturbance or in-water construction associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact water resources if this activity would not require ground disturbance or in-water construction. However, if the on-site delivery of additional power units, structural hardening, and physical security measures required travel through streams or ground disturbance, such as grading or excavation activities near streams, potential impacts to water resources could occur including stream sedimentation and physical disturbance associated with heavy equipment use.
  - *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 deployment 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 at the programmatic level 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* at the programmatic level. See Chapter 17, 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.

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 17, 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 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* to water resources 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, and assuming that all refueling and vehicle maintenance BMPs and mitigation measures are followed. If usage of heavy equipment as part of routine maintenance or inspections occurs off of 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. Chapter 17, 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.

15.2.4.5. Alternative Impact Assessment

The following section assesses potential impacts to water resources at the programmatic level 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 no 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.

Potential Deployment Impacts

As explained above, at the programmatic level, implementation of deployable technologies could result in *less than significant* impacts to water resources at the programmatic level 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 17, 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 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* to water resources at the programmatic level 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 of time, 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, at the programmatic level, 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 at the programmatic level 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 17, 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. Therefore, there would be *no impacts* to water resources at the programmatic level as a result of the No Action Alternative.

15.2.5. Wetlands

15.2.5.1. Introduction

This section describes potential impacts to wetlands in Virginia associated with construction/deployment and operation of the Proposed Action and alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.5.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on wetlands were evaluated using the significance criteria presented in Table 15.2.5-1. The categories of impacts are defined at the programmatic level as *potentially significant, less than significant with BMPs and mitigation measures 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 15.2.5-1: Impact Significance Rating Criteria for Wetlands at the Programmatic Level

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* at the programmatic level	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	USGS watershed level, and/or within multiple watersheds		USGS watershed or subwatershed level	NA
	Duration or Frequency	Long-term or permanent loss, degradation, or conversion to non-wetland		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* at the programmatic level	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	USGS watershed level, and/or within multiple watersheds		USGS 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* at the programmatic level	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	USGS watershed level, and/or within multiple watersheds		USGS watershed or subwatershed level	NA
	Duration or Frequency	Long-term or permanent change in function or type that is not restored within two growing seasons, or ever		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 (USACE 2014). 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.

15.2.5.3. 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, vibration, light, and other human disturbance. To the extent practicable or feasible, FirstNet and/ or their partners 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* at the programmatic level given the amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 17, 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.

There are approximately 1,308,000 acres of wetlands throughout Virginia (USFWS, 2014b). Palustrine (freshwater) wetlands found on river and lake floodplains across the state, and estuarine/marine (tidal) wetlands around Chesapeake Bay and the Atlantic Ocean coastline, as shown in Section 15.1.5, Figure 15.1.5-1 and Figure 15.1.5-2.

Based on the impact significance criteria presented in Table 15.2.5-1 and given the temporary nature of most proposed activities, the deployment activities would most likely have *less than significant* direct impacts on wetlands at the programmatic level. Additionally, most of the deployment activities would not violate applicable federal (e.g., CWA Section 404), state, and locally required regulations.

In Virginia, as discussed in Section 15.1.5, Wetlands, regulated high quality wetlands include wetlands associated with the Chesapeake Bay National Estuarine Research Reserve (NERR), Great Dismal Swamp NWR, and Virginia Natural Area Preserve System.

- Chesapeake Bay, the largest estuary in the country, has diverse estuarine habitats. The Chesapeake Bay-Virginia NERR is comprised of multiple sites (over 3,000 acres total) in Virginia, including the York River Basin, and parts of Sweet Hall Marsh, Taskinas Creek, Catlett Island, and Goodwin Islands. The Chesapeake Bay-Virginia NERR includes a wide

range of wetland habitats, including tidal wetlands, mudflats, sandy shoals, seagrass beds, and oyster reefs. (NOAA, 2015a)

- The Great Dismal Swamp National Wildlife Refuge (see Figure 15.1.8-6) contains over 112,000 acres of important wildlife and bird habitat, along with many acres of marshland, in southwest Virginia (USFWS, 2015c).
- The Virginia Natural Area Preserve System was established to protect and conserve natural heritage resources in the state. These areas include places containing habitats of rare plants and animals, exemplary natural communities, or other rare natural features, including wetlands. These preserves are administered by the Virginia Department of Conservation and Recreation, and managed by the Division of Natural Heritage (VDCR, 2010).

If any of the proposed deployment activities were to occur in these high quality wetlands, *potentially significant* impacts could occur. High quality wetlands occur throughout the state, and are not always included on state maps; therefore, site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work to avoid *potentially significant* impacts to wetlands. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 17, 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

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, 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 15.2.5-1, 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) could cause *potentially significant* impacts. In addition, introduction and establishment of invasive species to high quality wetlands within a watershed or multiple watersheds could be *potentially significant*. Other direct effects to high- and low-quality wetlands would be *less than significant* at the programmatic level 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 locally required wetlands regulations. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 17, 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 activities that could have other direct effects to wetlands in Virginia 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 can 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 Soil Changes:* Changes in soil chemistry can lead to degradation of wetlands that have a specific pH range and/or other parameter, such as the acidic conditions of sphagnum bogs and alkaline conditions of calcareous fens (which often contain rare habitats in Virginia).
- *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) can reduce light penetration, dissolved oxygen, and overall wetland productivity. Toxic materials in runoff can interfere with the biological processes of wetland plants, resulting in impaired growth, mortality, and changes in plant communities.

Indirect effects:[164] change in function(s)[165] 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 could divert surface runoff and can 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* at the programmatic level 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 locally required wetlands regulations. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 17, 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.

[164] 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

[165] 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.

Examples of functions related to wetlands in Virginia 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 can lower flood peaks by providing detention of storm flows.
- *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 can eventually threaten a wetland's existence. Where sediment inputs exceed rates of sediment export and soil consolidation, a wetland would gradually become filled.
- *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 can harm some wetland plant species, it promotes others. Shifts in plant communities because of hydrologic changes can 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 Table 15.2.5-1, 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 *less than significant* at the programmatic level. Since the majority of the approximately 1,308,000 acres of wetlands in Virginia are not considered high quality, deployment activities could have *less than significant* indirect impacts on wetlands at the programmatic level in the state. Implementation of BMPs and mitigation measures would further reduce potential impacts to all wetlands.

In areas where high quality wetlands occur, there could be *potentially significant* impacts at the project level that may require site-specific analysis depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. If avoidance were not possible, potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 17, 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.

15.2.5.4. Potential Impacts of the Preferred Alternative at the Programmatic Level

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Potential 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 Preferred Alternative Infrastructure could result in a range of *no impacts* to *potentially significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts at the Programmatic Level

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 at the programmatic level 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 at the programmatic level 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* to wetlands at the programmatic level because there would be no ground disturbance required.
  - 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 wetlands at the programmatic level. The section below addresses potential impacts if construction of new boxes, huts, or other equipment is required.
- 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 launches 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 could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would not impact wetlands, it is anticipated that this activity would have *no impact* to wetlands at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

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 and inland bodies of water would potentially impact wetlands found along shorelines. Site-specific impact assessments could be required for shoreline environments prior to installation to fully assess potential impacts to wetlands. 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 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 aircraft 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). 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. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 17, 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 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 potential deployment impacts. It is anticipated that there would be *no impacts* at the programmatic level to wetland resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections, and assuming that all federal, state, and local requirements associated with refueling and vehicle maintenance are followed. If heavy equipment is used as part of routine maintenance or inspections off of established access roads or

corridors, or if application of herbicides is used to control vegetation, potential wetland impacts could be *less than significant* at the programmatic level as explained above. Chapter 17, 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.

15.2.5.5. Alternatives Impact Assessment

The following section assesses potential impacts to wetlands at the programmatic level 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 no 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.

Potential 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. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 17, 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 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 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.

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 wetland resources associated with routine inspections of the Deployable Technologies Alternative, assuming the use of access roads and compliance with refueling and vehicle maintenance requirements, and *less than significant* potential impacts at the programmatic level associated with maintenance activities if heavy equipment is used as part of routine maintenance, if or inspections occur off of established access roads or corridors, or if routine maintenance and application of herbicides is used to control vegetation. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 17, 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. Therefore, there would be *no impacts* to wetlands at the programmatic level as a result of the No Action Alternative.

15.2.6. Biological Resources

15.2.6.1. Introduction

This section describes potential impacts to vegetation, wildlife, fisheries and aquatic habitat, and threatened and endangered species in Virginia associated with deployment and operation of the Proposed Action and its alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.6.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on vegetation, wildlife, fisheries, and aquatic habitats were evaluated using the significance criteria presented in Table 15.2.6-1. The categories of impacts are defined, at the programmatic level, as *potentially significant, less than significant with BMPs and mitigation measures 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 vegetation, wildlife, and fisheries and aquatic habitat addressed in Sections 15.2.6.3, 15.2.6.4, and 15.2.6.5, respectively, are presented as a range of possible impacts.

Refer to Section 15.2.6.6 for impact assessment methodology and significance criteria associated with threatened and endangered species in Virginia.

Table 15.2.6-1: Impact Significance Rating Criteria for Vegetation, Wildlife, Fisheries, and Aquatic Habitats at the Programmatic Level

Type of Effect	Effect Characteristic	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), Migratory Bird Treaty Act (MBTA), and Bald and Golden Eagle Protection Act (BGEPA).	Effect that is *potentially significant*, but with mitigation 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 Virginia for at least one species. Anthropogenic 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

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	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
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, refuge, or cover from weather or predators. Violation of various regulations including: MMPA, MSFCMA, MBTA, and BGEPA.	Effect that is *potentially significant*, but with mitigation 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 Virginia 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

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	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
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 mitigation 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.

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	Geographic Extent	Regional or site specific effects observed within Virginia 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
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 mitigation 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.

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	Geographic Extent	Regional effects observed within Virginia 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
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 mitigation 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.

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	Geographic Extent	Regional effects observed within Virginia for at least one species. Anthropogenic disturbances that lead to exclusion from prey or habitat resources required for breeding/spawning, or anthropogenic disturbances that lead to 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
Invasive Species Effects	Magnitude or Intensity	Extensive increase in invasive species populations over several seasons.	Effect that is *potentially significant*, but with mitigation 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.

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	Less than Significant with BMPs and Mitigation Measures Incorporated	Less than Significant	No Impact
	Geographic Extent	Regional impacts observed throughout Virginia.		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

15.2.6.3. Terrestrial Vegetation

Impacts to vegetation occurring in Virginia's environment 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 15.2.6-1, 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. The implementation of BMPs and mitigation measures and avoidance measures would help to minimize or altogether avoid potential impacts to plant population survival.

Vegetation and Habitat Loss, Alteration, or Fragmentation

Habitat impacts are primarily physical perturbations that result in alterations in the amount or quality of a habitat. 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 loss or breaking down of continuous and connected habitat.

Construction of new infrastructure and long-term facility maintenance would result in the alteration of the type of vegetative communities in these localized areas, and in some instances the permanent loss of vegetation. Further, if proposed sites with sensitive or rare regional vegetative communities are unavoidable, BMPs and mitigation measures would be recommended to minimize or avoid potential impacts.

Comments received on other regional Draft PEIS documents for the Proposed Action expressed concerns related to the potential impacts to vegetation from RF emissions. Some studies have indicated the potential for adverse effects to vegetation from RF emissions. As explained in Section 2.4, Radio Frequency Emissions, as well as the Wildlife portion of this Biological Resources Section, additional, targeted research needs to be conducted to more fully document the nature and effects of RF exposure, including the potential impacts to vegetation.

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 Code of Federal Regulations [CFR] 1508.8[b]). Indirect injury/mortality can include stress related to disturbance. The alteration of soils or hydrology within a localized area can 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. Increasing or decreasing hydrology in an area could lead to

moisture stress and/or mortality of plant species that are adapted to specific hydrologic regimes. Indirect injury/mortality impacts vary depending on the species, time of year and duration of construction or deployment, though BMPs and mitigation measures would help to minimize or avoid the potential impacts.

Effects to Migration or Migratory Patterns

No effects to the long-term migration or migratory patterns for 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 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 can have a dramatic effect on natural resources and biodiversity.

When non-native species are introduced into an ecosystem in which they did not evolve, their populations sometimes increase rapidly. Natural or native community species evolve together into an ecosystem with many checks and balances that limit the population growth of any one species. These checks and balances include such things as: predators, herbivores, diseases, parasites, and other organisms competing for the same resources and limiting environmental factors. However, when an organism is introduced into an ecosystem in which it did not evolve naturally, those limits may not exist and its numbers can sometimes dramatically increase. The unnaturally large population numbers can then have severe impacts to the environment, local economy, and human health. Invasive species can out-compete the native species for food and habitats and sometimes even cause their extinction. 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 potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities. BMPs and mitigation measures (see Chapter 17) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to vegetation as a result of the introduction of invasive species.

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 impacts to 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, depending on the deployment scenario or site-specific conditions. The vegetation that would be affected would depend on the ecoregion, the species' phenology[166], and the nature as well as the extent of the habitats affected.

Activities Likely to Have No Impacts at the Programmatic Level

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 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 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* to vegetation because there would be no ground disturbing 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 not impact 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 to vegetation.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential deployment-related impacts to 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

[166] Phenology is the seasonal changes in plant and animal lifecycles, such as emergence of insects or migration of birds.

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 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 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. Implementation of BMPs and mitigation measures could help to avoid or minimize potential 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 right-of-ways (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 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. Implementation of BMPs and mitigation measures could help to avoid or minimize potential 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. Implementation of BMPs and mitigation measures could help to avoid or minimize potential effects.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water would not impact vegetation. However, impacts to 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. Implementation of BMPs and mitigation measures could help to avoid or minimize potential 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, the vegetation loss, and invasive species effects. Implementation of BMPs and mitigation measures could help to avoid or minimize potential effects.
- Wireless Projects
  - New Wireless Communication Towers or Backhaul Equipment: 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 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 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 land-based deployable technologies including COWs, COLTs, or SOWs could result in direct impacts to 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 aircraft could potentially impact 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 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. These impacts are expected to be *less than significant* at the programmatic level due to the small-scale of expected deployment activities. See Chapter 17, BMPs and Mitigation Measures, for 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.

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 vegetation that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

At the programmatic level, it is anticipated that there would be *no impacts* to vegetation associated with 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

herbicides, may result in *less than significant* effects 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 vegetation, however impacts are expected to be *less than significant* due to the small-scale of expected activities. See Chapter 17, BMPs and Mitigation Measures, for 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.

Alternatives Impact Assessment

The following section assesses potential impacts to 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 no 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 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. However, impacts are expected to remain *less than significant* at the programmatic level, due to the relatively small-scale of FirstNet activities at individual locations. See Chapter 17, BMPs and Mitigation Measures, for 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.

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 to vegetation associated with routine operations and maintenance due to the relatively small-scale of likely FirstNet project sites. The impacts can vary greatly among species, vegetative community, and geographic region but are expected to remain *less than significant*.

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. Therefore, there would be *no impacts* to vegetation as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 15.1.6.3, Vegetation.

15.2.6.4. Wildlife

Impacts to amphibians and reptiles, terrestrial mammals, marine mammals, birds, and invertebrates occurring in Virginia and Virginia's near offshore environment (i.e., less than two miles from the edge of the coast) 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 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 15.2.6-1, *less than significant* impacts would be anticipated at the programmatic level, as discussed further below (except for birds which would be *less than significant with BMPs and mitigation measures incorporated*), given the anticipated small size and nature of the majority of proposed deployment activities. Although anthropogenic disturbances may be measurable but minimal for some FirstNet projects, 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.

Terrestrial Mammals

Vehicle strikes are common sources of direct mortality or injury to both small and large mammals in Virginia. Mammals are attracted to roads for a variety of reasons including use as a source of minerals, preferred vegetation along roadways, areas of insect relief, and ease of travel along road corridors (FHWA, 2015e). 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.

If 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 magnitude of this impact would be associated with the amount of tree removal and if maternity colonies are present. However, given the small scale of anticipated FirstNet activites (less than 1 acre), direct injury/mortality are not anticipated to be widespread or affect populations of bat species. See Chapter 17, 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 further minimize potential impacts.

Marine Mammals

Marine mammals swimming or hauled out on land are sensitive to boats, aircraft, and human presence. Noises, vibrations, smells, sounds, and sights may elicit a flight reaction. Trampling deaths associated with haulout disturbance are known source of mortality for seals but are not anticipated from the types of FirstNet deployment activities.

Entanglements from marine debris as well as ingestion of marine debris could result in injury or death to marine mammals. Marine debris is any man-made object discarded, disposed of, or abandoned that enters the marine environment. However, entanglements from marine debris are not anticipated from FirstNet activities.

Birds

Mortalities from collisions or electrocutions with man-made cables and wires are environmental concerns for avian species and violate MBTA and BGEPA. Generally, collision events occur to night-migrating birds, "poor" fliers (e.g., ducks), 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 (Gehring, J., Kerlinger, P. and A. Manville, 2011).

Avian mortalities or injuries can also result from vehicle strikes, although typically occur as isolated events.

Direct injury and mortality of birds can occur to ground-nesting birds when nests are either disturbed or destroyed during land clearing, excavation and trenching, and other ground disturbing activities. Individual species impacts may be realized depending on the nature of the deployment activity. 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 nesting 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, 1997). Direct injury/mortality are not anticipated to be widespread or affect bird populations due to the small-scale of likely FirstNet actions, however, DOI comments dated October 11, 2016[167] state that communication towers are "currently estimated to kill between four and five million birds per year" (Regulations.gov, 2016). Although collisions with towers

[167] See Appendix F, Draft PEIS Public Comments, for the full text of the Department of Interior comments.

have the potential to impact a large number of birds unless BMPs and mitigation measures are incorporated, tower collisions are unlikely to cause population-level impacts. Of particular concern is avian mortality due to collisions with towers at night, when birds can be attracted to tower obstruction lights. Research has shown that birds are attracted to steady, non-flashing red lights and are much less attracted to flashing lights, which can reduce migratory bird collisions by as much as 70%. The FAA has issued requirements to eliminate steady-burning flashing obstruction lights and use only flashing obstruction lights. Additionally, on Jan. 6, 2017 the FCC issued a notice titled Opportunities to Reduce Bird Collisions with Communications Towers While Reducing Tower Lighting Costs (FCC, 2017). See Chapter 17, BMPs and Mitigation Measures, for BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential impacts to birds from tower lighting. Site-specific analysis and/or consultation with FWS may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. If siting considerations, BMPs, and mitigation measures are implemented (Chapter 17), 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 (including possible "take").

Environmental consequences pertaining to federally listed species will be discussed in Section 15.2.6.6, Threatened and Endangered Species.

Reptiles and Amphibians

The majority of Virginia's amphibian and reptile species are widely distributed throughout Virginia. Direct mortality to amphibians or reptiles could occur in construction zones either by excavation activities or by vehicle strikes; however, these events are expected to be temporary and isolated, affecting only individual animals.

Five species of marine turtles – all listed as threatened or endangered under the ESA – occur in Virginia's offshore environment. Environmental consequences pertaining to these reptiles are discussed in Section 15.2.6.6, Threatened and Endangered Species.

Invertebrates

Ground disturbance or land clearing activities as well as use of heavy equipment could result in direct injury or mortality to invertebrates. However, deployment activities are expected to be temporary and isolated, thereby limiting the potential for direct mortality and likely affecting only a small number of invertebrates. The invertebrate populations of Virginia are so widely distributed that injury/mortality events are not expected to affect populations of species as a whole.

Vegetation and Habitat Loss, Alteration, or Fragmentation

Habitat impacts are primarily physical perturbations that result in alterations in the amount or quality of a habitat. 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 loss or breaking down of continuous and connected habitat, and impeding

access to resources and mates. There are areas in Virginia that have experienced extensive land use changes from urbanization and agriculture. However, there are portions of the state are forested and remain relatively unfragmented.

Additionally, habitat loss can 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.

Potential effects of vegetation and habitat loss, alteration, or fragmentation are described for Virginia's wildlife species below.

Terrestrial Mammals

Mammals occupy a wide range of habitats throughout Virginia and may experience localized effects of habitat loss or fragmentation. Removal or loss of vegetation may impact large mammals 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 that utilize these areas for roosting, foraging, sheltering, and for rearing their young. Loss of habitat or exclusions from these areas would be avoided or minimized by BMPs and mitigation measures.

Marine Mammals

A number of seal species may occur in the offshore areas of Virginia. Harbor seals tend to be non-migratory; they can be found in open waters and also using rocks, beaches or other coastal habitats as haulouts and pupping sites in Virginia (JMU, 2014). Seals could be temporarily excluded from a resource or abandon their haulout locations due to the presence of humans, noise, vibrations, or vessel traffic during deployment activities. For example, the seals would need to find a new haulout, likely at a less favorable location. Effects on seals from exclusion from resources would be low magnitude and temporary in duration.

Loss of habitat or exclusions from these areas for seals and whales could be avoided or minimized by implementing BMPs and mitigation measures (see Chapter 17).

Birds

The direct removal of most nests is prohibited under the MBTA. The USFWS can provide regional guidance on the most critical time periods (e.g., breeding season) to avoid vegetation clearing. The removal and loss of vegetation can affect avian species directly by loss of nesting, foraging, stopover, and cover habitat.

Noise and vibration 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 (Hill, 1997).

The degree to which habitat exclusion affects birds depends on many factors. The impact to passerine[168] 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 can 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, could help to avoid or minimize the potential impacts to birds from exclusion of resources.

Reptiles and Amphibians

Important habitats for Virginia's amphibians and reptiles typically consist of wetlands and, in some cases the surrounding upland forest. If proposed project sites were unable to avoid sensitive areas, BMPs and mitigation measures (see Chapter 17) could be implemented to avoid or minimize the potential impacts.

Filling or draining of wetland breeding habitat (see Section 15.2.4, Water Resources) and alterations to ground or surface water flow from development associated with the Proposed Action may also have effects to Virginia's amphibian and reptile populations, though BMPs and mitigation measures could help to avoid or minimize the potential impacts.

Invertebrates

Habitat loss and degradation are the most common causes of invertebrate species' declines; however, habitat for many common invertebrates is generally assumed to be abundant and widely distributed across the state. Impacts to sensitive invertebrate species are discussed below in Section 15.2.6.6, 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, potential impacts are expected to remain *less than significant* at the programmatic level (except for birds and bats due to potential exposure to RF emissions, see below), due to the short-term nature and limited geographic scope of expected activities. Additionally, FirstNet would attempt to avoid these areas, though BMPs and mitigation measures could further help to avoid or minimize the potential impacts. Chapter 17, 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) can reduce the overall fitness and productivity of young and adult terrestrial mammals. Indirect

[168]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.

effects could occur result to roosting bats from noise, vibrations, 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 after year. The majority of FirstNet deployment activities would be short-term in nature, and repeated disturbances are not expected. Depending on the project type and location, individual species may be disturbed resulting in *less than significant* impacts at the programmatic level (except for bats, see below).

There are no published studies that document physiological or other adverse effects to bats from radio frequency (RF) exposure. However, because bats are similar ecologically and physiologically to birds, they have the potential to be affected by RF exposure in similar ways to birds (see the birds subsection below). One study demonstrated that foraging bats avoided areas exposed to varying levels of electromagnetic radiation compared with control sites, and attributed this behavior to the increased risk of overheating and echolocation interference caused by electromagnetic field exposure (Nicholls & Racey, 2009). As stated below, experts emphasize that targeted field research needs to be conducted to more fully document the nature and extent of effects of RF exposure on bats and other wildlife, and the implications of those effects on populations over the long term (Manville, 2015) (Manville, 2016a) (Appendix G). FirstNet recognizes that RF exposure has the potential to adversely impact bats, particularly bats that communally roost or breed and nurture young in areas with RF exposure, and concurs with the need for further research. As such, and as a precaution, FirstNet would implement BMPs and mitigation measures that focus on siting towers away from known communal bat use areas to the extent practicable or feasible (described in Chapter 17, BMPs and Mitigation Measures). See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

Marine Mammals

Repeated disturbance (e.g., from vessel traffic), especially near haulouts, can cause stress to individuals resulting in lower fitness and productivity. Given that the majority of FirstNet deployment activities are not expected to be located onshore 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, can 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, 1997). The majority of FirstNet deployment activities would be short-term in nature; and repeated disturbances are not expected.

Depending on the Proposed Action type and location, individual species may be disturbed resulting in *less than significant* impacts at the programmatic level.

Research indicates that RF exposure may adversely affect birds. A comment letter on the Draft Programmatic Environmental Impact Statement for this region, presented by Dr. Albert

Manville, former USFWS agency lead on avian-structural impacts, summarizes the state of scientific knowledge of the potential effects of RF exposure on wildlife, particularly migratory birds; the comment letter is presented in its entirety in Appendix G. RF exposure may result in adverse impacts on wildlife, although a distinct causal relationship between RF exposure and responses in wild animal populations has not been established. Further, important scientific questions regarding the mechanisms of impact, the exposure levels that trigger adverse effects, and the importance of confounding factors in the manifestation of effects, among other questions, remain unanswered (Manville, 2016b) (Appendix G).

Research conducted to date under controlled laboratory conditions has identified a wide range of physiological and behavioral changes in avian and mammalian subjects, including embryonic mortality in bird eggs, genetic abnormalities, cellular defects, tumor growth, and reproductive and other behavioral changes in adult birds and rodents (Wyde, 2016) (Levitt & Lai, 2010) (DiCarlo, 2002) (Grigor'ev, 2003) (Panagopoulos, 2008).

Few studies of the effects of RF exposure on wild animal populations have been conducted due to the difficulty of performing controlled studies on wild subjects. Those that have been conducted are observational in nature (i.e., documenting of reproductive success and behavior in birds near RF-emitting facilities). These studies lack controls on exposure levels or other potentially confounding factors. Nevertheless, findings from these studies indicate reduced survivorship at all life stages; physiological problems related to locomotion and foraging success; and behavioral changes that resulted in delayed or unsuccessful mating in several species of nesting birds (Balmori, 2005) (Balmori, 2009) (Balmori & Hallberg, 2007) (Manville, 2016b) (Appendix G). Balmori (2005) documented effects as far as 1,000 feet from an RF source consisting of multiple cellular phone towers. Another study of wild birds conducted by Engels et al. (2014) documented that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise,[169] which can disrupt migration or send birds off course, potentially resulting in reduced survivorship.

Experts emphasize that targeted field research needs to be conducted to more fully document the nature and extent of effects of RF exposure on birds and other wildlife and the implications of those effects on wildlife populations over the long term (Manville, 2015) (Manville, 2016b) (Appendix G). Such studies should be conducted over multiple generations and include controls to more clearly establish causal relationships, identify potential chronic effects, and determine threshold exposure levels. FirstNet recognizes that RF exposure may adversely impact wildlife, particularly birds that nest, roost, forage, or otherwise spend considerable time in areas with RF exposure, and concurs with the need for further research. As such, and as a precaution, FirstNet would implement BMPs and mitigation measures that focus on siting towers away from high bird use areas to the extent practicable or feasible (described in Chapter 17, BMPs and Mitigation Measures). See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

[169] Urban electromagnetic noise is a term used to describe an area with a concentration of cell phone towers and users, which by sheer volume and level of use, creates a zone of electromagnetic noise.

Reptiles and Amphibians

Changes in water quality and quantity, especially during the breeding seasons, can cause stress resulting in lower productivity. The majority of FirstNet deployment activities would be short-term in nature, and repeated disturbances are not expected. Depending on the project type and location, individual species may be disturbed resulting in *less than significant* impacts at the programmatic level.

Invertebrates

Invertebrates can 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* at the programmatic level.

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* at the programmatic level due to the small-scale and localized nature of expected activities, which would be unlikely to result in long-term avoidance. Additionally, FirstNet would attempt to avoid areas of known migratory pathways. Potential effects to migration patterns of Virginia's amphibians and reptiles, terrestrial mammals, marine mammals, birds, and invertebrates are described below. Chapter 17, 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. See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure.

Terrestrial Mammals

Large game animals have well-defined migratory routes. Route knowledge is passed on from one generation to the next and includes important feeding and calving areas. Small mammals also have migratory routes that include spring and fall roosting areas between their summer maternity roosts and hibernacula.[170] Any clearance, drilling, and construction activities needed for network deployment, including noise and vibrations associated with these activities, has the potential to divert mammals from these migratory routes. Impacts can vary depending on the species, time of year of construction/operation, and duration, though BMPs and mitigation measures would help to avoid or minimize the potential impacts.

Marine Mammals

Noise and vibrations associated with the installation of cables in the near/offshore waters of coastal Virginia could impact marine mammal migration patterns, though impacts are likely to be short-term provided the noise and vibration sources are not wide ranging and below Level A and

[170] A location chosen by an animal for hibernation.

B sound exposure thresholds.[171] 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 impacts are expected to be *less than significant* at the programmatic level. BMPs and mitigation measures could help to 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 vast distances often involving many different countries. For example, as a group shorebirds undertake some of the longest-distance migrations of all animals. Virginia is located within the Atlantic Flyway, which spans more than 3,000 miles from the Arctic tundra to the Caribbean. Virginia has 21 IBAs spread throughout the state that serve as important stopover areas for migratory birds (NAS, 2011). Many migratory routes are passed from one generation to the next. Impacts can 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, however, impacts are expected to be *less than significant* at the programmatic level. Additionally, there is some evidence in the scientific literature that RF emissions could affect bird migration. Engels et al. (2014) documented that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise, which can disrupt migration or send birds off course, potentially resulting in reduced survivorship. It is unlikely that the limited amount of infrastructure, the amount of RF emissions generated by Project infrastructure, and the temporary nature of the deployment activities would result in impacts to large populations of migratory birds, but more likely that individual birds could be impacted. Chapter 17, BMPs and Mitigation Measures, provides a list of BMPs and mitigation measures that FirstNet and/or its partners would require, as practicable or feasible, to avoid or minimize potential effects to migratory pathways.

Reptiles and Amphibians

Several species of mole salamanders and the wood frog are known to seasonally migrate in Virginia. These amphibians often travel by the hundreds on their migration pathway that often crosses roadways. Mole salamanders are typically found in burrows in the forest floor. Frogs use diverse vegetation types from grassy meadows to open forests. Mortality and barriers to movement could occur as result of the Proposed Action (Calhoun & DeMaynadier, 2007).

Species that use streams as dispersal or migratory corridors may be impacted if these waterways are restricted or altered but and impacts are expected to be *less than significant* at the programmatic level. BMPs and mitigation measures would help to further avoid or minimize the potential impacts.

[171] 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).

Invertebrates

The majority of FirstNet deployment or operation activities are likely to be small-scale in nature; *no effects* to migratory patterns of Virginia's 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 can affect the overall population of individuals. Overall, potential impacts are anticipated to be *less than significant* at the programmatic level due to the short-term and limited nature of expected activities (except for birds and bats which are anticipated to be *less than significant with BMPs and mitigation measures incorporated*, see below), as FirstNet would attempt to avoid these areas. Chapter 17, 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. See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

Terrestrial Mammals

Restricted access to important winter hibernacula or summer maternity roosts for bats and calving grounds for large mammals has the potential to negatively affect body condition and reproductive success of mammals in Virginia.

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. Reproductive effects as a result of displacement and disturbance could be minimized through the use of BMPs and mitigation measures.

There are no published studies that document adverse effects to bats from RF exposure. As stated above, experts emphasize that targeted field research needs to be conducted to more fully document the nature and extent of effects of RF exposure on bats and other wildlife, and the implications of those effects on populations over the long term (*Manville 2015 and 2016*; Appendix G). FirstNet recognizes that RF exposure has the potential to adversely impact bats, particularly bats that communally roost or breed and nurture young in areas with RF exposure, and concurs with the need for further research. As such, and as a precaution, FirstNet would implement BMPs and mitigation measures that focus on siting towers away from known communal bat use areas to the extent practicable or feasible (described in Chapter 17, BMPs and Mitigation Measures). See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts

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* at the programmatic level. Reproductive effects as a result of displacement and disturbance could be minimized through the use of BMPs and mitigation measures

Marine Mammals

Restricted access to important calving grounds has the potential to negatively affect body condition and reproductive success of marine mammals in Virginia. For example, the displacement of female seals from preferred pupping habitats due to deployment or operation activities may reduce fitness and survival of pups potentially affecting overall productivity, though activities are likely to be small-scale in nature, and BMPs and mitigation measures would help to avoid or minimize the potential impacts.

Disturbance to hauled out seals from activities associated with the Proposed Action could result in the abandonment, or death of offspring, though BMPs and mitigation measures would 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, vibrations, 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 stage (Hill, 1997). Research conducted to date under controlled laboratory conditions has identified a wide range of physiological and behavioral changes in avian subjects, including embryonic mortality in bird eggs and reproductive changes in adult birds (Wyde, 2016) (Levitt & Lai, 2010) (DiCarlo, 2002) (Grigor'ev, 2003) (Panagopoulos, 2008). Laboratory studies conducted with domestic chicken embryos have shown that emissions at the same frequency and intensity as that used in cellular telephones have appeared to result in embryonic mortality (DiCarlo, 2002) (Manville, 2007). These studies suggest that RF emissions at low levels (far below the existing exposure guidelines for humans) (see Section 2.4.2, RF Emissions and Humans) may be harmful to wild birds; however, given the controlled nature of the studies and potential exposure differences in the wild, it is unclear how this exposure would affect organisms in the wild.

As such, and as a precaution, FirstNet would implement BMPs and mitigation measures that focus on siting towers away from high bird use areas to the extent practicable or feasible (described in Chapter 17, BMPs and Mitigation Measures) to help reduce bird mortalities associated with both RF emissions and tower collisions. See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

The majority of FirstNet deployment or operation activities are likely to be small scale in nature. BMPs and mitigation measures as defined through consultation with USFWS for compliance with MBTA or BGEPA, or another appropriate regulatory agency, if required, could help to avoid or minimize any potential impacts.

Reptiles and Amphibians

Reproductive effects to reptile nests may occur through direct loss or disturbance of nests. For example, the spotted turtle (*Clemmys guttata*) leaves its breeding pool in May and travels to its nesting site.

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, alter water quality through sediment infiltration, or obstruction of natural water flow to pools, though BMPs and mitigation measures would help to avoid or minimize the potential impacts. Overall, impacts to reptiles and amphibians are expected to be *less than significant* at the programmatic level due to the limited extent and temporary nature of the deployment.

Invertebrates

The majority of FirstNet deployment or operation activities are likely to be short-term in nature; no reproductive effects to 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 can have a dramatic effect on natural resources.

The majority of FirstNet deployment or operation activities are likely to result in short-term or temporary changes to specific project sites and are expected to return to its 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. Overall, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities.

Potential invasive species effects to Virginia's wildlife are described below.

Terrestrial Mammals

In Virginia, Eurasian boars (*Sus scrofa*) adversely impact several native large and small mammals, including bear (*Ursus americanus*), turkey (*Meleagris gallopavo*), waterfowl and deer. They feed on young mammals, destroy native vegetation resulting in erosion and water resource concerns, and can carry/transmit disease to livestock and humans. This, in turn, can seriously reduce native populations of animals and lead to the degradation of their habitat (VDGIF, 2016c).

FirstNet deployment activities are not expected to introduce 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. Overall, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities. BMPs and mitigation measures (see Chapter 17) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to terrestrial mammals as a result of the introduction of invasive species.

Marine Mammals

Invasive species displace native fauna and flora communities and/or radically change the nature of the habitats they invade. They also compete for the same natural resources and life requirements (i.e., food, space, and shelter) as native species and degrade local ecologies by disrupting the food chain, thereby causing the extinction of native species. Proposed FirstNet deployment activities near water would likely occur onshore with limited activities in the water; therefore, the introduction of non-native species would be limited. Overall, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities. BMPs and mitigation measures (see Chapter 17) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to marine mammals as a result of the introduction of invasive species.

Birds

Invasive plant and pest species directly alter the landscape or habitat to a condition that is more favorable for an invasive species, and less favorable for native species and their habitats. For example, in Virginia, mute swans (*Cygnus olor*) can impact native waterfowl and wetland birds causing nest abandonment or impacts to rearing young due to their aggressive behavior. Further, this invasive bird can lead to declines in water quality from increased fecal coliform loading in the water, and declines in submerged aquatic vegetation that support native fish and other wildlife (Swift, et al. 2013). The majority of FirstNet deployment activities are likely to result in short-term or temporary changes to specific project sites and are expected to return to its natural state in a year or two. Invasive species are not expected to be introduced from machinery or construction workers at project sites as part of the deployment activities. Overall, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities. BMPs and mitigation measures (see Chapter 17) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to birds as a result of the introduction of invasive species.

Reptiles and Amphibians

No invasive reptiles or amphibians are regulated in Virginia; although non-native reptiles and amphibians are known to occur there. Non-native reptiles and amphibians tend to be highly adaptable and can threaten native wildlife by competing with them for food sources and also spread disease. Proposed FirstNet deployment activities near water would likely occur onshore with limited activities in the water; therefore, the introduction of non-native species would be limited. Invasive reptile or amphibian species are not expected to be introduced at project sites from machinery or laborers. Overall, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities. BMPs and mitigation measures (see Chapter 17) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to reptiles and amphibians as a result of the introduction of invasive species.

Invertebrates

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 invertebrates would be similar to those described for habitat loss and degradation.

Invasive insects in particular pose a large threat to Virginia's forest and agricultural resources. The potential to introduce invasive invertebrates 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 potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities. BMPs and mitigation measures (see Chapter 17) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to invertebrates as a result of the introduction of invasive species.

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 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 at the programmatic level, from *no impacts* to *less than significant impacts with BMPs and mitigation measures incorporated*, 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.

Activities Likely to Have No Impacts at the Programmatic Level

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 and vibrations 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* to 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 and the use of portable devices that use satellite technology would have *no impact* on wildlife at the programmatic level 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 wildlife resources, it is anticipated that this activity would have *no impact* to wildlife resources at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

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. These types of infrastructure deployment activities that are anticipated to be *less than significant* to wildlife resources.

- 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), that utilize burrows (e.g., ground squirrels), or that are defending nest sites (such as ground-nesting birds). Disturbance, including noise and vibrations, 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. BMPs and mitigation measures (see Chapter 17) 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 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 and vibration 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 limited nearshore and inland bodies of water and construction of landings and/or facilities on the shore to accept submarine cables could potentially impact wildlife (see Section 15.2.4, 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 time 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 radio frequency 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 new power units, replacement towers, or structural hardening are required, impacts would be similar to new wireless construction. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.
  - Deployable Technologies: Implementation of land-based deployable technologies including COWs, COLTs, and SOWs could result in direct injury/mortalities to wildlife on roadways. If external generators are used, noise and vibration disturbance could potentially impact migratory patterns of wildlife. Deployment of drones, balloons, blimps, or 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 and vibrations. 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* with the exception of impacts to birds and bats, which are expected to be *less than significant with BMPs and mitigation measures incorporated.* 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, 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. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. See Chapter 17, BMPs and Mitigation Measures, for 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.

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.

At the programmatic level, it is anticipated that there would be *less than significant* impacts to wildlife resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Site maintenance would be infrequent, including mowing or the limited application of herbicides, may result in *less than significant* effects to wildlife including direct injury/mortality to less mobile wildlife, or exposure to contaminants from accidental spills from maintenance equipment or release of pesticides.

During operations, direct injury/mortality of wildlife could occur from collisions and/or entanglements with transmission lines, towers, and aerial platforms. In particular, collisions with new cell towers that may be installed as part of the Preferred Alternative could increase avian mortality. As stated above, these impacts would likely be limited to individual wildlife species. DOI comments dated October 11, 2016[172] state communication towers are "currently estimated

[172] See Appendix F, Draft PEIS Public Comments, for the full text of the Department of Interior comments.

to kill between four and five million birds per year" (Regulations.gov, 2016). Although collisions with towers have the potential to impact a large number of birds unless BMPs and mitigation measures are incorporated, tower collisions are unlikely to cause population-level impacts. Therefore, impacts to birds may result in *less than significant impacts with BMPs and mitigation measures incorporated*.

As stated above, potential impacts associated with RF emissions on birds and bats are also anticipated to be *less than significant with BMPs and mitigation measures incorporated*.

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 individual wildlife species and unlikely to cause population-level impacts, and therefore would likely be *less than significant* at the programmatic level. See Chapter 17, BMPs and Mitigation Measures, for 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.

Alternatives Impact Assessment

The following section assesses potential impacts to wildlife resources associated with the Deployable Technologies Alternative and the No Action Alternative.[173]

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 no 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.

[173] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Deployment Impacts

As described above, at the programmatic level, 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 state. However, impacts are expected to remain *less than significant* at the programmatic level because deployment activities are expected to be temporary, likely affecting only a small number of wildlife. See Chapter 17, BMPs and Mitigation Measures, for 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.

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 likely affecting only a small number of wildlife. The impacts can vary greatly among species and geographic region. See Chapter 17, BMPs and Mitigation Measures, for 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.

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. Therefore, there would be *no impacts* to wildlife resources as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 15.1.6.4, Terrestrial Wildlife.

15.2.6.5. Fisheries and Aquatic Habitats

Impacts to fisheries and aquatic habitats occurring in Virginia and Virginia's near offshore environment 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 entanglement, vessel strike, problems associated with accidental ingestion, and injuries incurred by sensitive animals from disturbance events (USEPA, 2012f).

Based on the impact significance criteria presented in Table 15.2.6-1, *less than significant* impacts would be anticipated given the size and nature of the majority of proposed deployment

activities. Although anthropogenic disturbances may be measurable but minimal for some FirstNet projects, individual behavior of fish species would be short-term and direct injury or mortality impacts at the population-level or sub-population effects 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

Habitat impacts are primarily physical perturbations that result in alterations in the amount or quality of a habitat. 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 shoreline habitat alteration in localized areas and 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. Additionally, deployment activities with the potential for impacts under the MSFCMA or other sensitive aquatic habitats could be addressed through BMPs and mitigation measures. Overall, impacts are expected to be *less than significant* at the programmatic level.

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 can include stress related to disturbance and disruption of life history patterns (such as migration and breeding) important for survival. A short-term stress response to an acute, temporary stressor, initiates a "fight or flight" response which diverts energy, otherwise used for reproduction and growth, to the immediate survival of the animal (Reeder, 2005). Most organisms are well adapted and recover quickly from these types of stressors. A chronic stress response to a persistent stressor, however, can be detrimental to the organism and result in cell death, compromised immune system, muscle wasting, reproductive suppression, and memory impairment (Reeder, 2005).

Water quality and quantity impacts from exposure to contaminants from accidental spills from vehicles and equipment, and erosion or sedimentation from land clearing and excavation activities near or within riparian areas, floodplains, wetlands, streams, and other aquatic habitats 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, though BMPs and mitigation measures to protect water resources (see Section 15.2.4, 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. For example, restrictions or alterations to waterways could alter migration patterns, limit fish passage, or affect foraging and spawning site access. Impacts are expected to be *less than significant* at the programmatic level, and are anticipated to be localized and at a small-scale, and would vary depending on the species, time of year, and duration of deployment. BMPs and mitigation measures could help to avoid or minimize the potential impacts.

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 can 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 expected to be *less than significant* at the programmatic level, though BMPs and mitigation measures could help to further avoid or minimize the potential impacts.

Invasive Species Effects

FirstNet deployment activities could result in *less than significant* impacts to aquatic populations at the programmatic level due to introduction of invasive species. The potential to introduce invasive plant (and plant seeds) and pest species (e.g., invasive insects) within construction zones 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. FirstNet deployment activities could result in short-term or temporary changes to specific project sites however, 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. Overall, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities. BMPs and mitigation measures (see Chapter 17) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to aquatic resources as a result of the introduction of invasive species. Should invasive species be found on a site, BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented to minimize invasive species effects to fisheries and aquatic species.

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 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,[174] and the nature and extent of the habitats affected.

Activities Likely to Have No Impacts at the Programmatic Level

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 and vibrationsassociated 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 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* to fisheries and aquatic habitats because there would be no disturbance of the aquatic environment.
- 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* to the aquatic environment.

Activities with the Potential to Have Impacts at the Programmatic Level

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

[174] Phenology is the seasonal changes in plant and animal lifecycles, such as emergence of insects or migration of birds.

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[175], 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 result in habitat loss, alteration and fragmentation; indirect injury/mortality; and invasive species effects if conducted near a water resource that supports fish.
  - 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 and vibrations, associated with the above activities could result in habitat loss, effects to migration patterns, indirect injury/mortality, reproductive effects, and invasive species effects. BMPs and mitigation measures could help to avoid or minimize potential impacts.
  - 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. Land/vegetation clearing, excavation

[175] POPs are connections or access points between two different networks, or different components of one network.

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 that support fish, could result in habitat loss, alteration and fragmentation; indirect injury/mortality, and invasive species effects. 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, or structural hardening are required, impacts would be similar to new wireless construction.
- Deployable Technologies: Implementation of land-based 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. 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 of deployment activities and the limited number of aquatic species expected to be impacted. See Chapter 17, BMPs and Mitigation Measures, for 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.

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.

At the programmatic level, it is anticipated that there would be *less than significant* impacts to fisheries and aquatic habitats associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Site

maintenance, if conducted near water resources that support fish, including the application of herbicides, may result in *less than significant* effects to fisheries and aquatic habitats at the programmatic level, including exposure to contaminants from accidental spills from maintenance equipment or release of pesticides.

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 invertebrates 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.

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 no 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.

<u>Deployment Impacts</u>

As explained above, at the programmatic level, 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. See Chapter 17, BMPs and Mitigation

Measures, for 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.

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, at the programmatic level, 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. The impacts can vary greatly among species and geographic region. See Chapter 17, BMPs and Mitigation Measures, for 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.

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. Therefore, there would be *no impacts* to fisheries and aquatic habitats as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 15.1.6.5, Fisheries and Aquatic Habitat.

15.2.6.6. Threatened and Endangered Species

This section describes potential impacts to threatened and endangered species in Virginia's inland and offshore environment associated with construction/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 17, 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 15.2.6-2. 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*. These impact categories are comparable to those defined in the *Endangered Species Consultation Handbook* and are described in general terms below (USFWS, 1998c):

- *No effect* means that no listed resources would be exposed to the action and its environmental consequences.
- *May affect, not likely to adversely affect* means that all effects are beneficial, insignificant, or discountable. Beneficial effects have contemporaneous positive effects without any *adverse effects* to the species or habitat. Insignificant effects relate to the size of the impact and

include those effects that are undetectable, not measurable, or cannot be evaluated. Discountable effects are those extremely unlikely to occur.

- *May affect, likely to adversely affect* means that listed resources are likely to be exposed to the action or its environmental consequences and would respond in a negative manner to the exposure.

At the programmatic level, 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 15.2.6-2: Impact Significance Rating Criteria for Threatened and Endangered Species at the Programmatic Level

Type of Effect	Effect Characteristic	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 Characteristic	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 15.2.6-2, any direct injury or mortality of a listed species at the individual-level could be *potentially significant* as well as any impact that has more than a negligible potential to result in unpermitted take of an individual species at any geographic extent, duration, or frequency. Direct injury/mortality environmental concerns pertaining to federally listed terrestrial mammals, marine mammals, birds, reptiles and amphibians, fish, invertebrates, and plants with known occurrence in Virginia are described below.

Terrestrial Mammals

Five terrestrial mammals are federally listed in Virginia, the Carolina northern flying squirrel, gray bat, Indiana bat, northern long-eared bat, and the Virginia big-eared bat. Direct mortality or injury to the federally listed bat species could occur if tree clearing activities occurred during the roosting season (i.e., approximately April-November) and 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. Direct mortality or injury to the federally listed squirrel species could occur from vehicle strikes as they are occasionally found along transportation corridors. Entanglement in fences or other barriers could also be a source of mortality or injury to this species. Impacts would likely be isolated, individual events. When disturbed by noise, vibration, or light, bats awaken resulting in a loss of body fat needed to help them survive in the spring (USFWS, 2015ch). 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 17, may be implemented as appropriate to further minimize potential impacts.

Birds

Four federally listed birds are known to occur within Virginia, the piping plover, red knot, red-cockaded woodpecker, and roseate tern. Depending on the project types and location, direct mortality or injury to these birds could occur from collisions or electrocutions with man-made cables and wires, vehicle strikes, or by disturbance or destruction of nests during ground disturbing activities. 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 17, may be implemented as appropriate to further minimize potential impacts.

Fish

Six federally listed fishes are found in the Virginia river systems and Virginia's offshore environment, including the blackside dace, duskytail darter, Roanoke logperch, slender chub, spotfin chub, and yellowfin madtom. Direct mortality or injury to the species could occur from vessel/boat strikes or entanglements resulting from the Proposed Action are unlikely as the majority of the FirstNet deployment projects would not occur in an aquatic environment. 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 17, may be implemented as appropriate to further minimize potential impacts.

Reptiles and Amphibians

One federally listed amphibian, the Shenandoah salamander, is known to occur in forested areas of Virginia. Direct mortality or injury could occur in construction zones either by excavation activities or by vehicle strikes. Impacts would likely be isolated, individual events.

Five federally listed sea turtles are also known to occur in the coastal area and offshore environment of Virginia, including the green sea turtle, hawksbill sea turtle, Kemp's Ridley sea turtle, leatherback sea turtle, and loggerhead sea turtle. Although FirstNet does not anticipate oceanic deployment, individual specimens of turtles could be impacted if they happened to come to shore during a FirstNet deployment action. Such impacts would be *less than significant* at the programmatic level, because of the unlikely timing coincidence. However, 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 17, may be implemented as appropriate to further minimize potential impacts.

Invertebrates

Thirty-two federally listed invertebrates occur in Virginia as presented in Table 15.1.6-10. Direct mortality or injury could occur to these species if land clearing or excavation activities associated with the Proposed Action occur in an area inhabited by one of these species. All of the listed mussels are known to occur in the westernmost region of the state along the rivers associated to the Tennessee River system, except the dwarf wedgemussel which is found in rivers on eastern regions of the state and the James spinymussel which is found in rivers on the northern region of the state. 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 17, may be implemented as appropriate to further minimize potential impacts.

Plants

Seventeen federally listed plants occur in Virginia as presented in Table 15.1.6-11. 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. In general, distribution of these species is limited throughout the state. 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 17, 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 either 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 Virginia are described below.

Mammals

Noise, vibrations, light, and other human disturbances associated with the Proposed Action could adversely affect federally listed mammals within or in the vicinity of Project activities. Impacts would be directly related to the frequency, intensity, and duration of these activities. 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 17, may be implemented as appropriate to further minimize potential impacts.

Birds

Impacts to bird habitat due to land clearing or excavation activities could directly affect nesting if deployment activities occur during the breeding/nesting season. In addition, habitat loss or degradation could lead to indirect affects to nesting due to birds having to find new nesting sites. Further, noise, vibrations, light, or human disturbance within nesting areas could cause piping plovers or roseate terns to abandon their nests, relocate to less desirable locations, or cause stress to individuals reducing survival and reproduction. The majority of FirstNet deployment activities would not occur on beaches or saltmarshes; therefore, impacts to these bird species are not anticipated. Noise, vibrations, light, or human disturbance within nesting areas could cause piping plovers or roseate terns to abandon their nests, relocate to less desirable locations, or cause stress to individuals reducing survival and reproduction. 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 17, may be implemented as appropriate to further minimize potential impacts.

Reptiles and Amphibians

Changes in water quality and quantity, especially during the breeding seasons, can cause stress resulting in lower productivity. Land clearing activities, noise, vibrations, and other human disturbance during the critical time periods (e.g., mating, nesting) could lower fitness and productivity. BMPs and mitigation measures would minimize potential impacts to federally listed species.

FirstNet does not anticipate any off-shore deployment. Also, the five federally listed sea turtles found in the offshore areas of Virginia are migrants. Consequently, no long-term reproductive effects to federally listed sea turtles are expected as a result of the Proposed Action.

Fish

Deployment activities in the upstream portions of the watershed areas of the state resulting in increased disturbance (e.g., humans, noise, vibrations), especially during spawning activity, and changes in water quality and quantity can cause stress resulting in lower productivity (see Section 15.2.4, Water Resources, for a discussion of potential impacts to water resources). Impacts to reproduction for the endangered fish species are unlikely as the majority of FirstNet deployment projects would not occur in an aquatic environment. 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 17, may be implemented as appropriate to further minimize potential impacts.

Invertebrates

Changes in water quality and quantity can cause stress resulting in lower productivity for the federally listed mollusks known to occur in Virginia. In addition, introduction of invasive aquatic species can indirectly affect the mussels as result of fish populations that they rely on for their reproductive cycle being altered (USFWS, 2012g). Impacts associated with deployment activities are expected to result in *less than significant* changes to water quality. 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 17, may be implemented, as appropriate, to further minimize potential impacts.

Plants

No reproductive effects to federally listed plants are expected as a result of the Proposed Action.

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, birds, reptiles and amphibians, fish, invertebrates, and plants with known occurrence in Virginia are described below.

Mammals

Direct mortality or injury to the federally listed bats could occur if tree clearing activities occurred during the roosting season (i.e., approximately April-November) and 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 this species; when disturbed by noise, vibrations or light, bats awaken resulting in a loss of body fat needed to help them survive in the spring (USFWS, 2015cj). It is clear that behavioral responses are strongly affected by the context of exposure and by the animal's experience, motivation, and

conditioning. 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 17, 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 vast 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. They often return to the same stopover sites year and after year. Disturbance in stopover, foraging, or breeding areas (visual, vibrations, 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 *adverse effects* to listed birds. 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 17, may be implemented as appropriate to further minimize potential impacts.

Reptiles and Amphibians

Habitat loss or alteration, particularly from fragmentation or invasive species, could adversely affect nesting and foraging sites of the Muhlenberg northern bog turtle, resulting in reduced survival and productivity, however, disturbances during deployment activities are not anticipated to stress federally listed turtles. 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 17, 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 fish species. Further, increased human disturbance, noise, vibrations, and vessel traffic could cause stress to the species causing them to abandon spawning locations or altering migration patterns. Behavioral changes to the fish are unlikely as the majority of FirstNet deployment projects would not occur in an aquatic environment. 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 17, may be implemented as appropriate to further minimize potential impacts.

Invertebrates

Changes in water quality and quantity, habitat loss or alternation, and introduction of aquatic invasive species could impact food sources for federally listed mollusks resulting in lower productivity. 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 17, may be implemented as appropriate to further 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. FirstNet activities are generally expected to be small-scale in nature, therefore large-scale impacts are not expected, however it is possible that small-scale changes could lead to *potentially significant adverse effects* for certain species. For example, impacts to designated critical habitat for a listed species that is only known to occur in one specific location geographically. Potential effects to federally listed terrestrial mammals, marine mammals, birds, reptiles and amphibians, fish, invertebrates, and plants with designated critical habitat in Virginia are described below.

Mammals

No designated critical habitat occurs for mammals in Virginia. 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

No critical habitat has been designated for birds that are known to occur in Virginia; therefore, *no effect* to these federally listed birds from the loss or degradation of designated critical habitat is expected as a result of the Proposed Action.

Reptiles and Amphibians

No designated critical habitat occurs for reptiles or amphibians in Virginia. 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.

Fish

Critical habitat occurs for three fish species in Virginia. Waterway alterations and pollution from riparian sources could lead to habitat loss or degradation, which could lead to *adverse effects* to the fish species depending on the duration, location, and spatial scale of the associated activities. BMPs and mitigation measures to help mitigate or reduce these impacts are described further below.

Invertebrates

Critical habitat occurs for six invertebrate species in Virginia. Waterway alterations and pollution from riparian sources could lead to habitat loss or degradation, which could lead to *adverse effects* to the fish species depending on the duration, location, and spatial scale of the associated activities. 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 17, may be implemented as appropriate to further minimize potential impacts.

Plants

No designated critical habitat occurs for plants in Virginia. 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 impacts 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.

Activities Likely to Have No Impacts at the Programmatic Level

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 threatened and endangered species or their habitat under the conditions described below:

- Wired Projects
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to threatened and endangered species or their habitat because there would be no ground disturbance and very limited human activity.
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance, including noise and vibrations, 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 threatened and endangered species and their habitat could be impacted,

it is anticipated that effects to threatened and endangered species would be temporary, infrequent, and likely not conducted in locations designated as vital or critical for any period.

- 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 threatened and endangered 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 protected species, it is anticipated that this activity would have *no impact* to protected species.

Activities with the Potential to Have Impacts at the Programmatic Level

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 impacts 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., reptiles, mollusks, small mammals, and young), that utilize burrows (e.g., ground squirrels) that are breeding in the area, or that are defending nest sites (e.g., ground-nesting birds). Disturbance, including noise and vibrations, associated with the above activities could result in direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat. 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 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, behavioral changes, and loss/degradation of designated critical habitat.

- 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, behavioral changes, and loss/degradation of designated critical habitat to threatened and endangered species. Noise and vibration 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 limited nearshore and inland bodies of water and construction of landings and/or facilities on the shore to accept submarine cables could potentially impact threatened and endangered species and their habitat, particularly aquatic species (see Section 15.2.4, Water Resources, for a discussion of potential impacts to water resources). Effects could include direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat. If activities occurred during critical time 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, behavioral changes, and loss/degradation of designated critical habitat 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, behavioral changes, and loss/degradation of designated critical habitat. Security lighting and fencing could result in direct injury/mortality, disruption of normal behavior patterns, as well as reproductive effects. For a discussion of radio frequency 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 threatened and endangered species. However, if new power units, replacement towers, or structural hardening are required, impacts would be similar to new wireless construction. Hazards related to security/safety lighting and fencing may produce direct injury/mortality, reproductive effects, and behavioral changes. For a discussion of radio frequency 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 and vibration disturbance could potentially result in reproductive effects or behavioral changes to threatened and endangered species. Deployment of drones, balloons, blimps, or piloted aircraft could potentially impact threatened and endangered species by direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat. The magnitude of these effects depends on the timing and frequency of deployments. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.

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, behavioral changes, and loss/degradation of designated critical habitat depending on the species' phenology and the nature and extent of the habitats affected. These impacts *may affect*, but are *not likely to adversely affect* protected species at the programmatic level. 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 17, 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 operations impacts *may affect*, but are *not likely to adversely affect*, threatened and endangered species associated with 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 at the programmatic level, as they would be done infrequently and in compliance with BMPs and mitigation measures developed through consultation with the appropriate resource agency.

During operations, direct injury/mortality of threatened and endangered species could occur from collisions and/or entanglements with transmission lines, towers, and aerial platforms. Listed species may be affected, but are not likely to be adversely affected at the programmatic level. 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 17, may be implemented as appropriate to further minimize potential impacts.

Threatened and endangered species may be affected, but are not likely to be adversely affected at the programmatic level, 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. 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 17, may be implemented as appropriate to further minimize potential impacts.

Alternatives Impact Assessment

The following section assesses potential impacts to threatened and endangered species 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 no 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 threatened and endangered species as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, at the programmatic level, implementation of deployable technologies *may affect*, but is *not likely to adversely affect*, threatened and endangered species through 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. 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 17, 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, at the programmatic level, it is anticipated that activities *may affect*, but are *not*

likely to adversely affect threatened and endangered species and their habitats associated with routine operations, management, and monitoring. The impacts can vary greatly among species and geographic region. 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 17, 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. Therefore, there would be *no impacts* to threatened and endangered species as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 15.1.6.6, Threatened and Endangered Species.

15.2.7. Land Use, Recreation, and Airspace

15.2.7.1. Introduction

This section describes potential impacts to land use, recreation, and airspace resources in Virginia associated with deployment and operation of the Proposed Action and alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.7.2. 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 15.2.7-1. The categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures 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 15.2.7-1: Impact Significance Rating Criteria for Land Use, Recreation, and Airspace at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures 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 BMPs and Mitigation Measures 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, vibrations 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 BMPs and Mitigation Measures 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

15.2.7.3. 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 easement. 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 above-ground 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 rights-of-way 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 15.2.7-1, *less than significant* impacts would be anticipated at the programmatic level 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 above-ground 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 rights-of-way 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 right-of-way, 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 15.2.7-1, *less than significant* impacts would be anticipated at the programmatic level as any new land use would be small-scale and consistent with the surrounding land uses in the area; only short-term impacts during the construction phase would be expected.

Loss of Access to Public or Private Recreation Land or Activities

Access to public or private recreation land or activities could be influenced by the deployment, operation, and maintenance of facilities and the acquisition of rights-of-way or easement. 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 15.2.7-1, *less than significant* impacts would be anticipated at the programmatic level 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. Enjoyment of recreation land could be temporarily impacted by crews accessing the site during the deployment and maintenance of structures, towers, roads, and other permanent features. 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 and vibration impacts, and the presence of deployment or maintenance crews.

Based on the impact significance criteria presented in Table 15.2.7-1, *less than significant* impacts would be anticipated at the programmatic level 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. 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 depending on the tower location. Use of aerial technologies could result in SUA considerations.

Based on impact significance criteria presented in Table 15.2.7-1, 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 of time, FirstNet would likely not impact airspace resources. Therefore, the potential impacts to Airspace is expected to be *less than significant* at the programmatic level.

15.2.7.4. 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, and others would not. Impacts to airspace are not anticipated as these activities would comply with all FAA regulations. 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 17, 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 at the Programmatic Level

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 Likely to Have Impacts* below.
    - Recreation: See *Activities Likely to Have Impacts* below.
    - Airspace: *No impacts* to airspace at the programmatic level 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 15.1.7.8, Obstructions to Airspace Considerations) and Code of Virginia Title 5.1 Aviation, Chapter 1 (See Section 15.1.7.9, Virginia Airspace).
  - 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 Likely to Have Impacts* below.
    - Airspace: It is anticipated that there would be *no impacts* to airspace at the programmatic level 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 15.1.7.8, Obstructions to Airspace Considerations) and Code of Virginia Title 5.1 Aviation, Chapter 1 (See Section 15.1.7.9, Virginia Airspace).

- New Build – Aerial Fiber Optic Plant: Installing new poles and hanging cables on previously disturbed or new (undisturbed) rights-of-way or easements and the potential construction of access roads.
  - Land Use: See *Activities Likely to Have Impacts* below.
  - Recreation: See *Activities Likely to Have Impacts* below.
  - Airspace: Installation of new poles would have *no impact* at the programmatic level 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 at the programmatic level 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 at the programmatic level 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 at the programmatic level 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 at the programmatic level since the activities would not directly or indirectly result in changes to existing and surrounding land uses.
  - Recreation: Use of existing dark fiber and installation of new equipment in existing huts would have no impact to recreation at the programmatic level because it would not impede access to recreational resources.
  - Airspace: Lighting of dark fiber would have *no impacts* to airspace at the programmatic level. Additionally, the installation of new associated equipment in existing huts would not impact airspace.
- New Build – Submarine Fiber Optic Plant: Installing cables limited nearshore and inland bodies of water and the constructing landings and/or facilities on shore to accept submarine cable.
  - Land Use: See *Activities Likely to Have Impacts* below.
  - Recreation: See *Activities Likely to Have Impacts* below.
  - Airspace: The installation of cables in limited near-shore and inland bodies of water and construction of landings/facilities would have *no impact* at the programmatic level to 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 15.1.7.8, Obstructions to Airspace Considerations)

and Code of Virginia Title 5.1 Aviation, Chapter 1 (See Section 15.1.7.9, Virginia Airspace).

- 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 Likely to Have Impacts* below.
  - Recreation: See *Activities Likely to Have Impacts* below.
  - Airspace: *No impacts* at the programmatic level 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 15.1.7.8, Obstructions to Airspace Considerations) and Code of Virginia Title 5.1 Aviation, Chapter 1 (See Section 15.1.7.9, Virginia Airspace).

- 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 at the programmatic level. The potential addition of power units, structural hardening, and physical security measures would not impact existing or surrounding land uses.
    - Airspace: See *Activities Likely to Have Impacts* below.
    - Recreation: See *Activities Likely 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* at the programmatic level 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 at the programmatic level are anticipated as deployable technologies would not affect the use or enjoyment of recreational lands.
    - Airspace: See *Activities Likely to Have Impacts* below.
- 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 at the programmatic level because these technologies would be temporarily located in areas compatible with other land uses.
    - Recreation: See *Activities Likely to Have Impacts* below.
    - Airspace: See *Activities Likely to Have Impacts* 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 land use, it is anticipated that this activity would have *no impact* to land use at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential construction/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 at the programmatic level- see previous section.
  - 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: *No impacts* are anticipated at the programmatic level - see previous section.
    - Recreation: Installation of fiber optic cable in existing conduits occurs in previously disturbed areas, which may include areas used for recreational purposes. It is possible that access to recreational lands or activities may be restricted during the deployment phase or a portion of the operations phase.
    - Airspace: *No impacts* are anticipated at the programmatic level - see previous section.
  - New Build – Aerial Fiber Optic Plant: Installing new poles and hanging cables on previously disturbed or new (undisturbed) rights-of-way 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 rights-of-way 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 at the programmatic level – see previous section.
  - New Build – Submarine Fiber Optic Plant: Installing cables in limited nearshore and 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 and inland bodies of water and the surrounding area during the deployment phase. Reductions in visitation may result during deployment.
    - Airspace: *No impacts* are anticipated at the programmatic level - 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 at the programmatic level - 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 the other criteria listed in Section 15.1.7.8, Obstructions to Airspace Considerations. An Obstruction Evaluation and Airport Airspace Analysis (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 Virginia's airports. If there is EMR associated with the equipment, then there could be an effect to the operation of air navigation facilities based on proximity.
    - 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 at the programmatic level - 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, 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 at the programmatic level – see previous section.
        - Recreation: *No impacts* are anticipated at the programmatic level – see previous section.
        - Airspace: Implementation of Deployable Aerial Communications Architecture (DACA) could result in potential temporary and 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 Virginia airports (See obstruction criteria in Section 15.1.7.8, Obstructions to Airspace Considerations). Potential impacts to airspace (such as SUAs and MTRs) may be possible depending on the planned use of drones, piloted aircraft, 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.

- 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 or results in EMR if in proximity to air navigation facilities and affects navigable airways.

In general, the abovementioned activities could potentially involve construction activities. Potential impacts to land uses associated with deployment of this infrastructure 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 are expected to be *less than significant* due at the programmatic level 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. See Chapter 17, BMPs and Mitigation Measures, for 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.

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. 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 15.2.8, 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. Chapter 17, 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.

15.2.7.5. 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 no 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 at the programmatic level. While a single deployable technology may have an 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. See Chapter 17, BMPs and Mitigation Measures, for 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.

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 at the programmatic level 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. See Chapter 17, BMPs and Mitigation Measures, for 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.

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* at the programmatic level to land use, recreation resources, or airspace. Environmental conditions would therefore be the same as those described in Section 15.1.7, Land Use, Recreation, and Airspace.

15.2.8. Visual Resources

15.2.8.1. Introduction

This section describes potential impacts to visual resources in Vermont associated with construction/deployment and operation of the Proposed Action and alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.8.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on visual resources were evaluated using the significance criteria presented in Table 15.2.8-1. The categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures 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 15.2.8-1: Impact Significance Rating Criteria for Visual Resources at the Programmatic Level

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

NA = Not Applicable

15.2.8.3. 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 Virginia, residents and visitors travel to many national and state parks, such as Shenandoah National Park to view its rolling hills and river valleys and expansive fall foliage. 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. Virginia's Environmental Impacts Report Act evaluates the environmental impacts of major construction projects initiated by a state agency. The Department of Historic Resources (DHR) is involved when a project might affect historic properties or archaeological sites (Virginia Department of Historic Resources, 2011). 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.

Based on the impact significance criteria presented in Table 15.2.8-1, impacts to the aesthetic character of scenic resources or viewsheds would be considered *potentially significant* at the programmatic level if landscapes were permanently removed or fragmented, or if damage to historic or cultural resources occurred. The majority of FirstNet deployment activities would not cause negative impacts to the aesthetic character to a noticeable degree. However, some projects, such a towers, facilities, or infrastructure could cause a negative impact on the aesthetic character of local viewsheds depending on their size and location. However, given the small scale of likely FirstNet activities, impacts are expected to be *less than significant* at the programmatic level.

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 would be considered *potentially significant* at the programmatic level.

Based on the impact significance criteria presented in Table 15.2.8-1, 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, although potentially minimized to *less than significant with implementation of BMPs and mitigation measures*, as defined in Chapter 17, BMPs and Mitigation Measures. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented.

15.2.8.4. 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, 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 with BMPs and mitigation measures incorporated* depending on the deployment scenario or site-specific conditions. Chapter 17, 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 at the Programmatic Level

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 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 and would result in *no impacts* to visual resources at the programmatic level.
  - 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 at the programmatic level 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* to 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 have *no impact* on visual resources at the programmatic level as 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 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 visual resources, it is anticipated that this activity would have *no impact* to visual resources at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential construction/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, location and type of 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 poles or replacement of 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 have *potentially significant* impacts at the programmatic level. 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 limited nearshore and inland bodies of water would have *no impact* on visual resources at the programmatic level. 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 shore to accept 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 the effects would likely be temporary and localized and are anticipated to be *less than significant*.

- 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 be *potentially significant* at the programmatic level.
  - 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 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 or areas of surface disturbance, or additional nighttime lighting.

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 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, although certain discrete locations could have potentially greater impacts to night skies or as a result of new towers. As discussed above, at the programmatic level, potential impacts to night skies from lighting are expected to be *less than significant with BMPs and mitigation measures incorporated*. See Chapter 17, BMPs and Mitigation Measures, for 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.

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* to visual resources 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. Nighttime lighting in isolated rural areas or if sited near a national park would be *less than significant with BMPs and mitigation measures incorporated* at the programmatic level during operations. Additionally, FirstNet would work closely with the National Park Service (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 17, 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.

15.2.8.5. 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 no 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, or required new nighttime lighting, impacts could occur to the aesthetic character of scenic resources or viewsheds, as described above. These impacts are expected to be *less than significant* at the programmatic level as generally they would be limited to the deployment location and could often be screened or otherwise blocked from view. See Chapter 17, BMPs and Mitigation Measures, for 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.

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* at the programmatic level. These potential impacts would be similar to the potential impacts described for the Deployable Technologies option of the Preferred Alternative, above, only likely with greater numbers of deployable units.

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. Therefore, there would be *no impacts* at the programmatic level to visual resources as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 15.1.8, Visual Resources.

15.2.9. Socioeconomics

15.2.9.1. Introduction

This section describes potential impacts to socioeconomics in Virginia associated with deployment and operation of the Proposed Action and alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.9.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on socioeconomics were evaluated using the significance criteria presented in Table 15.2.9-1. The categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures 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 15.2.9-1: Impact Significance Rating Criteria for Socioeconomics at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures 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 tax revenues, wages, major industries, or direct spending
	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

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	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 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

15.2.9.3. 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 Tax Revenues, Wages, Major Industries, or Direct Spending;
- 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 value due to below average public safety communication services. Improved services would likely reduce response times and improve responses. 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 considerably across Virginia. Median values of owner-occupied housing units in the 2009–2013 period ranged from nearly $425,000 in the Virginia portion of the Washington, DC area, to $160,000 in the Lynchburg area. 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 Tax Revenues, Wages, Major Industries, or Direct Spending

Developing the NPSBN may increase economic activity as governments and contractors 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.[176] 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. This is 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* at the programmatic level. It is also highly unlikely that these impacts would lead to significant market shifts or other significant changes to local/regional economic structure.

[176] See generally 47 U.S.C. § 1428, § 1457.

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 partners 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 is a 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 and/or its partners 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 Existing Environment, unemployment rates (as shown by the unemployment rate map and selected economic indicators table) vary considerably across Virginia. The average unemployment rate in 2014 was 5.2 percent, lower than the national rate of 6.2 percent. Counties with unemployment rates below the national average (that is, better employment performance) were located in the northern and

eastern portions of the state, with a few exceptions. Most counties in the south and southwestern portions of Virginia had unemployment rates above the national average.

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 at the programmatic level based on the criteria in Table 15.2.9-1 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.

15.2.9.4. 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 all represent economic activity that would result, for instance, in expenditures and generation of income. Even if the expenditure and income generation levels a very small for each project, and although not significant across the entire state, they are measurable socioeconomic impacts.

Activities Likely to Have No Impacts at the Programmatic Level

- 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* at the programmatic level to socioeconomic resources.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential impacts to socioeconomics for the Preferred Alternative would encompass a range of impacts that could result from deployment activities. The discussion below indicates which of the four types of socioeconomic impacts discussed above and listed again here apply to each type of deployment activity.

- Impacts to Real Estate
- Changes to Spending, Income, Industries, and Public Revenues
- Impacts to Employment
- 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* at the programmatic level.
    - 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* at the programmatic level.

- 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* at the programmatic level.
  - 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* at the programmatic level.
  - 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* at the programmatic level.
  - 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* at the programmatic level.
  - 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* at the programmatic level.
        - 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* at the programmatic level.
        - 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* at the programmatic level.
        - 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* at the programmatic level.
        - 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 vibrations, 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* at the programmatic level.

    - 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* at the programmatic level.
    - 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* at the programmatic level.
        - 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, as described above. 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. See Chapter 17, BMPs and Mitigation Measures, for 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.

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. All operational activities would be conducted by public or private sector employees, 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. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.9.5. 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 no 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* as described above. See Chapter 17, BMPs and Mitigation Measures, for 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.

Operation Impacts

All operational activities represent economic activity and thus have socioeconomic impacts. These impacts would primarily be beneficial, and because they are small individually, overall impacts would be *less than significant*.

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, vibrations, 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* at the programmatic level as they would be limited to a relatively small number of sites within the region and state. See Chapter 17, BMPs and Mitigation Measures, for 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.

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. Therefore, there would be *no impacts* at the programmatic level to socioeconomics as a result of the No Action Alternative. Socioeconomic conditions would therefore be the same as those described in Section 15.1.9, Socioeconomics.

15.2.10. Environmental Justice

15.2.10.1. Introduction

This section describes potential impacts to environmental justice in Virginia associated with construction/deployment and operation of the Proposed Action and alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.10.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on environmental justice were evaluated using the significance criteria presented in Table 15.2.10-1. The categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures 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 15.2.10-1: Impact Significance Rating Criteria for Environmental Justice at the Programmatic Level

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

15.2.10.3. 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

Executive Order (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 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 and Vibrations, Aesthetics and Visual Resources, and other resources.

Potential concerns noted in the impact analyses for these resources include dust, noise, vibrations, traffic, and other adverse impacts of construction activities. New wireless communication towers sometimes have adverse impacts on nearby property value (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. 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 emergency medical services; improvements in property values; and the generation of jobs and income. These impacts are considered in the Socioeconomics Environmental Consequences.

In general, environmental justice impacts manifest at the local level. Environmental justice populations are often highly localized. 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 Existing Environment (Section 15.1.10) as having Moderate Potential or High Potential for environmental justice populations would particularly warrant further screening. As discussed in Section 15.1.10, Virginia's population has roughly similar percentage of All Minorities compared to the region and the nation. It has a higher percentage of Black/African American population and a lower percentage of Hispanic population than the region or nation. The state has a lower rate poverty than the rates of the region and the nation. Virginia has many areas with High Potential for environmental justice populations. These areas are distributed widely across the state. The distribution of areas with Moderate Potential for environmental justice populations is also fairly even across the state. Further analysis using the data developed for the screening analysis in Section 15.1.10 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, 2015e; USEPA, 2014e).

Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Site-specific analysis would also evaluate whether an actual environmental justice impact on those populations would be likely to occur. Analysts can 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.

15.2.10.4. 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, 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.

Activities Likely to Have No Impacts at the Programmatic Level

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 have *no impact* at the programmatic level on 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* to 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 at the programmatic level.
- 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. Thus, if the activity would does not involve new construction, impacts to environmental justice communities would not occur at the programmatic level. 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* at the programmatic level to environmental justice.

Activities with the Potential to Have Impacts at the Programmatic Level

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, vibrations, 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, vibrations, 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, vibrations, 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 and 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 generate noise, vibrations, 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 generate noise, vibrations, 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, vibrations, 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, vibrations, 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, vibrations, and dust

could temporarily be generated, and traffic could be disrupted. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

- 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. Thus, as discussed above, this activity would only potentially impact environmental justice communities if it involves new construction that generates noise, vibrations, and dust, or disrupts traffic, and occurs disproportionately in environmental justice communities.

In general, the impacts from the abovementioned activities would be short-term and could potentially involve objectionable dust, noise, vibrations, traffic, or other localized impacts due to construction activities. In some cases, these effects and aesthetic effects could potentially impact property values, particularly for 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. 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, furthermore, site-specific analysis could evaluate site conditions and the impacts of the type of deployment, and could satisfy requirements associated with any other permits or permissions necessary to perform the work. BMPs and mitigation measures may be required to address potential impacts to environmental justice communities at the site-specific level. See Chapter 17, BMPs and Mitigation Measures, for 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.

Operation Impacts

Activities Likely to Have No Impacts at the Programmatic Level

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 at the programmatic level, as the intensity of these activities would be low (low potential for objectionable effects such as noise, vibrations, and dust) and their duration would be very short. Routine maintenance and inspection would not adversely affect property values, for the same reasons. Impacts are expected to be *less than significant*. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.10.5. 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 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 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, vibrations, and dust could temporarily be generated, 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* because they would be temporary in nature. See Chapter 17, BMPs and Mitigation Measures, for 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.

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 generate noise and vibrations, 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. See Chapter 17, BMPs and Mitigation Measures, for 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.

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. Therefore, there would be *no impacts* to environmental justice at the programmatic level as a result of the No Action Alternative.

Environmental conditions would therefore be the same as those described in Section 15.1.10, Environmental Justice.

15.2.11. Cultural Resources

15.2.11.1. Introduction

This section describes potential impacts to cultural resources in Virginia associated with deployment and operation of the Proposed Action and alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.11.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on cultural resources were evaluated using the significance criteria presented in Table 15.2.11-1. The categories of impacts are defined at the programmatic level as an *adverse effect; mitigated adverse effect; effect, but not adverse;* and *no effect*. These impact categories are comparable to those defined in *36 CFR § 800*, Secretary of Interior's Standards and Guidelines for Archaeology and Historic Preservation (NPS 1983), and the United States (U.S.) National Park Service's *National Register Bulletin: How to Apply the National Register Criteria for Evaluation* (NPS, 2002). 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 15.2.11-1: Effect Significance Rating Criteria for Cultural Resources at the Programmatic Level

Type of Effect	Effect Characteristics	Effect Level			
		Adverse Effect	Mitigated Adverse Effect[a]	Effect, but Not Adverse	No Effect
Physical damage to and/or destruction of historic properties[b]	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 at the programmatic level.	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 at the programmatic level.	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 at the programmatic level.	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	Effect Level			
		Adverse Effect	**Mitigated Adverse Effect[a]**	**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 at the programmatic level.	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

[a] Whereas mitigation measures for other resources discussed in this PEIS may be developed to achieve an impact that is "*less than significant with BMPs and mitigation measures 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 Indian tribes and Native Hawaiian Organizations, to develop appropriate mitigation.

[b] 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 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.

15.2.11.3. 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 15.2.11-1, direct deployment impacts could be adverse 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 avoid areas with archaeological deposits or within historic districts. However, given that archaeological sites and historic properties are present throughout Virginia, some deployment activities may be in these same areas, in which case BMPs would help avoid or minimize the potential impacts. Chapter 17, 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.

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 *adverse effects* 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. Chapter 17, 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.

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. *Adverse effects* such as these could be avoided or minimized through BMPs and mitigation measures, as defined through consultation with the appropriate resource agency. Chapter 17, 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. Chapter 17, 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.

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 *adverse effect* 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 by conducting research on particular areas and through the NHPA consultation process, and would minimize deployment activities that would cause such loss of access. Chapter 17, 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.

15.2.11.4. Potential Effects of the Preferred Alternative at the Programmatic Level

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Effects

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 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 from *no effect* to *effect, but not adverse* at the programmatic level depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Effect at the Programmatic Level

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 effect* to cultural resources at the programmatic level 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 effect* to cultural resources at the programmatic level 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 effect* to cultural resources at the programmatic level. If required, and if done in existing huts with no ground disturbance, installation of new associated equipment would also have *no effect* to cultural resources at the programmatic

level. The section below addresses potential impacts to cultural resources if deployment of new huts or other equipment is required.

- 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 or new above group components, there would be *no effect* to cultural resources at the programmatic level. The section below addresses potential impacts if construction of new boxes, huts, or other equipment is required.

- 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* to cultural resources at the programmatic level because those activities would not require ground disturbance or create perceptible 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 affect cultural resources, it is anticipated that this activity would have *no effect* to cultural resources at the programmatic level.

Activities with the Potential to Have Effects at the Programmatic Level

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 effect to cultural resources at the programmatic level 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 properties.
  - 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 properties.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Although lighting up of dark fiber would have *no impacts* to cultural resources as mentioned above, installation of new associated huts or equipment, if required, could the

disturbance of archaeological sites, and the associated structures could have visual effects on historic properties.

- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water could impact cultural resources, as coastal areas of Virginia have the potential to contain prehistoric archaeological sites, as well as sites associated with the state's significant maritime history since European colonization, such as shipwrecks. Impacts to cultural resources could also potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable, which could result in the disturbance of archaeological and historical sites, such as wharves and seawalls (Virginia has numerous maritime and riverine archaeological sites associated with its 18th and 19th century commercial expansion), and the associated network 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 effect* to cultural resources at the programmatic level. 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 impacts to 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 Richmond, that have larger numbers of historic 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 effect*s* 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 17, 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.

Potential Operation Effects

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 effect* 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 at the programmatic level. 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 17, 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.

15.2.11.5. Alternatives Effect Assessment

The following section assesses potential impacts to cultural resources at the programmatic level 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 no new construction. 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.

Potential Deployment Effects

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 17, 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.

Potential Operation Effects

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 at the programmatic level associated with implementation/running of the deployable technology. No *adverse effects* at the programmatic level would be expected 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 effect* to cultural resources 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. 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 17, 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. Therefore, there would be *no effect* to cultural resources at the programmatic level as a result of the No Action Alternative.

15.2.12. Air Quality

15.2.12.1. Introduction

This section describes potential impacts to Virginia's air quality from construction/deployment and operation of the Proposed Action and alternatives. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to air quality. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 17, BMPs and Mitigation Measures.

15.2.12.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on Virginia's air quality were evaluated using the significance criteria presented in Table 15.2.12-1. The categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures 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 Virginia's air quality addressed in this section are presented as a range of possible impacts.

Table 15.2.12-1: Impact Significance Rating Criteria for Air Quality at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures 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

15.2.12.3. 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 unknown 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. Areas exist in Virginia that are in maintenance or nonattainment for one or more criteria pollutants, particularly, ozone is an issue in the eastern portion of the state (see Section 15.1.12, Air Quality).

Based on the significance criteria presented in Table 15.2.12-1, 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. At the programmatic level, *less than significant* emissions could occur for any of the criteria pollutants within attainment areas in Virginia; however, NAAQS exceedances are not anticipated. Given that nonattainment areas are present in Virginia (Figure 15.1.12-1), and because infrastructure could be deployed in these areas, BMPs and mitigation measures (see Chapter 17, BMPs and Mitigation Measures) could help avoid or minimize potential air quality impacts. In addition, it is anticipated that any air pollution increase due to deployment would likely be short-term with pre-existing air quality levels generally achieved after some months (typically less than a year, and could be as short as a few hours or days for some activities such as pole construction).

15.2.12.4. 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.

Activities Likely to Have No Impacts at the Programmatic Level

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 air quality at the programmatic level 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 at the programmatic level.
  - 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 to air quality because it would create no new sources of emissions at the programmatic level.
- 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 at the programmatic level.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN. As adding equipment to an existing launch vehicle would be very unlikely to impact air quality, it is anticipated that this activity would have *no impact* at the programmatic level to air quality.

Activities with Potential to Have Impacts at the Programmatic Level

Construction, deployment, and operation activities related to the Preferred Alternative could impact air quality by generating various quantities of criteria and hazardous 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 at the programmatic level 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 limited nearshore and inland bodies of water could generate products of combustion from vehicles used to lay the cable. In addition, the construction of landings and/or facilities on shore to accept 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 may conduct 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. If 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 expected to be *less than significant* at the programmatic level due to the limited nature of the deployment. See Chapter 17, BMPs and Mitigation Measures, for 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.

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 at the programmatic level to air quality 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.

15.2.12.5. 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 no 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 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 cumulative impact, although this impact 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 concentrations and associated impacts would be dictated by the products of combustion from ground support vehicles, as well as the duration of ground support operations and travel between storage and deployment locations. 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.

No Action Alternative

Under the No Action Alternative, FirstNet would not deploy the NPSBN and there would be *no impact* at the programmatic level 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.

15.2.13. Noise and Vibration

15.2.13.1. Introduction

This section describes potential noise and vibration impacts from construction, deployment, and operation of the Proposed Action and alternatives in Virginia. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.13.2. Impact Assessment Methodology and Significance Criteria

The noise and vibration impacts of the Proposed Action were evaluated using the significance criteria presented in Table 15.2.13-1. The categories of impacts are defined at the programmatic level as *potentially significant, less than significant with BMPs and mitigation measures 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 and vibration impacts to Virginia addressed in this section are presented as a range of possible impacts.

Table 15.2.13-1: Impact Significance Rating Criteria for Noise and Vibration at the Programmatic Level

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 and vibration 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. Vibration levels would exceed 65 VdB for human receptors and 100 VdB for buildings.	Effect that is *potentially significant*, but with mitigation is *less than significant*	Noise and vibration levels resulting from project activities would exceed natural sounds, but would not exceed typical noise and vibration levels from construction equipment or generators.	Natural sounds would prevail. Noise and vibration 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

dBA = A-weighted decibel(s); VdB = vibration decibel(s)

15.2.13.3. Description of Environmental Concerns

Increased Noise and Vibration Levels

The Proposed Action has the potential to generate noise and vibration during construction and operation of various equipment used for deployment. These noise and vibration levels could be above what is typically generated in a given area and may alter the ambient acoustical environment. If significant, the noise and vibration could cause impacts on residential areas, or other facilities that are sensitive to noiseand vibration, 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 15.1.13, Noise and Vibration).

Based on the significance criteria presented in Table 15.2.13-1, noise and vibration impacts would likely be *less than significant* at the programmatic level 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 and vibration sources be deployed/operated long-term in the same area. Noise and vibration levels from deployment activities are not expected to exceed typical noise and vibration levels for short-term/temporary construction equipment or generators.

To the extent practicable, FirstNet would attempt to mitigate or minimize noise and vibration effects during construction or operation. BMPs and mitigation measures would be followed to limit impacts on nearby noise and vibration-sensitive receptors However, given that much of the construction and operation of the Proposed Action would often occur in populated areas, FirstNet would not be able to completely avoid noise or vibration impacts.

15.2.13.4. 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 and vibration 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* at the programmatic level depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios, the following are likely to have no noise and vibration 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 and vibration 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 or installation activities, and therefore would have no noise or vibration 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 and vibration would be emitted during installment of this equipment. Noise and vibration 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 and vibration environment.
  - 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 noise and vibration resources, it is anticipated that this activity would have *no impact* to noise.

Activities with the Potential to Have Impacts at the Programmatic Level

Construction, deployment, and operation activities related to the Preferred Alternative could create noise and vibration impacts from either the deployment 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 noise and vibration 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 and vibration 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 and vibration 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 increases in noise and vibration 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 and vibration 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 and inland bodies of water could generate noise and vibration 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 temporary increased noise and vibration levels to local residents and other noise and vibration sensitive receptors from heavy equipment used for grading, foundation excavation, or other ground disturbing activities.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Noise and vibration 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 from optical networks is relatively low, and vibration impacts do not occur. Heavy equipment used to grade and construct access roads could generate increased levels of noise and vibration 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 and vibration. Operating vehicles, other heavy equipment, and generators would be used on a short-term basis and could also increase noise and vibration 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 temporarily impact the local noise environment and create vibrations.
  - Deployable Technologies: The type of deployable technology used would dictate the types of noise and vibration generated. For example, mobile equipment deployed via heavy trucks could generate noise and vibration from the internal combustion engines associated with the vehicles and onboard generators. Aerial platforms (e.g., UASs or other aircraft, except balloons) generate noise and vibration during all phases of flight, including takeoff, landing, and flight operations over necessary areas that could impact the local noise environment and create vibrations.

In general, noise and vibration 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. These impacts are expected to be *less than significant* due to the temporary duration of deployment activities. Additionally, pre-existing noise and vibration levels achieved after some months (typically less than a year but could be as soon as a few hours for linear activities such as pole construction). See Chapter 17, BMPs and Mitigation Measures, for 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.

Operation Impacts

Operation activities associated with the Preferred Alternative would be *less than significant* 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 and vibration. 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 and vibration 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 and vibration impacts could result as explained above.

15.2.13.5. Alternatives Impact Assessment

The following section assesses potential noise and vibration 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 no 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 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 and vibration impacts are as follows:

Deployment Noise and Vibration Impacts

Implementing deployable technologies could result in noise and vibration 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 and vibration

impacts on residences or other noise and vibration-sensitive receptors as they pass by. With the exception of balloons, the deployment of aerial technology is anticipated to generate noise and vibration during all phases of flight. Aerial technologies would have the highest level of noise and vibration impact if they are required to fly above residential areas, areas with a high concentration of noise and vibration-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. See Chapter 17, BMPs and Mitigation Measures, for 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.

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 and vibration in the area. However, deployable technologies could be deployed to areas with few existing facilities, so noise and vibration 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 and vibration 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*, short-term impacts on any residential areas or other noise and vibration-sensitive receptors under the flight path of these vehicles. However, once these operations cease, noise and vibration levels would quickly return to baseline levels. See Chapter 17, BMPs and Mitigation Measures, for 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.

No Action Alternative

Under the No Action Alternative, FirstNet would not deploy the NPSBN and there would be *no impact* to ambient noise or vibration. Therefore, FirstNet would avoid generating noise and vibration from the No Action Alternative.

15.2.14. Climate Change

15.2.14.1. Introduction

This section describes potential impacts to climate and climate change-vulnerable resources in Virginia associated with deployment and operation of the Proposed Action and alternatives. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.14.2. 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 15.2.14-1. The categories of impacts are defined at the programmatic level as *potentially significant, less than significant with BMPs and mitigation measures 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).

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 can provide useful information to the project planning to ensure these projects are resilient to the impacts of climate change.

Table 15.2.14-1: Impact Significance Rating Criteria for Climate Change at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Contribution to climate change through GHG emissions	Magnitude or Intensity	See discussion below in Section 15.2.14.5, Potential Impacts of the Preferred Alternative	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	See discussion below in Section 15.2.14.5, Potential Impacts of the Preferred Alternative		Global impacts observed	NA
	Duration or Frequency	See discussion below in Section 15.2.14.5, Potential Impacts of the Preferred Alternative		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

15.2.14.3. Projected Future Climate

Climate model forecasts of future temperatures are highly dependent on emissions scenarios (low versus high), particularly in projections beyond 2050. By mid-century, the total number of days above 90 ºF is projected to increase in the majority of the Northeastern states especially the southern portion of the region. Under both low and high GHG emissions scenarios, the frequency, intensity, and duration of heat waves (sequential days with temperatures over 90 ºF) are also expected to increase, with the most intense heat waves occurring under higher emissions scenarios. Increases in temperature will also impact precipitation events, sea level rise, and ocean water acidity (USGCRP, 2014a).

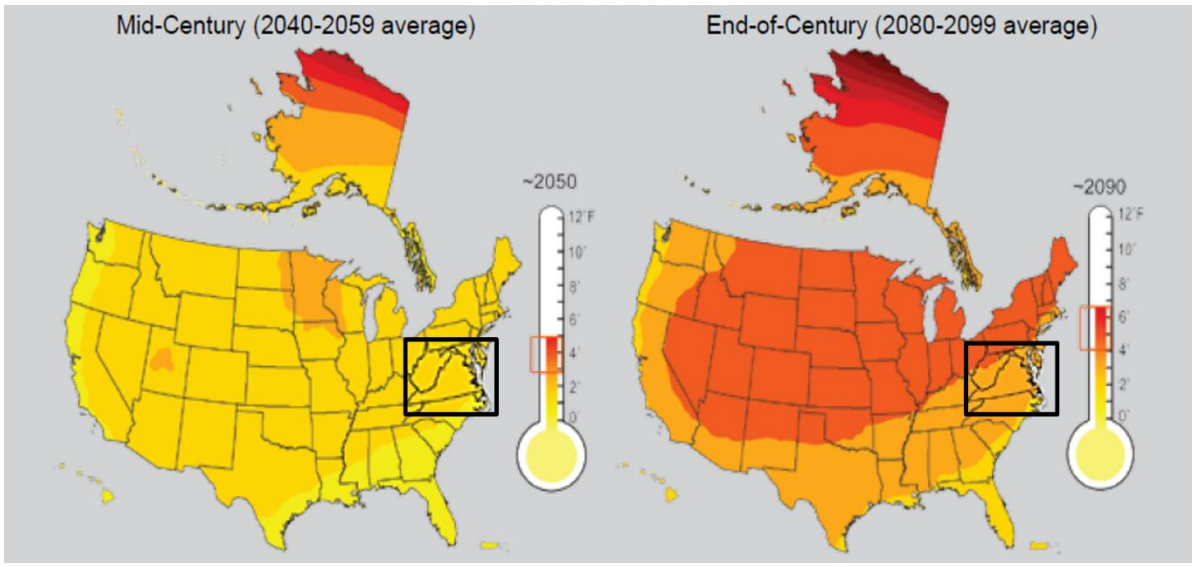
Air Temperature

Figure 15.2.14-1 and Figure 15.2.14-2 illustrate the anticipated temperature changes for low and high GHG emission scenarios for Virginia from a 1969 to 1971 baseline.

Cfa – Figure 15.2.14-1 shows that by mid-century (2040 to 2059), temperatures in the entire state of Virginia under a low emissions scenario will increase by approximately 4 °F, and by the end of the century (2080 to 2099) under a low emissions scenario temperatures in the entire state of Virginia will increase by approximately 5° F (USGCRP, 2009).

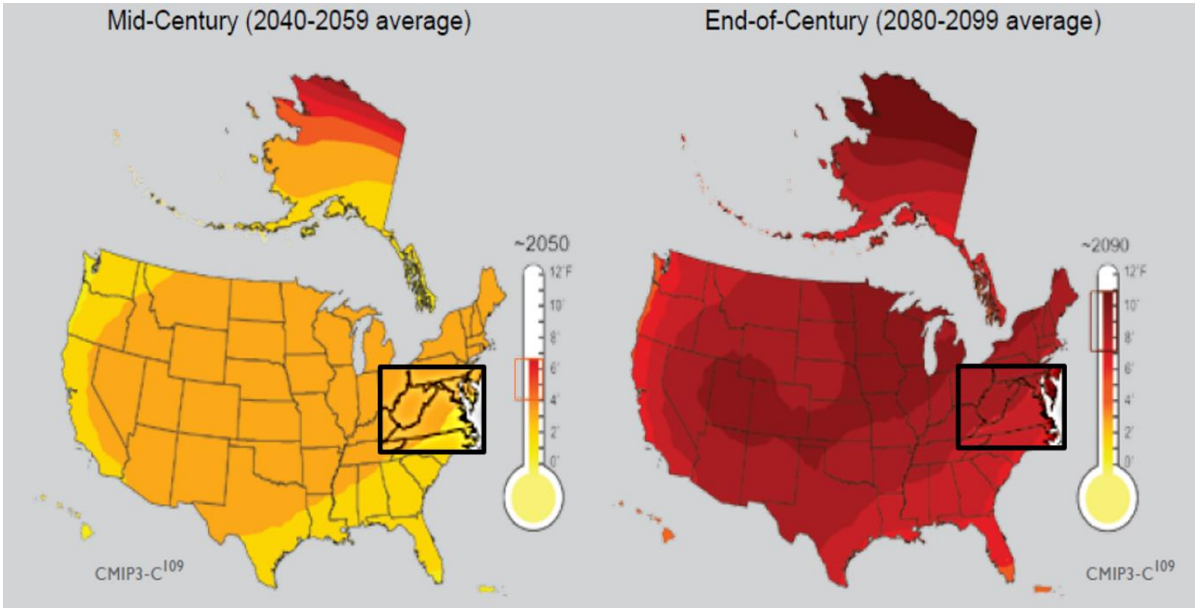
Figure 15.2.14-2 shows that under a high emissions scenario for the period (2040 to 2059), temperatures will increase by approximately 5 °F. Under a high emissions scenario for the period (2080 to 2099), temperatures will increase by approximately 8° F in the majority of the Cfa region. In the northwestern most portion of the Cfa region of the state under a high emissions scenario temperatures will increase by approximately 9° F by the end of the century (USGCRP, 2009).

Cfb – Temperatures in this region are expected to increase by mid-century (2040 to 2059) and by the end of the century (2080 to 2099) under a low emissions scenario are expected to increase at the same rate as the Cfa region of Virginia. By mid-century under a high emissions scenario temperatures will increase at the same rate as the Cfa region. And, in the Cfb region, temperatures by the end of the century will increase by approximately 8° F under a high emissions scenario (USGCRP, 2009).



Source: (USGCRP, 2009)

Figure 15.2.14-1: Virginia Low Emission Scenario Projected Temperature Change



Source: (USGCRP, 2009)

Figure 15.2.14-2: Virginia High Emission Scenario Projected Temperature Change

Precipitation

By late in the century under a high emissions scenario, winters in the Northeast are projected to be much shorter with fewer cold days and more precipitation. Winter and spring precipitation is projected to increase, and the frequency of heavy downpours is projected to continue to increase as the century progresses. Seasonal drought risk is also projected to increase in summer and fall

as higher temperatures lead to greater evaporation and earlier winter and spring snowmelt (USGCRP, 2009).

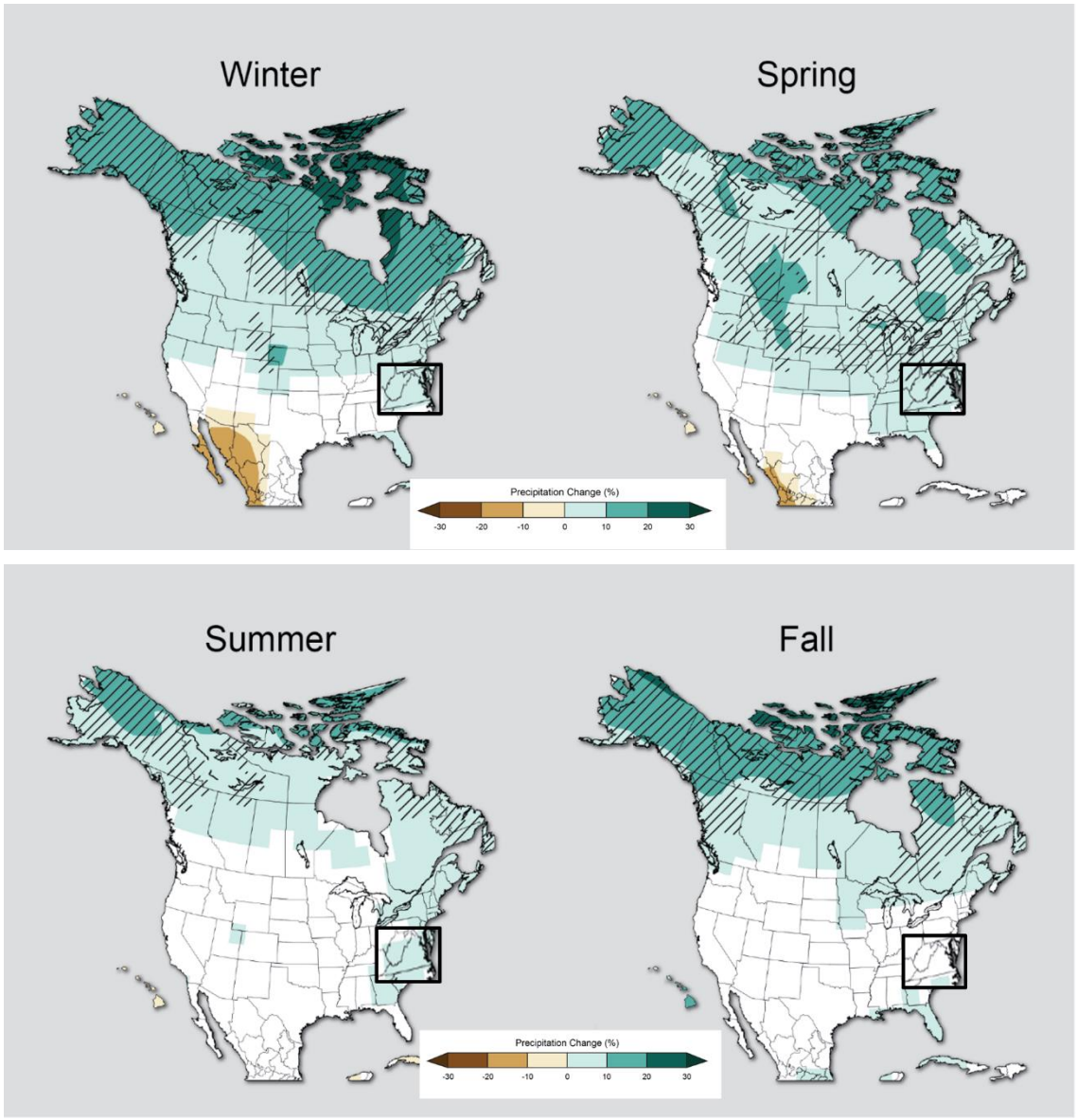
Figure 15.2.14-3 and Figure 15.2.14-4 show predicted seasonal precipitation change for an approximate thirty-year period of 2071 to 2099 compared to a 1970 to 1999 approximate thirty-year baseline. Figure 15.2.14-1 show seasonal changes in a low emissions scenario, which assumes rapid reductions in emissions where rapid reductions means more than 70 percent cuts from current levels by 2050 (USGCRP, 2014b).

Figure 15.2.14-4 shows a high emissions scenario, which assumes continued increases in emissions, with associated large increases in warming and major precipitation changes. Continued increases in emissions would lead to large reductions in spring precipitation in the Northeast. (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 - Figure 15.2.14-3 shows that in a rapid emissions reduction scenario in the 30-year period for 2071 to 2099, precipitation will increase by 10 percent in winter, spring and summer for the entire state of Virginia. However, there are no expected increases in precipitation in fall other than fluctuations due to natural variability (USGCRP, 2014b).

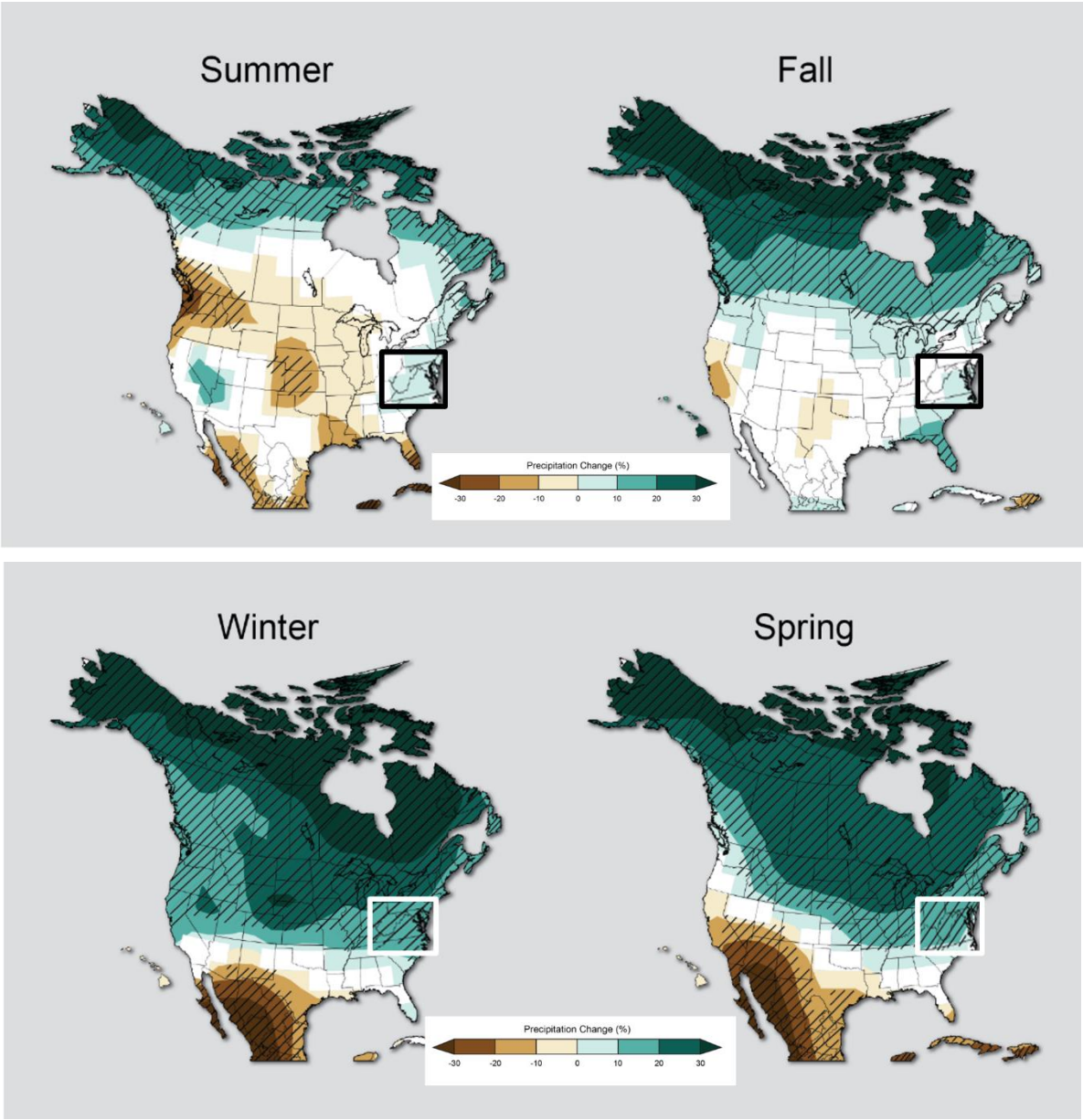
Figure 15.2.14-4 shows that if emissions continue to increase, winter precipitation could increase as much as 20 percent over the period 2071 to 2099. Summer precipitation under this emissions scenario is expected to increase approximately 10 percent. In spring, precipitation in this scenario could increase as much as 20 percent for the majority of the region. However, the southeastern portion of the region and along the southern state border portion, precipitation would increase only 10 percent in spring. In fall, precipitation in the majority of the Cfa region will increase by approximately 10 percent. Also, in fall, no significant change to a small southwestern portion is anticipated over the same period (USGCRP, 2014b).

Cfb – Precipitation changes for the Cfb region are consistent with projected changes for the Cfa region of Virginia under low and high GHG emissions scenarios, with the exception of fall under a high emissions scenario, which has no expected increases in precipitation (USGCRP, 2014b).



Source: (USGCRP, 2014b)

Figure 15.2.14-3: Predicted Seasonal Precipitation Change for 2071 to 2099 Compared to 1970 to 1999 Baseline in a Low Emissions Scenario



Source: (USGCRP, 2014b)

Figure 15.2.14-4: Predicted Seasonal Precipitation Change for 2071 to 2099 Compared to 1970 to 1999 Baseline in a High Emissions Scenario

Sea Level

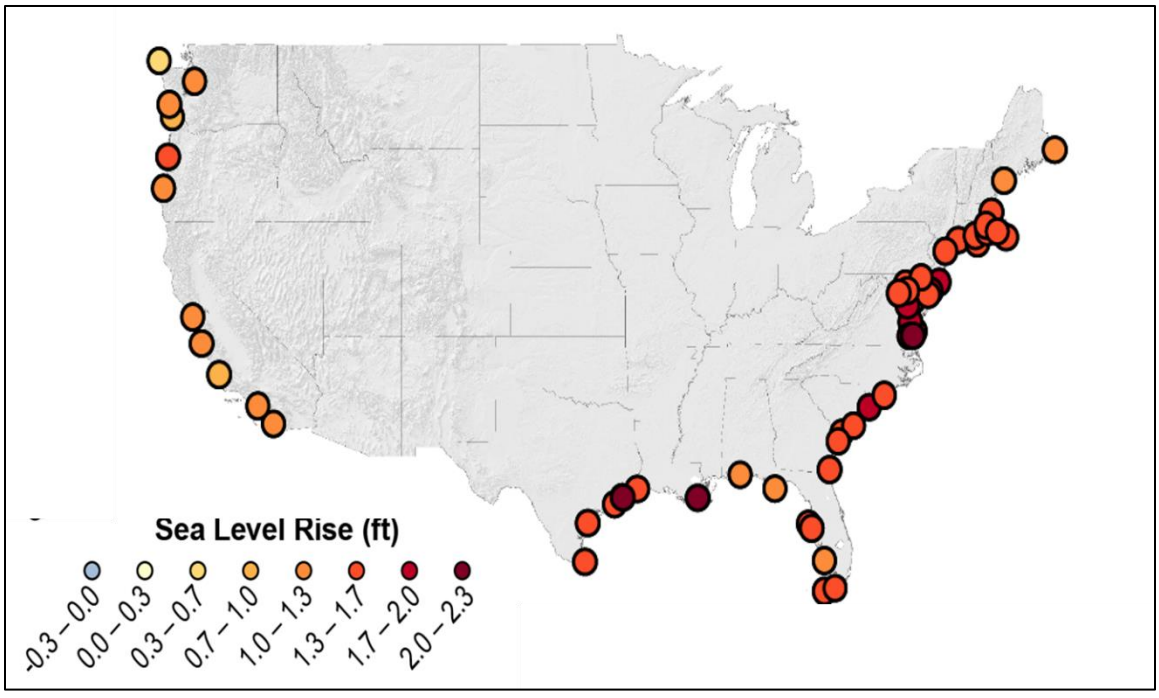
Several factors will continue to affect sea level rise in the future. Glacier melt adds water to the ocean, and increasing ocean temperatures result in thermal expansion. Worldwide, "glaciers have generally shrunk since the 1960s, and the rate at which glaciers are melting has accelerated over the last decade. The loss of ice from glaciers has contributed to the observed rise in sea level" (USEPA, 2012e). 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, 2012e). "Ocean heat content also influences sea level and currents" (USEPA, 2012e).

The amount of sea level rise will vary in the future along different stretches of the U.S. coastline and under different absolute global sea lever 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). The National Climate Assessment (NCA) reported on various potential sea level rise scenarios. These scenarios were developed based on varying degrees of ocean warming and ice sheet loss as estimated by organizations like IPCC. (NOAA; USGS; SERPD; and USACE, 2012) Figure 15.2.14-5 and Figure 15.2.14-6 show the increase in sea level above 1992 levels at different tide gauge stations. Figure 15.2.14-5 shows an 8 inch global sea level rise above 1992 levels by 2050 and Figure 15.2.14-6 shows a 1.24 foot global sea level rise above 1992 levels by 2050 (USGCRP, 2014c).

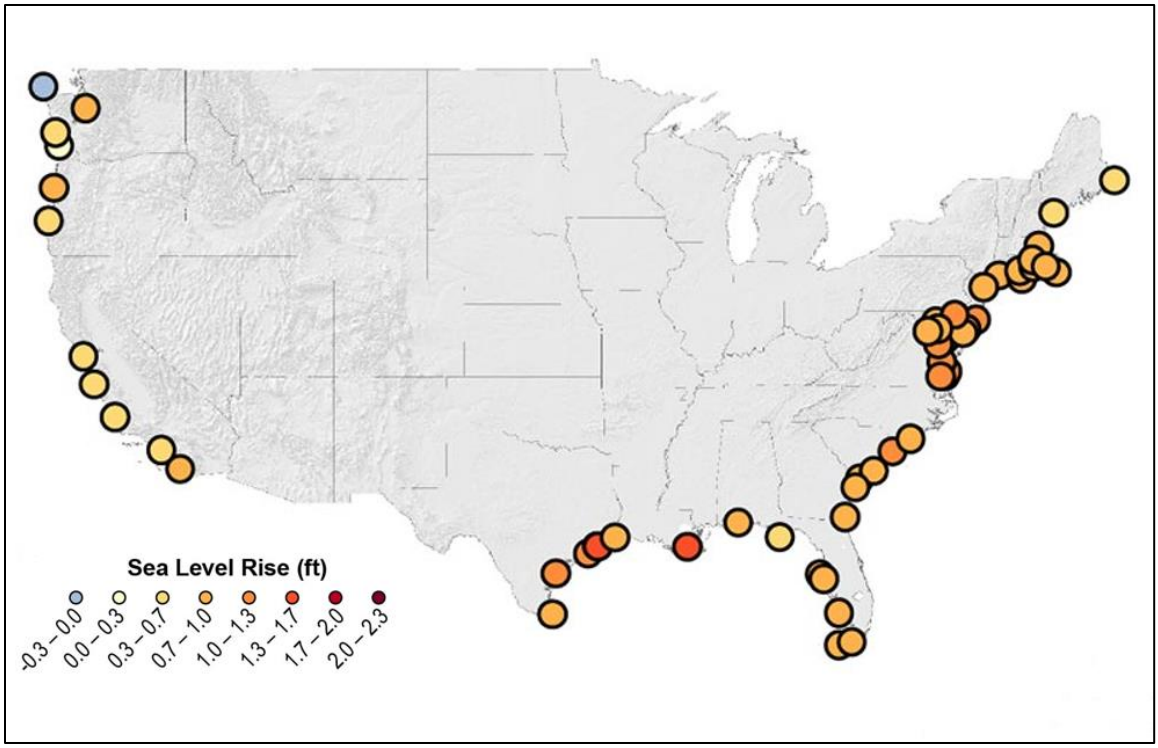
Cfa – Figure 15.2.14-5 presents an 8 inch global average sea level rise above 1992 levels, resulting in a 0.7 to 1.3 foot sea level rise in 2050 along the coast of Virginia. Figure 15.2.14-6 indicates that a 1.24 foot sea level rise above 1992 levels would result in a 1.3 to 2.3 foot sea level rise in 2050 along the coast of Virginia with the largest increase expected along the southern portion of the coast (USGCRP, 2014c).

Cfb – This region of Virginia is not affected by sea level rise.



Source: (USGCRP, 2014c)

Figure 15.2.14-5: 8-inch Sea Level Rise Above 1992 Levels by 2050



Source: (USGCRP, 2014c)

Figure 15.2.14-6: 1.24-foot Sea Level Rise Above 1992 Levels by 2050

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 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).

15.2.14.4. 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 15.2.14-1, 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. 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.

Climate Change

Climate change may impact project-related effects by magnifying or otherwise altering impacts in other resources areas. For example climate change may impact air quality, water availability, and recreation. These effects would vary from state to state depending on the resources in question and their relationship to climate change. These impacts will be considered fully in Chapter 19, Cumulative Impacts. No BMPs will be described in this chapter for this aspect of the resource.

Climate change impacts on FirstNet installations and infrastructure will vary from state to state, depending on the placement and vulnerability of the installations and infrastructure, and the impacts that climate change is anticipated to have in that particular location. Based on the impact significance criteria presented in Table 15.2.14-1, climate change effects on FirstNet installations and infrastructure would be significant if they negatively affected the operation of these facilities.

15.2.14.5. Potential Impacts of the Preferred Alternative

Greenhouse Gas Emissions

Given this assessment is programmatic and does not include any site-specific locations or deployment technology, it is impossible to determine the actual GHG emissions associated with any of the action alternatives. This information could only be captured once the site-specific information is determined. However, an assessment of potential impacts is provided in this section based on the potential emissions associated with the various activities that could occur as

a result of the implementation of the Preferred Alternative in Virginia 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 with BMPs and mitigation measures incorporated* depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts at the Programmatic Level

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 operational power requirements for optical networks are relatively low (significantly less than transmitters); the resulting GHG emissions will not be significant, and are likely to have *no 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 short-term emissions. Long-term impacts are not likely, as optical networks are relatively energy efficient, the resulting GHG emissions will not be significant, and are likely to have *no impacts*.
- Satellites and Other Technologies
  - Distribution and Use of Satellite-Enabled Devices: 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. As adding equipment to an existing launch vehicle would be very unlikely to impact Climate Change, it is anticipated that this activity would have *no impact* on those resources.

Activities with the Potential to Have Impacts at the Programmatic Level

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 Projects
  - 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 construction would not take place. 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, or SOWs: The long-term operations of these mobile systems have the potential to have GHG emission impacts 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.

- Deployable Aerial Communications Architecture: Emissions associated with the deployment and maintenance of a complete network solution of this type may be significant if large numbers of piloted or manned 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. These emissions would arise from the combustion of fuel used by equipment during construction and operation. The total potential level of GHG emissions would be *less than significant* at the programmatic level; although geographically large (all 50 states, 5 territories, and the District of Columbia) any one site would be limited in extent and emit minor levels of GHG emissions as explained in the analysis. Land use related 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. See Chapter 17, BMPs and Mitigation Measures, for 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.

Climate Change Impacts on FirstNet Infrastructure or Operations

At the programmatic level, climate change effects on the Preferred Alternative could be *potentially significant to less than significant 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. 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.

15.2.14.6. 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 no 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.

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 a *less than significant* 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* at the programmatic level. 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 deployment and 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* due the limited duration of deployment activities.

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.

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* at the programmatic level on the deployed technology 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 17, 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.

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. Therefore, there would be *no impacts* to GHG emissions or climate as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 15.1.14, Climate Change.

15.2.15. Human Health and Safety

15.2.15.1. Introduction

This section describes potential impacts to human health and safety in Virginia associated with deployment of the Proposed Action and alternative. See Chapter 17, BMPs and Mitigation Measures, for 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.

15.2.15.2. 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 15.2.15-1. The categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures 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 15.2.15-1: Impact Significance Rating Criteria for Human Health and Safety at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures 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 (TWAs). 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 BMPs and Mitigation Measures 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 general 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
Exposure to Hazardous Materials, Hazardous Waste, and Occupational Hazards as a Result of Natural And Man-Made Disasters	Magnitude or Intensity	Exposure to concentrations of chemicals above regulatory limits, or USEPA chemical screening levels protective of the general public. Site contamination conditions could preclude development of sites for the proposed use. Physical and	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	No exposure to chemicals, unsafe conditions, or other safety and exposure hazards.

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	Less than Significant with BMPs and Mitigation Measures Incorporated	Less than Significant	No Impact
		biologic hazards. Loss of medical, travel, and utility infrastructure.		exposures or risks. No exposure to unsafe conditions. No loss of medical, travel, or utility infrastructure.	
	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

15.2.15.3. 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 are inherently dangerous. 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 15.2.15-1, 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 general public if there are trespassers or if any physical of chemical hazard extends beyond the restricted access of proposed work sites. For example, if fuel is spilled from an onsite fuel tank, the spilled fuel could migrate down gradient and infiltrate underground drinking water sources. The general public may then be exposed to hazardous chemicals in their drinking water if they utilize the same groundwater aquifer.

To protect occupational workers, the U.S. Occupational Safety and Health Administration (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, 2015b).

1. Engineering controls;
2. Work practice controls;
3. Administrative controls; and then
4. 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, 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.

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, 2015b). To the extent practicable, FirstNet partner(s) 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 (SDS) 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 SDSs, standard operating procedures (SOP) 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, 2015b). 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.

The Virginia Department of Labor and Industry (VDOLI) is authorized by U.S. OSHA to administer the state program which oversees employee safety in all state and local government workplaces. The FirstNet proposed action and site work will not be performed by state or local employees. The involvement of state and local employees will be limited to emergency responders (e.g., police, fire, emergency medical transporters, etc.) and local government permitting authorities. VDOLI is not authorized by U.S. OSHA to administer the state's private sector program for occupational safety or federal employers. Therefore, VDOLI defers all regulatory authority and enforcement for occupational safety relating to FirstNet site work to the leadership and interpretation of U.S. 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. 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 as a

result of underground shaft collapses or seismic shifting. Based on the impact significance criteria presented in Table 15.2.15-1, 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 Cleanups in My Community database and U.S. Department of Interior's Abandoned Mine Lands inventory, through the Virginia Department of Environmental Quality (VADEQ), or through an equivalent commercial resource, such as Environmental Data Resources, Incorporated.

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. When sites containing known environmental contamination (or mine lands) are selected for 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 FirstNet deployment site, it is possible undocumented environmental contamination is present.

During FirstNet deployment activities, if any soil or groundwater is observed to be stained or emitting an unnatural odor, it may be an indication of environmental contamination. If such instances are encountered, it may be necessary to stop work until the anomaly is further assessed through record reviews or environmental sampling. 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, Superfund, and applicable Massachusetts state laws in order to protect workers and the general 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 VADEQ 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 15.2.15-1, 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 also 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, forest fire activities, seismic activities, and other news worthy 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. Therefore, FirstNet (or its partners) would likely develop disaster response plans that outline specific steps employees should take in the event of a natural or manmade disaster.

15.2.15.4. 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.

Activities Likely to Have No Impacts at the Programmatic Level

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, 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* at the programmatic level 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* at the programmatic level to 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* at the programmatic level to human health and safety.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential construction/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 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, vibrations 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 FirstNet 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 be performed along road right-of-ways, increasing the potential for vehicle traffic to collide with site workers or equipment. As a result of operating heavy equipment, managing hazardous materials and hazardous waste, and site location challenges there is a potential for impacts to human health and safety.

- New Build – Aerial Fiber Optic Plant: Installation of new poles and fiber optic lines would require excavation activities, working from heights, use of hazardous materials, and site locations in right-of-ways. 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 FirstNet 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. As a result of operating heavy equipment, managing hazardous materials and hazardous waste, and site location challenges there is a potential for impacts to human health and safety.
- 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 FirstNet 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. As a result of operating heavy equipment, managing hazardous materials and hazardous waste, and site location challenges there is a potential for impacts to human health and safety.
- 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 FirstNet 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. As a result of working over water, weather exposure, operating heavy equipment, construction activities, managing hazardous materials and hazardous waste, and site location challenges there is a potential for impacts to human health and safety.
- 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 FirstNet 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. As a result of operating heavy equipment, construction activities, managing hazardous materials and hazardous waste, and site location challenges there is a potential for impacts to human health and safety. 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 FirstNet 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. As a result of operating heavy equipment, working from heights, construction activities, managing hazardous materials and hazardous waste, and site location challenges there is a potential for impacts to human health and safety. For a discussion of radio frequency 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. This would require 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 FirstNet 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. As a result of operating heavy equipment, working from heights, construction activities, managing hazardous materials and hazardous waste, and site location challenges there is a potential for impacts to human health and safety. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.
- Deployable Technologies
  - The use of deployable technologies could result in soil disturbance in land-based deployables occur in 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 and vibrations could potentially impact human health; and vehicles and heavy equipment present the risk of workplace and road traffic accidents that could result in injury. COWs, COLTs, and SOWs: 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, vibrations, 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 radio frequency 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 and vibration 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. See Chapter 17, 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.

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, assuming that the inspections do not require climbing towers or confined space entry. In those instances, 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. 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 and vibration 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. See Chapter 17, 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.

15.2.15.5. 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 no 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. 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 and vibration 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. See Chapter 17, 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.

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 associated with routine inspections of the Preferred Alternative, assuming that the inspections do not require climbing towers or confined space entry. In those instances, 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. See Chapter 17, 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.

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. Therefore, there would be *no impacts* to human health and safety at the programmatic level as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 15.1.15.

VA APPENDIX A - WATER RESOURCES

Table A- 1: Characteristics of Virginia's Watersheds, as Defined by VDCR

Watershed/Size Land Area within VA (square miles)	Major Surface Waterbodies	Major Water Quality Concerns
Potomac-Shenandoah (5,702)	Potomac River S. Fork Shenandoah River N. Fork Shenandoah River	• Pathogens • Mercury in fish tissue • Low dissolved oxygen • PCBs
Chesapeake Bay Coastal (2,577)	Chesapeake Bay Piankatank River	• Pathogens • Ammonia • Low dissolved oxygen
Atlantic Ocean Coastal (580)	Chincoteague Bay Hog Island Bay	• Pathogens • Excess nitrogen • Excess phosphorous • Cyanide • Low dissolved oxygen
Rappahannock (2,174)	Rappahannock River Rapidan River Hazel River	• Pathogens • Low dissolved oxygen • PCBs
York (2,669)	York River Pamunkey River Mattaponi River	• Pathogens • PCBs • Mercury in fish tissue • Low dissolved oxygen • Aquatic plants
James (10,236)	James River Appomattox River Maury River Jackson River Rivanna River	• Pathogens • Low dissolved oxygen • Mercury in fish tissue • Low dissolved oxygen • Excess phosphorous
Chowan (3,675)	Nottaway River Meherrin River Blackwater River	• Mercury in fish tissue • Low dissolved oxygen • Pathogens • Excess phosphorous
Albemarle Sound Coastal (577)	Dismal Swamp North Landing River Back Bay	• Excess phosphorous • Pathogens • Sediment
Roanoke (6,274)	Roanoke River Dan River Banister River Kerr Reservoir	• Pathogens • Mercury in fish tissue • PCBs • Low dissolved oxygen
Yadkin (118)	Ararat River	• Pathogens • Mercury in fish tissue
New (3,068)	New River Little River Walker Creek	• Pathogens • PCBs • Temperature • Low dissolved oxygen • Mercury in fish tissue
Holston (Upper Tennessee) (1,322)	N. Fork Holston River Middle Fork Holston River	• Pathogens • PCBs

Watershed/Size Land Area within VA (square miles)	Major Surface Waterbodies	Major Water Quality Concerns
	S. Fork Holston River	
Clinch – Powell (1,811)	Clinch River Powell River Guest River	• Pathogens • Mercury in fish tissue • Sediment
Big Sandy (999)	Levisa Fork Russel Fork Tug Fork	• Pathogens • PCBs

Source: (VDEQ, 2014) (VDCR, 2014a) (USEPA, 2015l)

Table A- 2: Virginia State Scenic Rivers

River Name	River Segment Description
Appomattox River	Approximately 100 feet from the Lak Chesdin Dam to the James River.
Banister River	The Route 29 Bridge to the Dan River.
Big Cedar Creek	Approximately from Lebanon to the Clinch River.
Blackwater River	Proctor's Bridge at Route 621 to the Nottoway River/ Virginia-North Carolina border.
Catoctin Creek	Approximately from Waterford to the Potomac River.
Chickahominy River	From near Route 360 to Hanover-Henrico-New Kent County border.
Clinch River	(a) Approximately near the confluence with the Little River to Route 645 the Nash Ford Bridge
	(b) Near Route 58 in Saint Paul to the Guest River.
Cranesnest River	Approximately Route 327 to Flanagan reservoir at the Cranesnest Launch Ramp.
Dan River	Approximately Route 880 at Berry Hill Road to Danville's Abreu-Grogan Park
Dan River- Halifax	The Virginia-North Carolina border in Halifax County to Aaron's Creek.
Goose Creek	From where the north and south prong of Goose Creek meet to the Potomac River.
Guest River	Approximately 100 feet downstream from Route 72 to the Clinch River.
Hughes River	From the Shenandoah National Park border to the Hazel River.
Historic Falls of the James	From the border of West Richmond from 1970, to Orleans Street extended.
Upper James River	Approximately two miles southeast of Route 43 to the Route 630 Bridge.
Lower James Historic River	Approximately 1 mile east of Trees Point to Lawnes Creek.

River Name	River Segment Description
Jordan River	The Route 522 Bridge to the Rappahannock River.
North Mayo River	From Route 695 to the Virginia-North Carolina border.
South Mayo River	From the Patrick County Border to the Virginia-North Carolina border.
Meherrin River	From the North Meherrin River to the Brunswick County-Greensville County border.
North Meherrin River	From the Route 712 Bridge to the South Meherrin River
Moormans River	From the Charlottesville Reservoir to the Mechums River
North Landing River	From Route 165 to the Virginia-North Carolina border.
Nottoway River	From the Route 40 Bridge to the Blackwater River/ Virginia-North Carolina border.
Rappahannock River	Approximately Chester Gap to the Route 3 Maysfield Bridge.
Rivanna River	From the South Fork Rivanna River Reservoir to the James River.
Rockfish River	From Route 693 to the James River.
Russell Fork River	From the Splashdam railway crossing to the Virginia-Kentucky border.
Shenandoah River	From the Warren County-Clark County border
St. Mary's River	From the headwaters in Augusta County to the boundary of the George Washington and Jefferson National Forest border.
Staunton River	Route 761 in Long Island to Route 360.
Tye River	Route 738 to the James River

Source: (VDCR, 2015b)

VA APPENDIX B – VIRGINIA TERRESTRIAL COMMUNITIES OF CONCERN

Table B- 1: VNHP S1-Ranked Terrestrial Communities of Concern in Virginia[177]

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
Spruce and Fir Forests	Blue Ridge	Coniferous and mixed forests with dominance of Red spruce (*Picea rubens*) or Fraser fir (*Abies fraseri*) in the overstory. Forest understories are light but an often densely populated herb layer includes mountain wood fern (*Dryopteris campyloptera*) and mountain wood-sorrel (*Oxalis montana*) dominate a relatively dense herb layer.	The northern range of Fraser fir extends to southwestern portion of the state at elevations above 5,400 feet on Mount Rogers.
Southern Appalachian Shrub and Grass Balds	Blue Ridge	Rare communities with four vegetation types evergreen shrubland dominated by Catawba rhododendron (*Rhododendron catawbiense*); mixed shrubland dominated by Catawba rhododendron, mountain laurel (*Kalmia latifolia*), black huckleberry (*Gaylussacia baccata*); deciduous shrubland dominated by American mountain ash (*Sorbus americana*), minniebush (*Menziesia pilosa*), and southern mountain-cranberry (*Vaccinium erythrocarpum*); and deciduous shrubland dominated by Smooth Blackberry (*Rubus canadensis*).	Higher elevation summits (greater than 5,000 feet) and higher southern Blue Ridge slopes. Shrub balds are limited to higher rocky summits of Mt. Rogers – Whitetop Mountains, and a few rocky peaks of the Iron and Clinch Mountains.
Northern Hardwood Forest	Appalachians, Blue Ridge, Ridge and Valley	Dominant trees include sugar maple (*Acer saccharum)*, American beech (*Fagus grandifolia*), black cherry (*Prunus serotina* var. *serotina*), yellow birch (*Betula alleghaniensis*), and yellow buckeye (*Aesculus flava*) in variable proportions. Sapling sugar maple, striped maple (*Acer pensylvanicum*) and mountain maple (*Acer spicatum*) are common understory species. Smooth blackberry (*Rubus canadensis*) and hobblebush (*Viburnum lantanoides*) are dominant shrubs. Dominant herbs include Appalachian white snakeroot (*Ageratina altissima* var. *roanensis*), southern lady fern (*Athyrium asplenioides*), evergreen wood fern (*Dryopteris intermedia*), mountain wood aster (*Eurybia chlorolepis*), sweet white violet (*Viola blanda*), and Appalachian woodland sedge (*Carex lucorum* var. *austrolucorum*).	Southern and Central Appalachia in higher elevations (greater than 3,000 feet) of the western part of the state. Occurring in the Mount Rogers-Whitetop Mountain area of the Blue Ridge and at Iron Mountain, Clinch Mountain, Allegheny Mountain, and smaller populations on higher elevation, north-facing slopes in the Blue Ridge, Ridge and Valley, and Cumberland Mountains.
High-Elevation Boulderfield	Blue Ridge, Ridge and Valley	Yellow birch (*Betula alleghaniensis*), American mountain-ash (*Sorbus americana*),	Community occurs at elevations above 3,000 feet in both the Blue Ridge and

[177] Wetland communities are described in Section 15.1.5.

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
Forests and Woodlands		and mountain maple (*Acer spicatum*) are the typical dominant trees. Typical shrubs include gooseberries (*Ribes cynosbati, Ribes glandulosum, Ribes rotundifolium*), hobblebush (*Viburnum lantanoides*), red raspberry (*Rubus idaeus* ssp. *strigosus*), and red-berried elder (*Sambucus racemosus* var. *pubens, Sambucus pubens*). Appalachian rock polypody (*Polypodium appalachianum*) is an abundant herb. Additional herbaceous species include: yellow blue-bead lilly (*Clintonia borealis*), whorled aster (*Oclemena acuminata = Aster acuminatus*), and Appalachian oak fern (*Gymnocarpium appalachianum*).	Ridge and Valley provinces, often more densely distributed on north-facing slopes with extreme winter weather conditions.
High-Elevation Cove Forests	Appalachians, Ridge and Valley	Cool moist habitats with rich organic soils in a transitional zone between higher elevation northern hardwood forests and rich cover forests in lower elevations. Dominant trees include sugar maple (*Acer saccharum*), yellow birch (*Betula allegheniensis*), basswoods (*Tilia americana* var. *americana* and var. *heterophylla*), American beech (*Fagus grandifolia*), white ash (*Fraxinus americana*), and yellow buckeye (*Aesculus flava*). Dense herb layers include mountain black cohosh (*Actaea podocarpa*), ramps (*Allium tricoccum*), filmy angelica (*Angelica triquinata*), evergreen wood fern (*Dryopteris intermedia*), two-leaf toothwort (*Cardamine diphylla*), blue cohosh (*Caulophyllum thalictroides*), Goldie's wood fern (*Dryopteris goldiana*), Canada waterleaf (*Hydrophyllum canadense*), wood nettle (*Laportea canadensis*, sweet white violet (*Viola blanda*).	Protective slopes and drainages in elevations ranging between 3,000 and 4,800 feet. Small communities restricted to Mount Rogers – Whitetop Mountain area, Cumberland Mountains and Ridge and Valley region, and Allegheny Mountain.
High-Elevation Outcrop Barrens [178]	Ridge and Valley, Blue Ridge	Scrubs and herbs typically of rock outcrops on soils with very thin organic matter, subject to severe weather conditions. Dominant shrubs include American mountain-ash (*Sorbus americana*), red chokeberry (*Aronia melanocarpa*), black huckleberry (*Gaylussacia baccata*), northern bush-honeysuckle (*Diervilla lonicera*), common ninebark (*Physocarpus opulifolius* var. *opulifolius*, on mafic outcrops), mountain	Blue Ridge and very local Ridge and Valley sites, typically ranging in elevations between 3,200 and 4,000 feet.

[178] Barrens: "Areas of thin soils with scattered, sometimes scrubby, oak and pine trees and a ground layer of sedges and forbs." (USEPA, 2015c)

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		laurel (*Kalmia latifolia*), and stunted yellow birch (*Betula alleghaniensis*). Dominant herbs include cliff saxifrage (*Hydatica petiolaris*), Rand's goldenrod (*Solidago randii*), mountain sandwort (*Minuartia groenlandica*), Allegheny stonecrop (*Hylotelephium telephioides*), three-toothed cinquefoil (*Sibbaldia tridentata*), silverling (*Paronychia argyrocoma*), wavy hairgrass (*Avenella flexuosa*).	
Eastern Hemlock – Hardwood Forests	Piedmont, Ridge and Valley, Blue Ridge	Eastern hemlock (*Tsuga canadensis*) is dominant or co-dominant throughout this community. Other typical trees include sweet and yellow birches (*Betula lenta* var. *lenta* and *Betula alleghaniensis*), northern red and chestnut oaks (*Quercus rubra*) and (*Quercus montana*), and eastern white pine (*Pinus strobus*), American beech (*Fagus grandifolia*), and white oak (*Quercus alba*). Understory shrubs include mountain laurel (*Kalmia latifolia*) or Catawba rhododendron (*Rhododendron catawbiense*).	Mesic, sheltered habitats within the mountains and north-facing drainages of the Piedmont region. Old-growth hemlock forests occur on Shenandoah Mountain and Shenandoah National Park.
Montane Dry and Dry-Mesic Calcareous Forests	Ridge and Valley	Largely coniferous, mesic and steep habitats often aligned west to north upon bedrock[179] formations. Dominant or co-dominant tree is the northern white-cedar (*Thuja occidentalis*). Eastern white pine (*Pinus strobus*) and/or eastern hemlock (*Tsuga canadensis*) are often co-dominant) trees. Understory and herbaceous layers include ebony sedge (*Carex eburnea*), American barberry (*Berberis canadensis*), leatherwood (*Dirca palustris*), northern bedstraw (*Galium boreale*), and sharp-lobed hepatica (*Anemone acutiloba*).	Small isolated stands in the Ridge and Valley Province.
Carolina Hemlock Forests	Ridge and Valley, Blue Ridge	Dominant trees include chestnut oak (*Quercus montana*, = *Quercus prinus*), white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*), pines (*Pinus* spp.), and blackgum (*Nyssa sylvatica*), typically on Rocky, steep, and shallow soils.	Habitat is limited to the Ridge and Valley Province, south of the James River and a few xeric slopes of the Blue Ridge Mountains. An isolated stand is loacated in the southern Piedmont.

[179] Bedrock: "Bedrock is the rock that underlies the soil; it can be permeable or non-permeable." (USEPA, 2015c)

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
Mountain/Piedmont Acidic Woodlands	Piedmont, Blue Ridge, Ridge and Valley, Appalachians	Coniferous, mixed, and deciduous[180] woodlands typically pine-oak woodlands in xeric habitats. Dominant trees include Virginia pine (*Pinus virginiana*), shortleaf pine (*Pinus echinata*), chestnut oak (*Quercus montana*, = *Quercus prinus*), and post oak (*Quercus stellata*). Sparser populated heath shrubs and herbs include little bluestem (*Schizachyrium scoparium* var. *scoparium*), Pennsylvania sedge (*Carex pensylvanica*), poverty oatgrass (*Danthonia spicata*), and starved panic grass (*Dichanthelium depauperatum*).	Scattered stands in the inner Piedmont, northern Blue Ridge, Ridge and Valley, Cumberland Mountains, and the fall zone along the west side of the Potomac River.
Montane Dry Calcareous[181] Forests and Woodlands	Ridge and Valley, Blue Ridge, Appalachians	Deciduous and mixed forests and woodlands often located in xeric fertile habitats in steep and rocky slopes between 1,000 to 2,900 feet in elevation. Dominant overstory trees include chinquapin oak (*Quercus muehlenbergii*), sugar maple (*Acer saccharum*), black maple (*Acer nigrum*), northern red oak (*Quercus rubra*), white oak (*Quercus alba*), Shumard oak (*Quercus shumardii*), white ash (*Fraxinus americana*), and blue ash (*Fraxinus quadrangulata*. Understory and herbaceous vegetation include Carolina buckthorn (*Frangula caroliniana*), round-leaved ragwort (*Packera obovata, = Senecio obovatus*), robin's-plantain (*Erigeron pulchellus* var. *pulchellus*), American beakgrain (*Diarrhena americana*), hairy sunflower (*Helianthus hirsutus*), smooth coneflower (*Echinacea laevigata*), and Addison's leatherflower (*Clematis addisonii*).	Mountainous areas of the Ridge and Valley, Blue Ridge, and Cumberland Mountains.
Coastal Plain Dry Calcareous Forests and Woodlands	Middle Atlantic Coastal Plain, Southeastern Plains	Habitats within slightly alkaline[182] calcium-rich soils. Dominant overstory trees include chinquapin oak (*Quercus muehlenbergii*), southern sugar maple (*Acer floridanum*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), bitternut hickory (*Carya cordiformis*), American beech (*Fagus grandifolia*), white ash (*Fraxinus americana*). In areas near tidal streams overstory includes hackberries (*Celtis occidentalis* and *Celtis laevigata*).	Small localized communities on south facing slopes of drainages and bluffs of the inner Coastal Plain and steeply sloped banks along estuaries of the Coastal Plain.

[180] Deciduous: "Trees such as oaks and maples that lose their leaves during part of the year." (USEPA, 2015c)
[181] Calcareous: "Pertaining to or containing calcium carbonate." (USEPA, 2015c)
[182] Alkaline: "The condition of water or soil that contains a sufficient amount of alkali substance to raise the pH above 7.0." (USEPA, 2015c)

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		Understory vegetation include eastern red cedar (*Juniperus virginiana* var. *virginiana*), eastern redbud (*Cercis canadensis* var. *canadensis*), American holly (*Ilex opaca* var. *opaca*), buckthorn bumelia (*Sideroxylon lycioides*), and flowering dogwood (*Cornus florida*). Typical herbs include robin's-plantain (*Erigeron pulchellus* var. *pulchellus*), Bosc's panic-grass (*Dichanthelium boscii*), bearded shorthusk (*Brachyelytrum erectum*), white crownbeard (*Verbesina virginica* var. *virginica*), American bellflower (*Campanula americana*), hairy leafcup (*Smallanthus uvedalius*), whorled rosin weed (*Silphium asteriscus* var. *trifoliatum*), few-flowered tick-trefoil (*Hylodesmum pauciflorum*), and eastern needlegrass (*Piptochaetium avenaceum*).	
Oak-Hickory Woodlands and Savannas	Northern Piedmont, Piedmont	Rolling upland hills upon a granitic[183] base supporting woodland and savannah[184] habitats. Dominant overstory trees include a mix of white oak (*Quercus alba*), black oak (*Quercus velutina*), southern red oak (*Quercus falcata*), scarlet oak (*Quercus coccinea*), post oak (*Quercus stellata*), and mockernut hickory (*Carya tomentosa*). Herb layers include densely populated grasses and legumes[185] and include little bluestem (*Schizachyrium scoparium* var. *scoparium*), indian grasses (*Sorghastrum nutans* and *Sorghastrum elliottii*), broomsedges (*Andropogon virginicus* var. *virginicus*) and (*Andropogon gyrans*), poverty oatgrass (*Danthonia spicata*), and bush-clovers *Lespedeza* spp.).	Limited to endemic, fire-resistant communities at Quantico Marine Base and Fort Pickett in the Northern Piedmont and Piedmont Provinces.
Piedmont Hardpan Forests	Northern Piedmont, Piedmont	Deciduous and mixed forests underlain by mafic[186] rocks or slates with clay and silt soils. Dominant overstory trees consist of a mix of post oak (*Quercus stellata*) pignut hickory (*Carya glabra*), Carolina shagbark hickory (*Carya carolinae-septentrionalis*),	Typically distributed upon level to mild slopes Piedmont uplands and stream terraces in the Piedmont Province.

[183] Granitic: "A very hard natural igneous rock formation of visibly crystalline texture formed essentially of quartz and orthoclase or microcline." (Merriam-Webster, 2016)
[184] Savannah: "A community of grasses and other herbaceous plants with less than 50 percent tree cover." (USEPA, 2015c)
[185] Legume: "Any of thousands of plant species that have seed pods that split along both sides when ripe. Some of the more common legumes used for human consumption are beans, lentils, peanuts, peas, and soybeans. Others, such as clover and alfalfa, are used as animal feed." (USEPA, 2015c)
[186] Mafic: "Of, relating to, or being a group of usually dark-colored minerals rich in magnesium and iron." (Merriam-Webster, 2016)

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		white oak (*Quercus alba*), blackjack oak (*Quercus marilandica* var. *marilandica*), Virginia pine (*Pinus virginiana*), and white ash (*Fraxinus americana*). Typical understory trees include winged elm (*Ulmus alata*), sweetgum (*Liquidambar styraciflua*), and eastern red cedar (*Juniperus virginiana* var. *virginiana*). Shrubs and herbaceous vegetation include eastern redbud (*Cercis canadensis* var. *canadensis*), black haw (*Viburnum prunifolium*), blueberries (*Vaccinium* spp), eastern needlegrass (*Piptochaetium avenaceum*), and little-headed nutrush (*Scleria oligantha*).	
Low –Elevation Basic Outcrop Barrens	Piedmont, Blue Ridge	Sparsely populated and often stunted woodlands, scrub, and herbaceous vegetation generally located on rock outcrops or other bedrock formations, often with thin but organic soil layers. Typical species include white ash (*Fraxinus americana*), eastern red cedar (*Juniperus virginiana* var. *virginiana*), fringetree (*Chionanthus virginicus*), staghorn sumac (*Rhus typhina*), aromatic sumac (*Rhus aromatica* var. *aromatica*), and hoptree (*Ptelea trifoliata* var. *trifoliata*), eastern prickly-pear (*Opuntia humifusa* var. *humifusa*, nodding onion (*Allium cernuum*), roundleaf fameflower (*Phemeranthus teretifolius*), hairy lip fern (*Cheilanthes lanosa*), little bluestem (*Schizachyrium scoparium* var. *scoparium*), hoary mountain-mint (*Pycnanthemum incanum* var. *incanum*), lacegrass (*Eragrostis capillaris*), false pennyroyal (*Trichostema brachiatum*), Virginia dwarf-dandelion (*Krigia virginica*), and American alumroot (*Heuchera americana*).	Distributed in the Piedmont and Blue Ridge Provinces.
Limestone and Dolomite Woodlands Barrens	Ridge and Valley	Predominantly herbaceous community upon thin soils and gravels. Some barrens are located along more gentle, rolling hills. Stunted trees and shrubs include chinquapin oak (*Quercus muehlenbergii*), eastern red cedar (*Juniperus virginiana* var. *virginiana*), and Carolina buckthorn (*Frangula caroliniana*). Dominant prairie grasses include big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium* var. *scoparium*), side-oats grama (*Bouteloua curtipendula* var. *curtipendula*), and ebony	Generally located on rock outcrops and south- to west-facing rocky slopes throughout the state's western Ridge and Valley Province.

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		sedge (*Carex eburnea*). Perennial forbs[187] include western silvery aster (Canada bluets (*Houstonia canadensis*), tall blazing star (*Liatris aspera*), rattlesnake-master (*Manfreda virginica*), southern obedient-plant (*Physostegia virginiana* ssp. *praemorsa*), white blue-eyed-grass (*Sisyrinchium albidum*), low wild-petunia (*Ruellia humilis*), and stiff goldenrod (*Solidago rigida* var. *rigida*).	
Mountain/Piedmont Cliffs	Ridge and Valley, Blue Ridge, Northern Piedmont, Piedmont	On south- and west-facing cliffs, warmer microclimates[188] provide more sparsely populated woodland, scrub, and herbaceous vegetation including eastern red cedar (*Juniperus virginiana* var. *virginiana*), chinquapin oak (*Quercus muehlenbergii*), hairy mock orange (*Philadelphus hirsutus*), poison ivy (*Toxicodendron radicans* var. *radicans*), ebony sedge (*Carex eburnea*), rocktwist (*Draba ramosissima*), three-flowered melic (*Melica nitens*), and cliff-brakes (*Pellaea atropurpurea* and *Pellaea glabella* ssp. *glabella*). On cooler north-facing cliffs, common plants include northern white-cedar (*Thuja occidentalis*), basswoods (*Tilia americana* var. *americana* and var. *heterophylla*), slippery elm (*Ulmus rubra*), and wild hydrangea (*Hydrangea arborescens*). Characteristic herbs include ebony sedge (*Carex eburnea*), bulblet fern (*Cystopteris bulbifera*), cliff stonecrop (*Sedum glaucophyllum*), and northern bedstraw (*Galium boreale*).	Very steep sloped or cliff bedrock faces frequently in the Ridge and Valley Province and less common in the Piedmont Province.
Ultramafic[189] Woodlands and Barrens	Northern Piedmont, Piedmont, Blue Ridge	Gently sloped and rocky uplands with shallow, dry, mineral-rich soils. Piedmont vegetation commonly includes post oak (*Quercus stellata*), blackjack oak (*Quercus marilandica* var. *marilandica*), Virginia pine (*Pinus virginiana*), little bluestem (*Schizachyrium scoparium* var. *scoparium*). Blue Ridge occurrences are dominated by post oak, pitch pine (*Pinus rigida*), eastern white pine (*Pinus strobus*), big bluestem	Location limited to the Piedmont Province and southern Blue Ridge Plateau.

[187] Perennial forbs: "A plant which lives for more than two years." (USEPA, 2015c) "Any herbaceous plant that is not a grass." (USEPA, 2015c)
[188] Microclimate: "A climate in a small area that varies significantly from the overall climate of a region. Microclimates are formed by natural or man-made geography and topography, such as hills, buildings, and the presence or absence of trees and vegetation." (USEPA, 2015c)

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		(*Andropogon gerardii*), and balsam ragwort (*Packera paupercula* var. *paupercula*). Ultramafic barren vegetation differs considerably between both barrens. The Piedmont Barren includes little bluestem (*Schizachyrium scoparium* var. *scoparium*), Appalachian ragwort (*Packera paupercula var. appalachiana = Senecio plattensis*), and glade wild quinine (*Parthenium auriculatum*), Piedmont fameflower (*Phemeranthus piedmontanus*), and Kate's Mountain clover (*Trifolium virginicum*). The southern Blue Ridge Barren includes a mixture of upland and wetland vegetation including indian grass (*Sorghastrum nutans*), narrow-leaf mountain-mint (*Pycnanthemum tenuifolium*), and balsam ragwort (*Packera paupercula* var. *paupercula , = Senecio pauperculus*), cross-leaved milkwort (*Polygala cruciata*), twisted yellow-eyed grass (*Xyris torta*), and Virginia meadow beauty (*Rhexia virginica*).	
Riverside Outcrop Barrens	Northern Piedmont, Piedmont, Blue Ridge, Ridge and Valley	Limited vascular[190] plants, shrubs, herbaceous vegetation typically found in crevices, and humus shelves including eastern red cedar (*Juniperus virginiana* var. *virginiana*), common ninebark (*Physocarpus opulifolius* var. *opulifolius*), shrubby St. John's-wort (*Hypericum prolificum*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium* var. *scoparium*), field chickweed (*Cerastium velutinum* var. *velutinum*), and riverbank goldenrod (*Solidago rupestris*). Species limited to the Potomac Gorge west of Washington, D.C. include Nantucket serviceberry (*Amelanchier nantucketensis*), stiff-leaved aster (*Ionactis linariifolia*), balsam ragwort (*Packera paupercula* var. *paupercula , = Senecio pauperculus*), and sticky goldenrod (*Solidago racemosa*).	Xeric outcrops within the flood zone of major rivers of the Piedmont and mountain zones, notably in gorges of the Potomac, Shenandoah, and James Rivers.
Lichen/Bryophyte Nonvascular Boulderfields and Outcrops	Ridge and Valley, Blue Ridge	Dominant vegetation are lichens and bryophytes[191] on boulderfields and outcrops supporting colonies including *Umbilicaria mammulata*, *Lasallia papulosa*, golden moonglow lichen (*Dimelaena oreina*), *Cladonia rangiferina*, *Cladonia furcata*, and *Cladonia squamosa* . Vascular plants are generally limited and include evergreen wood	Within the higher elevations of the state's western Ridge and Valley and Blue Ridge mountains.

[190] Vascular: "Higher plants with vessels that conduct sap throughout the plant." (USEPA, 2015c)
[191] Bryophytes: "Any of a division (Bryophyta) of nonflowering plants comprising the mosses, liverworts, and hornworts." (Merriam-Webster, 2016)

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		fern (*Dryopteris intermedia*) and Appalachian rock polypody (*Polypodium appalachianum*).	
Maritime Dune Scrub	Middle Atlantic Coastal Plain, Southeastern Plains	Dominant scrubby species include northern bayberry (*Morella pensylvanica*), live oak (*Quercus virginiana*, southeastern Virginia), common persimmon (*Diospyros virginiana*), black cherry (*Prunus serotina* var. *serotina*), high-tide bush (*Baccharis halimifolia*, northern coast), dwarf shrub sand heather (*Hudsonia tomentosa*), Gray's flatsedge (*Cyperus grayi*), and beach pinweed (*Lechea maritima*var. *virginica*).	Typically within protected maritime[192] back dunes and leeward[193] slopes of dunes along the Atlantic coast.
Maritime Dune Woodlands	Middle Atlantic Coastal Plain, Southeastern Plains	Deciduous, coniferous, and broadleaf evergreen woodlands generally located on back dunes [194]sheltered from salt spray. Varied mix of species including live oak (*Quercus virginiana*), bluejack oak (*Quercus incana*), and sassafras (*Sassafras albidum*) dominate stands, with loblolly pine (*Pinus taeda*), black cherry (*Prunus serotina* var. *serotina*), hercules'-club (*Zanthoxylum clava-herculis*), sand heather (*Hudsonia tomentosa*), prickly-pear (*Opuntia humifusa* var. *humifusa*), and seaside little bluestem (*Schizachyrium littorale*), = *Schizachyrium scoparium ssp. littorale*). Dominant vegetation on the barrier islands [195]includes eastern redcedar (*Juniperus virginiana* var. *virginiana*), with a mix of herbaceous plants such as sea-beach needlegrass (*Aristida tuberculosa*), cottony golden-aster (*Chrysopsis gossypina*), yellow thistle (*Cirsium horridulum* var. *horridulum*), oval flowered panic grass (*Dichanthelium ovale* var. *ovale*), coastal bedstraw (*Galium hispidulum*), and grass-leaved golden-aster (*Pityopsis graminifolia* var. *latifolia*).	Maritime back dunes of the mainland and barrier islands of the eastern Atlantic shore.
Maritime Upland Forests	Middle Atlantic Coastal Plain, Southeastern Plains	Pine-dominant maritime forests with dark sand and sandy clay soils. Forest overstories include varied hardwood mixes that commonly include loblolly pine (*Pinus taeda*), black cherry (*Prunus serotina* var. *serotina*), southern red oak (*Quercus falcata*), black oak (*Quercus velutina*), and willow oak (*Quercus phellos*). Related but more sparse	Along the length of the outer Coastal Plain maritime region and barrier islands, including the Chesapeake Bay's western shore.

[192] Maritime: "Located near or next to the sea." (Merriam-Webster, 2016)
[193] Leeward: "The side that is sheltered from the wind." (Merriam-Webster, 2016)
[194] Back dune: "Dunes inland from the lakes with well-established vegetation." (USEPA, 2015c)
[195] Barrier island: "A long, narrow coastal sandy island that is above high tide and parallel to the shore, and that commonly has dunes, vegetated zones, and swampy terraces extending landward from the beach." (USEPA, 2015c)

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		understories include red maple (*Acer rubrum*), black cherry (*Prunus serotina* var. *serotina*), and sassafras (*Sassafras albidum*). Shrubs include wax myrtle (*Morella cerifera*) and highbush blueberries (*Vaccinium corymbosum*, *Vaccinium formosum*, and *Vaccinium fuscatum*). Muscadine grape (*Vitis rotundifolia* var. *rotundifolia*, and greenbriers (*Smilax rotundifolia*) and *Smilax bona-nox*).	
Sandhill and Fluvial Terrace Woodlands	Middle Atlantic Coastal Plain, Southeastern Plains	Elevated forests and woodlands upon xeric, sandy soils, located higher than adjacent swamps. Dominant trees are hickories (*Carya pallida* and *Carya tomentosa*). Drought-tolerant oaks (*Quercus falcata*, *Quercus nigra*, *Quercus marilandica* var. *marilandica*, *Quercus alba*) and pines (*Pinus taeda*, *Pinus virginiana*) occur in lesser numbers. Shrubs include sand post oak (*Quercus margarettae*), common sweetleaf (*Symplocos tinctoria*), American holly (*Ilex opaca* var. *opaca*), and eastern red cedar (*Juniperus virginiana* var. *virginiana*). Typical herbs include sedges (*Carex physorhyncha*, *Carex pensylvanica*, and *Carex tonsa*), sandhill goldenrod (*Solidago tarda*), and prickly-pear (*Opuntia humifusa* var. *humifusa*), eastern redbud (*Cercis canadensis* var. *canadensis*), wild columbine (*Aquilegia canadensis*), robin's-plantain (*Erigeron pulchellus* var. *pulchellus*), and elm-leaved goldenrod (*Solidago ulmifolia*).	Level sandy terraces and islands along the Coastal Plain rivers in eastern Virginia.
Piedmont/Mountain Floodplain Forest and Swamps	Northern Piedmont, Piedmont, Blue Ridge, Ridge and Valley	Mixed forests of river banks that are often flooded but on a temporary basis. Dominant species include silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), bitternut hickory (*Carya cordiformis*).	Located on most floodplains of rivers of the Piedmont region as well mountain valleys.
Sand/Gravel/Mud Bars and Shores	All	Small predominantly herbaceous communties with habitats that are partially submerged sometimes located on mudflats and freshwater river shorelines. Species include creeping dayflower (*Commelina diffusa*), red-root flatsedge (*Cyperus erythrorhizos*), creeping lovegrass (*Eragrostis hypnoides*), small-flower halfchaff sedge (*Lipocarpha micrantha*), common water-willow (*Justicia americana*), shade mudflower (*Micranthemum umbrosum*), warty panic grass (*Panicum verrucosum*), and coastal rose-pink (*Sabatia calycina*).	Scattered throughout the state, often well-developed along larger rivers.

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
Rocky Bar and Shores	Northern Piedmont, Piedmont, Blue Ridge, Ridge and Valley, Appalachians	Habitats occur within cobble[196] and boulder bars and shores and islands with sloped streams where flood scouring[197] occurs. Vegetation includes woodland and herbaceous species such as common water-willow (*Justicia americana*), twisted sedge (*Carex torta*), sycamore (*Platanus occidentalis*), river birch (*Betula nigra*), green ash (*Fraxinus pennsylvanica*), and American hornbeam (*Carpinus caroliniana* ssp. *virginiana*).	Located in the Piedmont and throughout Virgina mountains.
Riverside Prairies[198]	Northern Piedmont, Piedmont	Savanna-type growth of grasses, forbs, small trees, typically located above the mean tide[199] level of temporarily inundated [200]boulder bars, which include stunted green ash (*Fraxinus pennsylvanica*), big bluestem (*Andropogon gerardii*), indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum* var. *virgatum*), little bluestem (*Schizachyrium scoparium* var. *scoparium*), and narrow-leaf mountain-mint (*Pycnanthemum tenuifolium*).	Potomac River, west of Washington D.C. and James River near the Blue Ridge.
Coastal Plain/Piedmont Bottomland Forests	Middle Atlantic Coastal Plain, Southeastern Plains, Piedmont, Northern Piedmont	Well-drained forest and swamp species include swamp chestnut oak (*Quercus michauxii*), cherrybark oak (*Quercus pagoda*), shagbark hickory (*Carya ovata*), deciduous holly (*Ilex decidua* var. *decidua*), water hickory (*Carya aquatica*), and bitternut hickory (*Carya cordiformis*).	Forests located on seasonally flooded river terraces and floodplains of the Coastal Plain and Piedmont provinces.
Mountain/Piedmont Seepage[201] Swamps	Appalachians, Ridge and Valley, Blue Ridge	Saturated coniferous or mixed forests associated with streams, headwaters,[202] springs, and drainages above elevations of 3,000 feet. Tree species include eastern hemlock (*Tsuga canadensis*), yellow birch (*Betula alleghaniensis*), red maple (*Acer rubrum*), and red spruce (*Picea rubens*). Shrub layers include great rhododendron (*Rhododendron maximum*) and mountain laurel (*Kalmia latifolia*). Herbaceous species include eastern rough sedge (*Carex scabrata*),	Higher elevations of the western portion of the state.

[196] Cobble: "Rock chunks made of durable rock generally 5 to 25 cm (2 to 10 inches) in diameter." (USEPA, 2015c)
[197] Scouring: "Material removed by scouring [of flood waters]." (USEPA, 2015c) (Merriam-Webster, 2016)
[198] Prairie: "A large, mostly flat area of land in North America that has few trees and is covered in grasses." (Merriam-Webster, 2016)
[199] Mean tide: "Same as half tide level." "A tidal datum. The arithmetic mean of mean high water and mean low water. Same as mean tide level." (NOAA, 2016)
[200] Inundated: "To cover (something) with a flood of water." (Merriam-Webster, 2016)

[202] Headwater: "The upper watershed area where streams generally begin; typically consists of 1st- and 2nd-order streams." (USEPA, 2015c)

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		slender mannagrass (*Glyceria melicaria*), cinnamon fern (*Osmundastrum cinnamomeum* var. *cinnamomeum*), and American false-hellebore (*Veratrum viride*).	
Appalachian Bogs	Blue Ridge, Ridge and Valley	Often saturated woodlands, shrubs, ad herbaceous vegetation in bogs[203] of no greater than 10 acres, often at headwater streams and groundwater seepages along gently sloping valley floors of mountain regions. Species include great rhododendron (*Rhododendron maximum*), Catawba rhododendron (*Rhododendron catawbiense*), cinnamon fern (*Osmundastrum cinnamomeum* var. *cinnamomeum*), tawny cottongrass (*Eriophorum virginicum*), pitch pine (*Pinus rigida*), and bog willow-herb (*Epilobium leptophyllum*).	Southern Blue Ridge Mountains and southwestern Ridge and Valley provinces.
Montane Depression Swamps and Ponds	Blue Ridge, Ridge and Valley	Seasonally flooded basin wetlands situated on ridge crests, landslide benches, and the base of alluvial fans. Dominant wetlands species include buttonbush (*Cephalanthus occidentalis*), three-way sedge (*Dulichium arundinaceum* var. *arundinaceum*), common mermaid-weed (*Proserpinaca palustris*), Canada mannagrass (*Glyceria canadensis*), highbush blueberry (*Vaccinium corymbosum*), red maple (*Acer rubrum*) and blackgum (*Nyssa sylvatica*), and cinnamon fern (*Osmundastrum cinnamomeum* var. *cinnamomeum*).	Often located in the mountainous areas of the Ridge and Valley and Blue Ridge Mountain provinces.
Calcareous Fens[204]and Spring Marshes	Ridge and Valley	A mix of predominantly shrubs and herbaceous vegetation often located on hillsides, spring seeps, and prarie-like wetlands often saturated by perched groundwater. Species include smooth alder (*Alnus serrulata*), swamp rose (*Rosa palustris*), several sedges (e.g., *Carex flava*, *Carex hystericina*, *Carex interior*, *Carex suberecta*, *Carex tetanica*), bristly-stalk sedge (*Carex leptalea* var. *leptalea*), royal fern (*Osmunda spectabilis*), and golden ragwort (*Packera aurea = Senecio aureus*).	Smaller wetlands are located in the western part of the state, primarily in the Ridge and Valley province.
Mafic Fens and Seeps	Blue Ridge	Saturated wetlands occurring on weathered rock-based soils. Smaller patches of vegetation can include open woodlands, shublands, and herbaceous species such as	Located in the southern Blue Ridge Plateau and northern Blue Ridge regions.

[203] Bog: "A type of wetland that accumulates appreciable peat deposits. Bogs depend primarily on precipitation for their water source, and are usually acidic and rich in plant residue with a conspicuous mat of living green moss." (USEPA, 2015c)
[204] Fen: "Low land that is covered wholly or partly with water unless artificially drained and that usually has peaty alkaline soil and characteristic flora (as of sedges and reeds)." (Merriam-Webster, 2016)

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		red maple (*Acer rubrum*), eastern white pine (*Pinus strobus*), smooth alder (*Alnus serrulata*), meadowsweets (*Spiraea latifolia* and *Spiraea tomentosa*), stiff dogwood (*Cornus racemosa*), common ninebark (*Physocarpus opulifolius* var. *opulifolius*), maleberry (*Lyonia ligustrina* var. *ligustrina*), spicebush (*Lindera benzoin* var. *benzoin*), and alder-leaved buckthorn (*Rhamnus alnifolia*).	
Spray Cliffs	Appalachian Highlands, Ridge and Valley, Blue Ridge	Located on wet rock faces within spray and splash zones of waterfalls or sheltered saturated cliffs. Dominant plants include mosses and liverworts.[205] Species include brook saxifrage (*Boykinia aconitifolia*), small enchanter's night-shade (*Circaea alpina* ssp. *alpina*), small-flowered alumroot (*Heuchera parviflora*), rock clubmoss (*Huperzia porophila*), saxifrages (*Micranthes caroliniana* and *Micranthes micranthidifolia*), and mountain meadow-rue (*Thalictrum clavatum*).	Very few sites are scattered throughout the mountain regions of the state with large, constant waterfalls or staturated cliffs.
Inland Salt Marshes	Ridge and Valley	Remnant inland salt marshes fed by saline[206] springs, with water salinity varying over time. Species include saltmarsh bulrush (*Bolboschoenus robustus – Scirpus robustus*), black-grass rush (*Juncus gerardii*), dwarf spikerush (*Eleocharis parvula*), halberd-leaf orach (*Atriplex prostrata*), jointed glasswort (*Salicornia virginica*), orange jewelweed (*Impatiens capensis*), and swamp rose-mallow (*Hibiscus moscheutos*).	Limited to a small mountain valley near Saltville, Smyth County, in the Ridge and Valley region.
Coastal Plain Depression Swamps and Ponds	Middle Atlantic Coastal Plain, Southeastern Plains, Piedmont	Basin wetlands with poor drainage located on flat terraces with changing perched water tables. Species include red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), swamp tupelo (*Nyssa biflora*), willow oak (*Quercus phellos*), overcup oak (*Quercus lyrata*), bald cypress (*Taxodium distichum*) and (*Cephalanthus occidentalis*).	Located at Grafton Ponds on The Peninsula of York County, the Great Dismal Swamp, the eastern Piedmont, and Coastal Plain terraces.
Coastal Plain/Piedmont Seepage Bogs	Middle Atlantic Coastal Plain, Southeastern Plains, Piedmont	Open, acidic soil wetlands that predominantly include saturated shrubs and herbaceous vegetation. Species include sweetbay (*Magnolia virginiana*), poison sumac (*Toxicodendron vernix*), smooth alder (*Alnus serrulata*), beakrushes (*Rhynchospora* spp.), bushy bluestem (*Andropogon glomeratus* var. *glomeratus*), yellow-eyed-grasses (*Xyris*	Located in the non-maritime Coastal Plain region and outer Piedmont. Healthy communities exist on military bases with incendiary burning sustains

[205] Liverworts: "Any of a class (Hepaticae) of bryophytic plants characterized by a thalloid gametophyte or sometimes an upright leafy gametophyte that resembles a moss." (Merriam-Webster, 2016)
[206] Saline (salinity): "The relative concentration of dissolved salts, usually sodium chloride, in a given water." (USEPA, 2015c)

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		spp.), and vervain thoroughwort (*Eupatorium pilosum*).	the necessary ecological process.
Piedmont Upland Depression Swamps	Piedmont, Northern Piedmont	Wetland vegetation that often occurs on shallow, temporarily flooded upland[207] basins as well as along small streams and stream bottoms, often underlain by mafic rocks or slates.[208] Species include pin oak (*Quercus palustris*), swamp white oak (*Quercus bicolor*), red maple (*Acer rubrum*), overcup oak (*Quercus lyrata*), climbing common greenbrier (*Smilax rotundifolia*), sedges (*Carex festucacea* and *Carex albolutescens* in the southern Piedmont, and *Carex pellita* in the northern Piedmont).	Scattered in the eastern and central Piedmont region.
Non-Riverine Flatwoods and Swamps	All	Forests exposed to seasonal flooding and/or saturation, often with changing groundwater conditions. Species include mixtures of swamp chestnut oak (*Quercus michauxii*), cherrybark oak (*Quercus pagoda*), willow oak (*Quercus phellos*), laurel oak (*Quercus laurifolia*), red maple (*Acer rubrum*), American hornbeam (*Carpinus caroliniana*), switch cane (*Arundinaria tecta*), American holly (*Ilex opaca* var. *opaca*), sweet pepperbush (*Clethra alnifolia*), sweetbay magnolia (*Magnolia virginiana*), coastal dog-hobble (*Leucothoe axillaris*), and highbush blueberries (*Vaccinium* spp.), netted chain fern (*Woodwardia areolata*), red maple (*Acer rubrum*), blackgum (*Nyssa sylvatica*), red bay (*Persea palustris*), coastal dog-hobble (*Leucothoe axillaris*), and south of the James River, switch cane (*Arundinaria tecta*).	
Pond Pine Woodlands and Pocosins	Middle Atlantic Coastal Plain, Southeastern Plains	Coniferous, highly flammable[209] woodlands typically located on saturated peatlands. Dominant species include stunted pond pine (*Pinus serotina*), switch cane (*Arundinaria tecta*), inkberry (*Ilex glabra*), Carolina laurel (*Kalmia carolina*), laurel-leaf greenbrier (*Smilax laurifolia*), and Virginia chain fern (*Woodwardia virginica*).	Located in southeastern region of the state in the Coastal Plain. Largest community occurrence is in the Great Dismal Swamp Nation Wildlife Refuge.
Peatland Atlantic White-Cedar Forests	Middle Atlantic Coastal Plain, Southeastern Plains	Coniferous forests limited to saturated Coastal Plain peatlands and non-riverine wetland flats. Common species include Atlantic white-cedar (*Chamaecyparis thyoides*), big gallberry (*Ilex coriacea*), inkberry (*Ilex glabra*), shining fetterbush	Endemic to southeastern portion of the state.

[207] Upland: "An area of the terrestrial environment that does not have direct interaction with surface waters." (USEPA, 2015c)
[208] Slate: "Type of hard rock that splits easily into thin layers." (Merriam-Webster, 2016)
[209] Flammable: "Describes any material that can be ignited easily and that will burn rapidly." (USEPA, 2015c)

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		(*Lyonia lucida*), and poison ivy (*Toxicodendron radicans* var. *radicans*).	
Sea-Level Fens	Middle Atlantic Coastal Plain	Maritime seepage wetlands situated above the normal highest tide levels and along the foot of slopes with groundwater discharges. Common species include red maple (*Acer rubrum*), blackgum (*Nyssa sylvatica*), sweetbay magnolia (*Magnolia virginiana*), twig-rush (*Cladium mariscoides*), beaked spikerush (*Eleocharis rostellata*), and water sundew (*Drosera intermedia*).	Limited in the state to four sites along the Atlantic Coast, on the Eastern Shore of Accomack County.
Maritime Swamps	Middle Atlantic Coastal Plain, Southeastern Plains	Near-estuarine maritime wetlands often located at back-dune hollows and inlets that include seasonally saturated forests and woody vegetation, often exposed to wind and salt spray. Species include black willow (*Salix nigra*), wax myrtle (*Morella cerifera*), inkberry (*Ilex glabra*), highbush blueberries (*Vaccinium* spp.), whorled marsh-pennywort (*Hydrocotyle verticillata*), cranberry (*Vaccinium macrocarpon*), and bushy bluestem (*Andropogon glomeratus* var. *glomeratus*).	Dispersed along the outer Coastal Plain from the Eastern Shore to Cape Henry and False Cape, the barrier islands, and both shores of the Chesapeake Bay.
Interdune Swales and Ponds	Middle Atlantic Coastal Plain	Maritime grassland and shrubland communities occur in very low flats or depressions on maritime dunes, often subject to perched water conditions or temporary flooding from both freshwater and salt water sources. Species include saltmeadow cordgrass (*Spartina patens*), rushes (*Juncus scirpoides*), sedges (*Cyperus odoratus* var. *odoratus*, *Fimbristylis caroliniana*, *Schoenoplectus pungens* var. *pungens*), slender flat-top goldenrod (*Euthamia caroliniana*), long-leaved aster (*Symphyotrichum novi-belgii*, - *Aster novi-belgii*), and Richard's yellow-eyed grass (*Xyris jupicai*).	Location limited to Eastern Shore, behind barrier beaches.
Tidal Oligohaline Marshes	Middle Atlantic Coastal Plain, Southeastern Plains	Slightly brackish wetlands species include big cordgrass (*Spartina cynosuroides*), dotted smartweed (*Persicaria punctata*), arrow-arum (*Peltandra virginica*), and swamp rose-mallow (*Hibiscus moscheutos*).	Tidal streams and rivers of the Coastal Plain.
Wind-Tidal Oligohaline Marshes	Middle Atlantic Coastal Plain, Southeastern Plains	Herbaceous wetlands subject to wind-influenced flooding, often closed inlets separated by ocean influences. Species include big cordgrass (*Spartina cynosuroides*), black needlerush (*Juncus roemerianus*), switchgrass (*Panicum virgatum* var. *virgatum*), horned beaksedge	Mid-Atlantic Embayed Region in the southeastern portion of the state.

Vegetative Community Type	USEPA Ecoregion(s)	Description	Distribution
		(*Rhynchospora macrostachya*), swamp rose-mallow (*Hibiscus moscheutos*), few-flower milkweed (*Asclepias lanceolata*), and white water-lily (*Nymphaea odorata* ssp. *odorata*).	
Tidal Swamp Forests and Woodlands	Middle Atlantic Coastal Plain, Southeastern Plains	Coniferous or mixed swamp woodlands and forests sometimes located between tidal marshes and non-tidal uplands. Dominant species include bald cypress (*Taxodium distichum*) and shoreline sedge (*Carex hyalinolepis*).	Located in upper tidal regions of southeastern rivers.
Tidal Freshwater and Oligohaline Aquatic Beds	Middle Atlantic Coastal Plain, Southeastern Plains, Piedmont	Herbaceous vegetation is limited to small tributaries, creeks, pools along freshwater and sections of tidal rivers. Species include common hornwort (*Ceratophyllum demersum*), western waterweed (*Elodea nuttallii*), greater duckweed (*Spirodela polyrrhiza*), and narrow-leaved spatterdock (*Nuphar sagittifolia*).	Noted occurrences in the southeastern portion of the state along wind-tidal rivers and tributaries as well as freshwater tributaries.
High-Energy Tidal River Shores	Middle Atlantic Coastal Plain, Southeastern Plains	Herbaceous vegetation often in small patches, generally exposed at low tide. Species include common threesquare bulrush (*Schoenoplectus pungens* var. *pungens*), soft-stem bulrush (*Schoenoplectus tabernaemontani*), Parker's pipewort (*Eriocaulon parkeri*), and dotted smartweed (*Persicaria punctata*).	Distribution occurs in narrow tidal flats, shores, and channels, typically in the low intertidal zone.

Source: (VDCR, 2017b)

ACRONYMS

Acronym	Definition
AARC	Average Annual Rate of Change
ACHP	Advisory Council on Historic Preservation
ACS	American Community Survey
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
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
BYA	Billion Years Ago
CAA	Clean Air Act
CCD	Common Core of Data
CCMP	Comprehensive Conservation and Management Plan
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CGP	Construction General Permit
CH_4	Methane
CHO	Charlottesville-Albemarle Airport
CIMC	Cleanups in My Community
CIO	Chief Information Officer
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COLT	Cell On Light Trucks
COMLINK	Commonwealth Link to Interoperable Communications
COW	Cell On Wheels
CRS	Community Rating System
CWA	Clean Water Act
CWS	Community Water Systems
CZM	Coastal Zone Management
DACA	Deployable Aerial Communications Architecture
DCA	Washington National Airport
DCR	Department of Conservation and Recreation
DEQ	Department of Environmental Quality
DHR	Department of Historic Resources
DMME	Department of Mines, Minerals, and Energy
DMV	Department of Motor Vehicles
DOAV	Department of Aviation
DOE	Department of Energy
DRPT	Department of Rail and Public Transportation
DVRS	Digital Vehicular Repeater System
EDACS	Enhanced Digital Access System

Acronym	Definition
EIA	Energy Information Agency
EMS	Emergency Medical Services
EO	Executive Order
EPCRA	Emergency Planning and Community Right to Know Act
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FCC	Federal Communication Commission
FDMA	Frequency Division Multiplexing
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
FR	Federal Register
FRA	Federal Railroad Administration
FTA	Federal Transit Authority
FSDO	Flight Standards District Offices
FSS	Flight Service Station
GAO	Government Accountability Office
GHG	Greenhouse Gas
GNIS	Geographic Names Information System
H_2S	Hydrogen Sulfide
HAP	Hazardous Air Pollutant
HASP	Health and Safety Plans
HHRA	Human Health Risk Assessment
IAD	Washington Dulles International Airport
IBA	International Birding Area
IFR	Instrument Flight Rules
IPCC	Intergovernmental Panel On Climate Change
ISMP	Invasive Species Management Plan
ISWG	Invasive Species Working Group
IV&D	Integrated Voice and Data
LBS	Locations-Based Services
LCCS	Land Cover Classification System
LID	Low Impact Development
LMR	Land Mobile Radio
LRR	Land Resource Regions
LTE	Long Term Evolution
LYH	Lynchburg Regional/Preston Glen Field
MBTA	Migratory Bird Treaty Act
MDI	Methylene Diphenyl Diisocyanate
MHI	Median Household Income
MLRA	Major Land Resource Areas
MOA	Memorandum of Agreement
MMPA	Marine Mammal Protection Act
MMT	Million Metric Tons
MSFCMA	Magnuson-Stevens Fisheries Conservation Management Act
MSHA	Mine Safety and Health Administration
MSL	Mean Sea Level
MSW	Municipal Solid Waste
MT	Million Tons

Acronym	Definition
MTN	Microwave Transmission Network
MWAA	Metropolitan Washington Airports Authority
MYA	Million Years Ago
N_2O	Nitrous Oxide
NA	Not Applicable
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
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
NIH	National Institute of Health
NIST	National Institute of Standards and Technology
NIT	Norfolk International Terminals
NM	Nautical Miles
NNL	National Natural Landmarks
NNMT	Newport News Marine Terminal
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notices To Airmen
NO_X	Oxides of Nitrogen
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	New Source Review
NTIA	National Telecommunications and Information Administration
NTFI	National Task Force On Interoperability
NTNC	Non-Transient Non-Community
NWI	National Wetlands Inventory
NWR	National Wildlife Refuges
NWS	National Weather Service
OC	Optical Carrier
OCIO	Office of the CIO
OE/AAA	Obstruction Evaluation and Airport Airspace Analysis
ORF	Norfolk International Airport
OSHA	Occupational Safety and Health Administration
OTR	Ozone Transport Region
PAB	Palustrine Aquatic Bed
PEIS	Programmatic Environmental Impact Statement
PEM	Palustrine Emergent Wetland
PFO	Palustrine Forested Wetland

Acronym	Definition
PGA	Peak Ground Acceleration
PHF	Newport News/Williamsburg International Airport
PM	Particulate Matter
PMT	Portsmouth Marine Terminal
POP	Points of Presence
POR	Port of Richmond
PPE	Personal Protective Equipment
PSAP	Public Safety Answering Point
PSCR	Public Safety Communications Research
PSD	Prevention of Significant Deterioration
PSS	Palustrine Scrub-Shrub Wetland
PUB	Palustrine Unconsolidated Bottom
R&D	Research and Development
RACOM	Radio Communications
RCRA	Resource Conservation and Recovery Act
RF	Radio Frequency
RIC	Richmond International Airport
ROA	Roanoke Regional / Woodrum Field
ROW	Right-of-Way
SAA	Sense and Avoid
SAIPE	Small Area Income and Poverty Estimates
SASP	State Aviation System Plan
SCC	State Corporation Commission
SDS	Safety Data Sheets
SDWA	Safe Drinking Water Act
SF_6	Sulfur Hexafluoride
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SIRS	Statewide Interdepartmental Radio System
SO_2	Sulfur Dioxide
SO_3	Sulfur Trioxide
SOC	Standard Occupational Classification
SONET	Synchronous Optical Network
SOP	Standard Operating Procedures
SOW	System On Wheels
SO_X	Oxides of Sulfur
SPHQ	State Police Headquarters
SPL	Sound Pressure Level
SRS	Statewide Radio System
STARS	Statewide Agencies Radio System
SUA	Special Use Airspace
SWPPP	Storm Water Pollution Prevention Plan
THPO	Tribal Historic Preservation Office
TMDL	Total Maximum Daily Load
TPY	Tons Per Year
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average
UA	Unmanned Aircraft
UAS	Unmanned Aircraft Systems
UHF	Ultra High Frequency
USACE	U.S. Army Corps of Engineers

Acronym	Definition
USDA	U.S. Department of Agriculture
USDOI	U.S. Department of Interior
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
VA	Virginia
VAAAQS	Virginia Ambient Air Quality Standards
VADEQ	Virginia Department of Environmental Quality
VADMME	Virginia Department of Mines Minerals and Energy
VDCR	Virginia Department of Conservation and Recreation
VDEM	Virginia Department of Emergency Management
VDEQ	Virginia Department of Environmental Quality
VDGIF	Virginia Department of Game and Inland Fisheries
VDH	Virginia Department of Health
VDMME	Virginia Department of Mines, Minerals, and Energy
VDOLI	Virginia Department of Labor and Industry
VDOT	Virginia Department of Transportation
VFR	Visual Flight Rules
VHF	Very High Frequency
VMRC	Virginia Marine Resources Commission
VNHP	Virginia Natural Heritage Program
VOC	Volatile Organic Compounds
VOSH	Virginia Occupational Safety and Health
VPDES	Virginia Pollutant Discharge Elimination System
VPP	Voluntary Protection Program
VRE	Virginia Railway Express
VWAP	Virginia Wildlife Action Plan
VWP	Virginia Water Protection
WMATA	Washington Metropolitan Area Transit Authority
WMA	Wildlife Management Areas
WWI	World War I
WWII	World War II

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