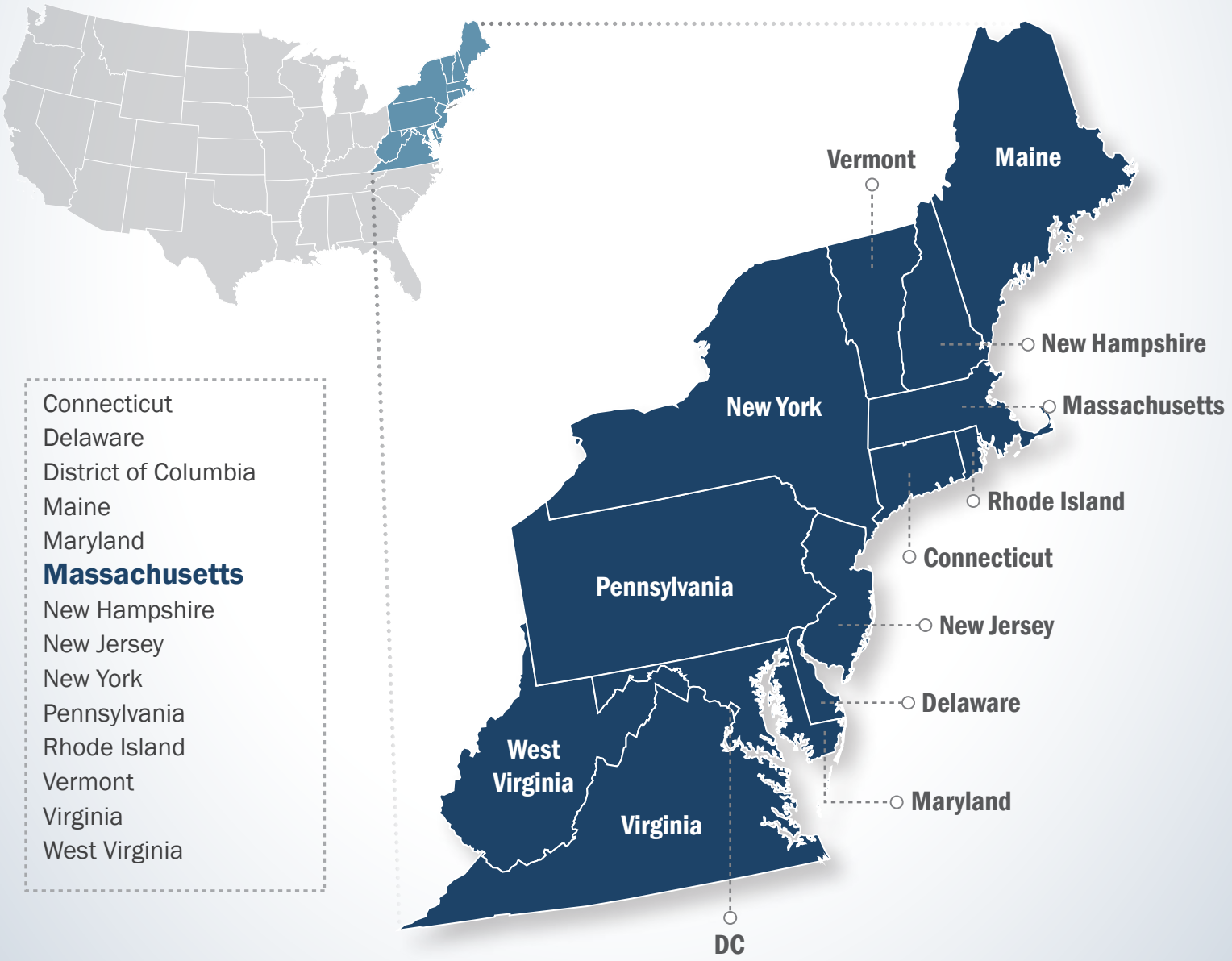
FirstNet®

Nationwide Public Safety Broadband Network

Draft Programmatic Environmental Impact Statement for the Eastern United States

VOLUME 6 - CHAPTER 8



APRIL 2016

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First Responder Network Authority

FirstNet®

Nationwide Public Safety Broadband Network

Draft Programmatic Environmental Impact Statement for the Eastern United States

VOLUME 6 - CHAPTER 8

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

April 2016

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8. MASSACHUSETTS

The Mayflower pilgrims established the first colony in Massachusetts at Plymouth Rock in 1620. Massachusetts was the site of many important historical events, including the Boston Massacre, the Boston Tea Party, and the first battle of the Revolutionary War (Secretary of the Commonwealth of Massachusetts, 2011). Located in the northeastern United States, Massachusetts is bordered by Vermont and New Hampshire in the north, Connecticut and Rhode Island in the south, and New York in the west. This chapter provides details about the existing environment of Massachusetts as it relates to the Proposed Action.

General facts about Massachusetts are provided below:

- **State Nickname**: The Bay State
- **Area:** 10,554 square miles; **U.S. Rank**: 44 (U.S. Census Bureau, 2010a)
- **Capital:** Boston
- **Counties:** 14 (Secretary of the Commonwealth of Massachusetts, 2011)
- **Estimated Population:** Over 6.7 million people; **U.S. Rank:** 15 (U.S. Census Bureau, 2015a)
- **Most Populated Cites:** Boston, Worcester, and Springfield (U.S. Census Bureau, 2015a)
- **Main Rivers:** Connecticut River, Merrimack River, Blackstone River, Mystic River, Charles River, and Taunton River
- **Bordering Waterbodies:** Cape Cod Bay, Nantucket Sound, and the Atlantic Ocean
- **Mountain Ranges:** Berkshire Hills and Blue Hills
- **Highest Point:** Mt. Greylock (3,491 ft.) (Secretary of the Commonwealth of Massachusetts, 2011)

8.1. AFFECTED ENVIRONMENT

8.1.1. Infrastructure

8.1.1.1. Definition of the Resource

This section provides information on key Massachusetts 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 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).

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." Massachusetts is a typical U.S. state with developed population centers that demand high levels of infrastructure, connected by various levels of transportation infrastructure, most notably highly developed road, rail, and air travel systems.

The traffic and transportation infrastructure in Massachusetts includes road and rail networks, airport facilities, and ports and harbors. The description of existing transportation systems in Massachusetts are based on a review of maps, aerial photography, and federal and state data sources. Transportation in Massachusetts is presented in more detail in Section 8.1.1.3.

Massachusetts 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 Massachusetts are presented in more detail in Section 8.1.1.4.

Telecommunication resources in Massachusetts can be divided into two primary categories: specific public safety communications infrastructure and commercial telecommunications infrastructure. Telecommunications throughout the state are based on a variety of publicly and commercially owned technologies, and may include coaxial cable (traditional copper cable), fiber optics, hybrid fiber optics/coaxial cable, microwave, wireless, and satellite systems providing voice, data, and video services. Section 8.1.1.4 presents details on communications resources in Massachusetts.

Utilities typically consist of the power, water, sewer, transit, and telecommunications systems that are essential to support daily operations in the state. Changes in land use, population density, and development usually generate changes in the demand for and supply of utilities. Utilities in Massachusetts are presented in more detail in Section 8.1.1.6 (telecommunications resources are presented in Section 8.1.1.5, as noted above).

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

8.1.1.2. Specific Regulatory Considerations

Multiple Massachusetts laws and regulations pertain to the state's public utility and transportation infrastructure and its public safety community. Table 8.1.1-1 identifies the relevant laws and regulations, the affected agencies, and their jurisdiction as derived from the state's applicable statutes and administrative rules referenced in column one. Appendix C, Environmental Laws and Regulations, identifies applicable federal laws and regulations.

Table 8.1.1-1: Relevant Massachusetts Infrastructure Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
General Laws of Massachusetts: Chapter 22C Department of State Police; Chapter 22D Department of Fire Services	Massachusetts Fire Service Commission	Oversees the development of a comprehensive law enforcement and criminal justice plan; operates and maintains the public safety information system
220 Code of Massachusetts Regulations (CMR) Department of Public Utilities	Department of Public Utilities	Regulates water, gas, electric, steam distribution, telecommunications and cable utilities, and motor carriers; oversees the safety of railroad tracks; (forbears from regulating of Voice over Internet protocol (VoIP) service or IP-enabled services)
740 CMR Massachusetts Port Authority	Registry of Motor Vehicles	Administers transportation policies, planning, and programs related to design, construction, maintenance, operations, and financing of highways and roads, passenger and freight rail, public transportation, aviation, shipping, and water transportation; controls and operates the state highway system, the metropolitan highway system, and the turnpike
360 CMR Massachusetts Water Resources Authority	Water Resources Management Advisory Committee	Ensures an adequate volume and quality of water for all citizens of the commonwealth; preserves and controls watershed and water supply systems; defines and delineates river basins and governs the interbasin transfer of waters; promotes water conservation

Sources: (Commonwealth of Massachusetts, 2015a) (Massachusetts Judicial Branch, 2016)

8.1.1.3. Transportation

This section describes the traffic and transportation infrastructure in Massachusetts, including specific information related to the road networks, airport facilities, rail networks, harbors, and ports. The movement of vehicles is commonly referred to as traffic, as well as the circulation along roads. Roadways can range from multilane road networks with asphalt surfaces to unpaved gravel or private roads. The information regarding existing transportation systems in Massachusetts are based on a review of maps, aerial photography, and federal and state data sources.

The Massachusetts Department of Transportation (MassDOT) has jurisdiction over freeways and major roads, airports, railroads, mass transit, and ports in the state; local counties have jurisdiction for local streets and roads. The mission of the MassDOT is to "deliver excellent customer service to people who travel in the Commonwealth, and to provide our nation's safest and most reliable transportation system in a way that strengthens our economy and quality of life" (MassDOT, 2015a).

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

- Over 36,000 miles of road (MassDOT, 2015b) and over 5,000 bridges (MassDOT, 2014);
- 1,139 miles of rail network that includes passenger rail and freight (MassDOT, 2010);
- 223 aviation facilities that includes both public and private airports (FAA, 2015a);
- 76 harbors (US Harbors, 2015); and
- 5 major ports that includes both public and private facilities (MassDOT, 2013a).

Road Networks

As identified in Figure 8.1.1-1, the major urban centers of the state are Boston-Worcester in the east and Springfield in the west (USGS, 2013a). Massachusetts has five 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. Table 8.1.1-2 lists the interstates and their starting and ending points in Massachusetts. Per the national standard, even numbered interstates run from west to east with the lowest numbers beginning in the west; odd numbered interstates run from north to south with the lowest numbers beginning in the south (USDOT, 2015).

Table 8.1.1-2: Massachusetts Interstates

Interstate	Southern or Western Terminus in MA	Northern or Eastern Terminus in MA
I-84	CT line at Holland	I-90 in Sturbridge
I-90	NY line at West Stockbridge	Route 1A in Boston
I-91	CT line at Longmeadow	VT line at Bernardston
I-93	I-95 in Canton	NH line at Methuen
I-95	RI line at Attleboro	NH line at Salisbury

In addition to the Interstate System, Massachusetts 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 8.1.1-1 illustrates the major transportation networks, including roadways, in Massachusetts. Section 8.1.8, Visual Resources, describes the National and State Scenic Byways found in Massachusetts from an aesthetic perspective.

National Scenic Byways are roads with nationwide interest. These byways are designated and managed by the U.S. Department of Transportation's Federal Highway Administration. Massachusetts has one National Scenic Byway:

- Connecticut River Byway: 498.7 miles following the Connecticut River through the western section of Massachusetts (FHWA, 2015a).

Massachusetts State Scenic Byways are roads with statewide interest and are designated and managed by MassDOT. Massachusetts has 12 State Scenic Byways, in addition to the Connecticut River Byway, that crisscross the entire state (MassDOT, 2011):

- Battle Road Scenic Byway
- Blackstone Canal Heritage Highway
- Chappaquiddick Road
- Essex Coastal Scenic Byway
- Jacob's Ladder Trail
- Minuteman Highway
- Mohawk Trail
- Mount Greylock Scenic Byway
- Route 112 Scenic Byway
- Route 116 Scenic Byway
- Route 122 Scenic Byway
- Taconic Trail

Airports

Air service to the state is provided by one major international airport. Boston Logan International Airport (BOS) is owned and operated by the Massachusetts Port Authority (Massport). The state legislature created Massport as an independent public authority in 1959 (Massport, 2015a). Boston Logan International Airport is the largest airport not only in Massachusetts, but also in New England; it generates $7 billion (B) annually in economic activity (Massport, 2015b). In 2014, Boston Logan International Airport facilitated 181,920 inbound flights and 181,977 outbound flights, for a total of 363,797 flights in that year (Massport, 2014). The airport served 31,634,445 passengers on all flights and handled 585,459,955 pounds of freight in 2014 (Massport, 2014). Figure 8.1.1-1 illustrates the major transportation networks, including airports, in the state. Section 8.1.7, Land Use, Recreation, and Airspace, provides greater detail on airports and airspace in Massachusetts.

Rail Networks

Massachusetts has multiple rail corridors with high levels of commercial and commuter rail traffic. These major rail corridors extend from Boston to Attleboro, Middleborough, Kingston, Greenbush, Forge Park, Newburyport, Gallagher, Fitchburg, and Springfield, as well as Springfield to other major cities in New England. There are also a number of other rail corridors that join these major rail lines and connect with other cities. (MassDOT, 2010)

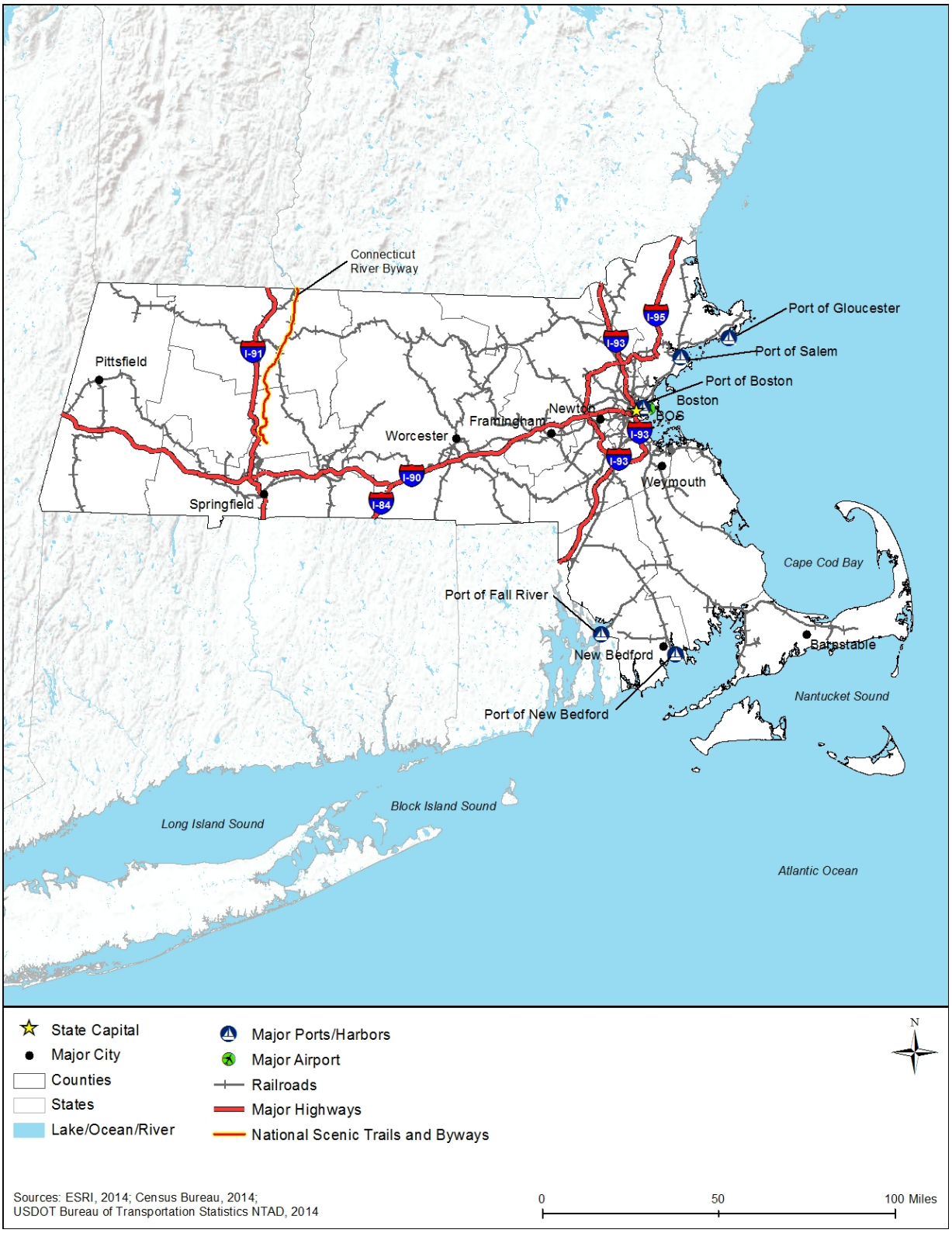


Figure 8.1.1-1: Massachusetts Transportation Networks

Source: (BTS, 2014)

Massachusetts is connected to a vast rail network of passenger rail (Amtrak), public transportation (commuter rail), and freight rail. MassDOT provides oversight and management of the Massachusetts Bay Transportation Authority (MBTA) and the 15 Regional Transit Authorities in the state (MassDOT, 2014). Figure 8.1.1-1 illustrates the major transportation networks, including rail lines, in Massachusetts.

Amtrak runs numerous lines throughout Massachusetts, including the Acela Express and Northeast Regional, which is a popular line, with routes running from Washington, D.C. to Boston in 6 hours 40 minutes and 7 hours 50 minutes, respectively. Amtrak serves three different stations in Boston: Back Bay, North Station, and South Station. Table 8.1.1-3 provides a complete list of Amtrak lines that run through Massachusetts.

Table 8.1.1-3: Amtrak Train Routes Serving Massachusetts

Route	Starting Point	Ending Point	Length of Trip	Cities Served in Massachusetts
Acela Express	Boston, MA	Washington, D.C.	6 hours 40 minutes	Boston
Downeaster	Brunswick, ME	Boston, MA	3 hours 25 minutes	Boston
Lake Shore Limited	Boston, MA	Chicago, IL	19 hours	Boston, Worcester, Springfield
Northeast Regional	Boston, MA	Virginia Beach, VA	12 hours 30 minutes	Boston, Springfield
Vermonter	St. Albans, VT	Washington, D.C.	13 hours 45 minutes	Springfield

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

The MBTA operates in and around Boston with a fleet of 2,500 trains and buses (MassDOT, 2014). The MBTA provides the following rail services on 885 miles of track: light rail (street-level trains to suburbs and subway through center city), heavy rail (core subway service), and commuter rail (longer distance to suburbs) (MassDOT, 2014). The MBTA serves over 1.3 million passengers daily, making it one of the largest public transportation agencies in the nation (MassDOT, 2014).

MassDOT and the MBTA own 41 percent of the rail network, and 59 percent is owned by private rail carriers (MassDOT, 2010). The state has 14 freight railroads that operate on over 1,000 miles of track (MassDOT, 2015b). These freight railroads carry over 18 million tons of cargo in over 450,000 train cars (MassDOT, 2015b).

Harbors and Ports

Much of eastern Massachusetts is coastal, which lends itself to the development of ports and harbors. A number of ferry services connect the towns and islands of coastal Massachusetts, such as the ferries running from Hyannis on the mainland to the islands of Nantucket and Martha's Vineyard. Ferries also run from Oak Bluffs on the island of Martha's Vineyard to harbors in Woods Hole, New Bedford, and Falmouth (MassDOT, 2012). These small harbors boast ferries and other commercial attractions but are dwarfed by the state's shipping ports. Massachusetts is home to five major shipping ports, situated on the bays that dot the eastern end of the state. The Port of Gloucester and the Port of Salem are in the northeast of the state, while the ports of New Bedford and Fall River lie to the south. The largest of the five is the Port of

Boston, situated on the Boston Harbor in the middle of eastern Massachusetts. The locations of these ports can be found in Figure 8.1.1-1.

The Port of Gloucester is the north-most port in the state, found on the Gloucester Harbor. The Port of Gloucester offers boat repair services, cruise terminals and a marina (Gloucester MA, 2015). The port also does a minimal amount of shipping, as evidenced by the U.S. Census Bureau. In 2013, the port imported $400,000 in trade goods and exported goods worth $1.5 million (M) (U.S. Census Bureau, 2015b). The Port of Salem is the second deepest of Massachusetts' ports, and is home to an electrical power plant. The port is located on Salem Harbor and offers service to recreational, cruise and shipping vessels (Salem MA, 2015). In 2013, the Port of Salem was responsible for the import of 199,000 tons of goods, worth $16.7M. The same year, $700,000 worth of goods weighing 300 tons was exported through the Port of Salem (U.S. Census Bureau, 2015b).

The Port of New Bedford is located on an inlet of Buzzards Bay on the southern end of Massachusetts. The Port of New Bedford is visited by about 300 vessels each year, bringing refrigerated goods such as fish or other products (Port of New Bedford, 2015). In 2013, the port was responsible for $3.4M in imports. The Census Bureau lists minimal exports for that year (U.S. Census Bureau, 2015b). However, the cargo that is shipped from the Port of New Bedford is sent to locations in Canada, Europe, and Africa. The port is home to commercial fishing vessels, ferry services, shipyards, cruise ships and a host of other tenants (Port of New Bedford, 2015). The Port of Fall River can be found on the Mt. Hope Bay, southeast of the city of Providence, RI. The Port of Fall River is an important shipping port, having imported $38.8M worth of trade goods in 2013. U.S. Census data indicates that the port was responsible for $600,000 in exports that year.

The Port of Boston, found on the Massachusetts Bay, is the largest port in the state. The Port of Boston's public terminals are operated by Massport, who also owns and operates 500 acres of property in the surrounding Boston neighborhoods. The natural gas and petroleum terminals at the port are the source of over 90 percent of the state's fossil fuel requirements (Massport, 2015c). Between August of 2014 and July of 2015, the port handled 38,625 automobiles, 340,163 cruise ship passengers, and 150,395 short tons of cement, a 5.9 percent increase over the previous year. In that same timeframe, the port handled nearly two million short tons of containerized cargo (Massport, 2015d). According to U.S. Census data, the Port of Boston imported $9.9B in goods, weighing 9.6 million kg. It also exported 1.4 million kg of goods, worth $1.2M.

8.1.1.4. Public Safety Services

Massachusetts 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 roughly follows key state demographic indicators. Table 8.1.1-4 presents Massachusetts's key demographics including population; land area; population density; and number of counties, cities/towns, and municipal governments. More information about these demographics is presented in Section 8.1.9, Socioeconomics.

Table 8.1.1-4: Key Massachusetts Indicators

Massachusetts Indicators	
Estimated Population (2014)	6,745,408
Land Area (square miles) (2010)	7,800
Population Density (persons per sq. mile) (2010)	839.4
Municipal Governments (2013)	45

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

Table 8.1.1-5 presents Massachusetts's public safety infrastructure, including fire and police stations. Table 8.1.1-6 identifies first responder personnel including dispatch, fire and rescue, law enforcement, and emergency medical personnel in the state.

Table 8.1.1-5: Public Safety Infrastructure in Massachusetts by Type

Infrastructure Type	Number
Fire and Rescue Stations	1,159
Law Enforcement Agencies	325
Fire Departments	797

Source: (National Fire Department Census, 2015)

Table 8.1.1-6: First Responder Personnel in Massachusetts by Type

First Responder Personnel	Number
Police, Fire and Ambulance Dispatchers	2,800
Fire and Rescue Personnel	16,890
Law Enforcement Personnel	57,545
Emergency Medical Technicians and Paramedics	6,660

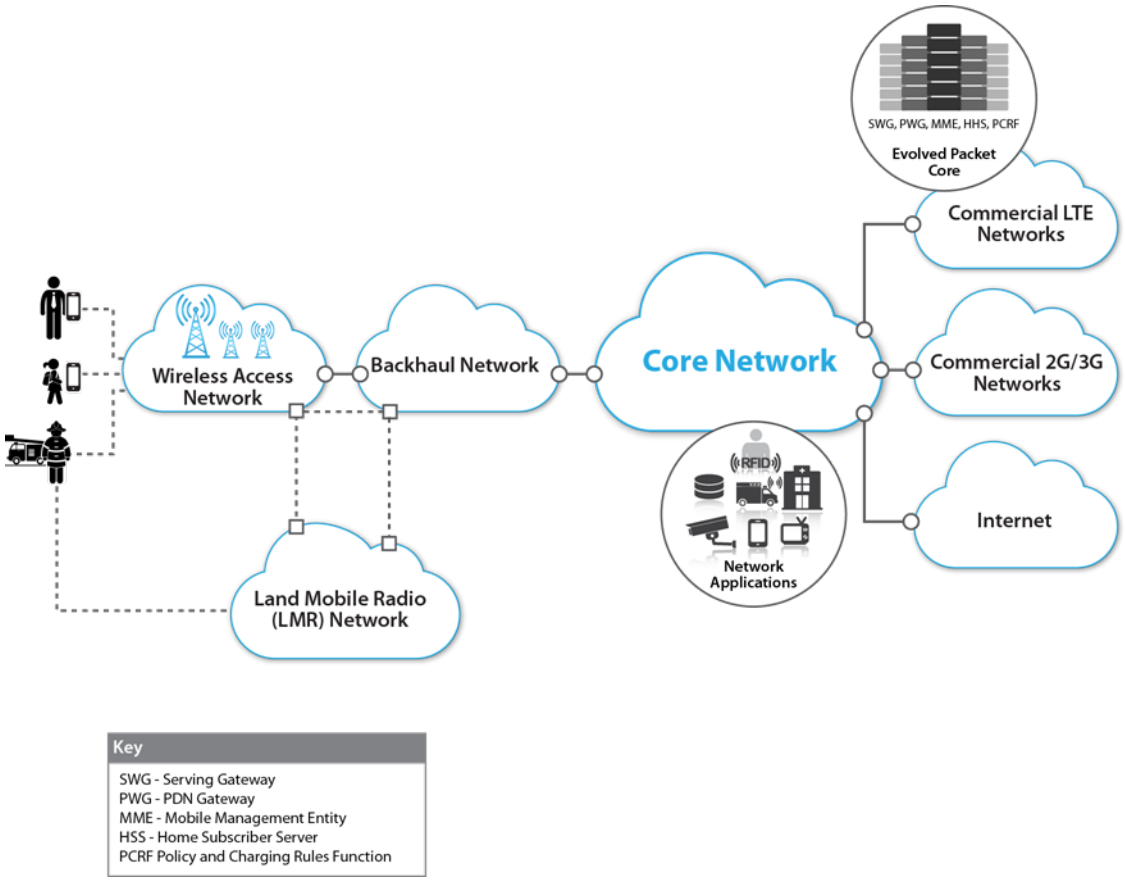
Sources: (National Fire Department Census, 2015) (BLS, 2015a)

8.1.1.5. Telecommunications Resources

Telecommunication resources in Massachusetts 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 Massachusetts 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 8.1.1-2 presents a typical wireless configuration including both a narrowband public safety land mobile radio network (traditional radio network) and a commercial broadband access network (wireless technology); backhaul (long-distance wired or wireless connections), core, and commercial networks including a long-

term evolution (LTE) evolved packet core (modern broadband cellular networks); and network applications (software) delivering voice, data, and video communications (FCC, 2016a).



Prepared by: Booz Allen Hamilton

Figure 8.1.1-2: Wireless Network Configuration

Public Safety Communications

In order to protect and best serve the public interest, first responder and law enforcement communities must be able to communicate effectively. The evolution of the communications networks used by public safety stakeholders toward a broadband wireless technology, such as long term evolution (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). 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 Massachusetts.

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 dissimilar Land Mobile Radio networks into a nationwide public safety LTE broadband network, the U.S. Department of Commerce (DOC) Public Safety Communications Research Program (PSCR) – Boulder Laboratories, in 2015, prepared a locations-based services (LBS) research and development 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 Massachusetts reflect a combination of older Low-band and High-Band Very High Frequency (VHF)[2] and Ultra High Frequency (UHF)[3] analog[4] radios operating across multiple frequencies bands as well as 700 Megahertz (MHz) and 800 MHz analog and digital[5] wireless radios and infrastructure (Massachusetts Executive Office of Public Safety and Security, 2007).

Massachusetts's 2007 Statewide Communications Interoperability Plan (SCIP) called attention to three significant, challenging conditions regarding public safety communications, network modernization, and communications interoperability in the state: (1) a large number of cities and towns with across the state's 14 counties (50 cities and 351 towns; see Figure 8.1.1-3 and Figure 8.1.1-4); (2) geographic and agency diversity across the sub-regions, as Figure 8.1.1-3 illustrates; and, (3) the splitting of the state into five discrete regions (Figure 8.1.1-5) by the Department of Homeland Security, which does not necessarily correlate with public safety radio networks coverage and infrastructure, and makes coordination complex (Massachusetts Executive Office of Public Safety and Security, 2007).

Within this jurisdictional construct, governance and operational responsibility for public safety networks and emergency management communications in Massachusetts varies based on multiple factors, including: state and local service needs, legacy regional and local network

[2] VHF band covers frequencies ranging from 30 MHz to 300 MHz. (NTIA, 2005)

[3] UHF band covers frequencies ranging from 300 MHz to 3000 MHz. (NTIA, 2005)

[4] Analog networks are those based on circuit switching, which establishes a connection and then maintains it through the whole communication. Although now digitized, the nation's original telephone system is an example of an analog network.

[5] Digital networks are those that allow for simultaneous digital transmission of voice, data, video, and other network services over the traditional public-switched telephone network, or over new 3G, 4G, or LTE wireless networks.

responsibilities, scope of service territory and required network coverage, and mission-centric agency communications (e.g. police, fire, EMS dispatch, and tactical communications).

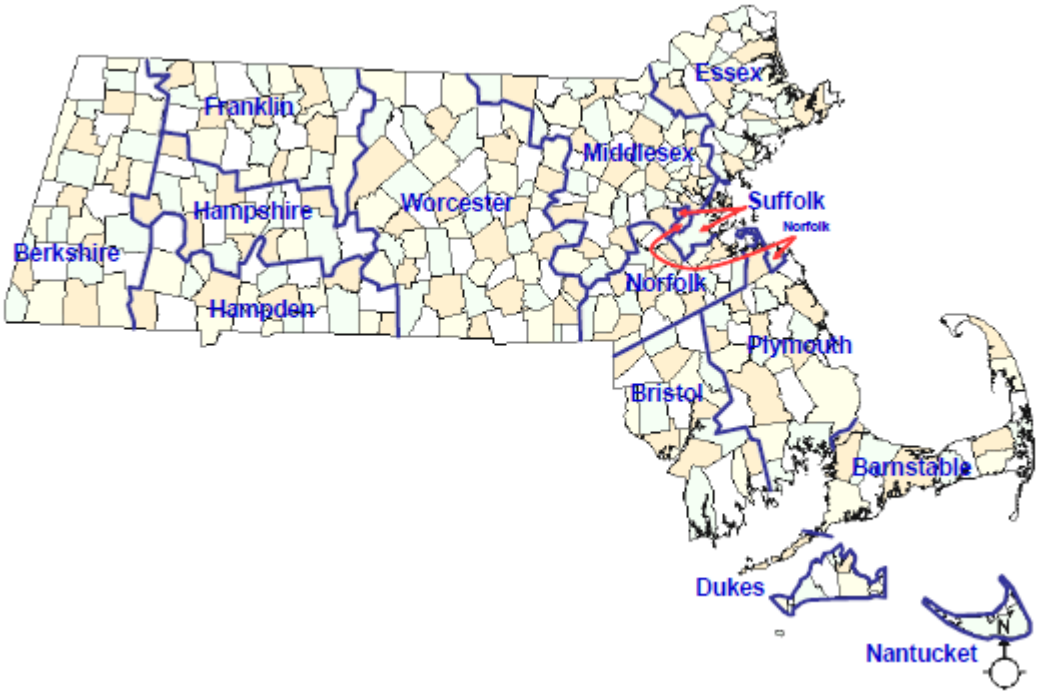


Figure 8.1.1-3: Massachusetts Counties and Towns

Source: (EOPSS, 2007)

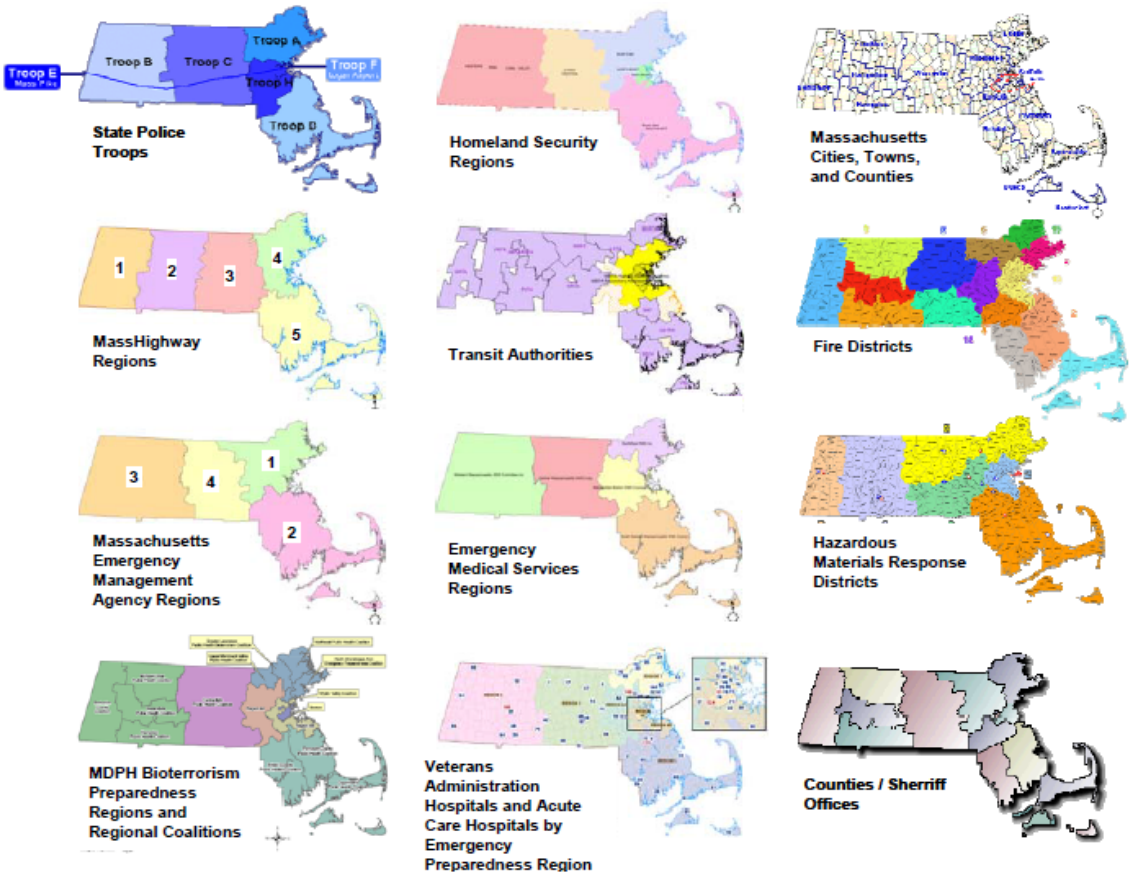


Figure 8.1.1-4: Massachusetts Agency Regions and Districts

Source: (VA, 2015)

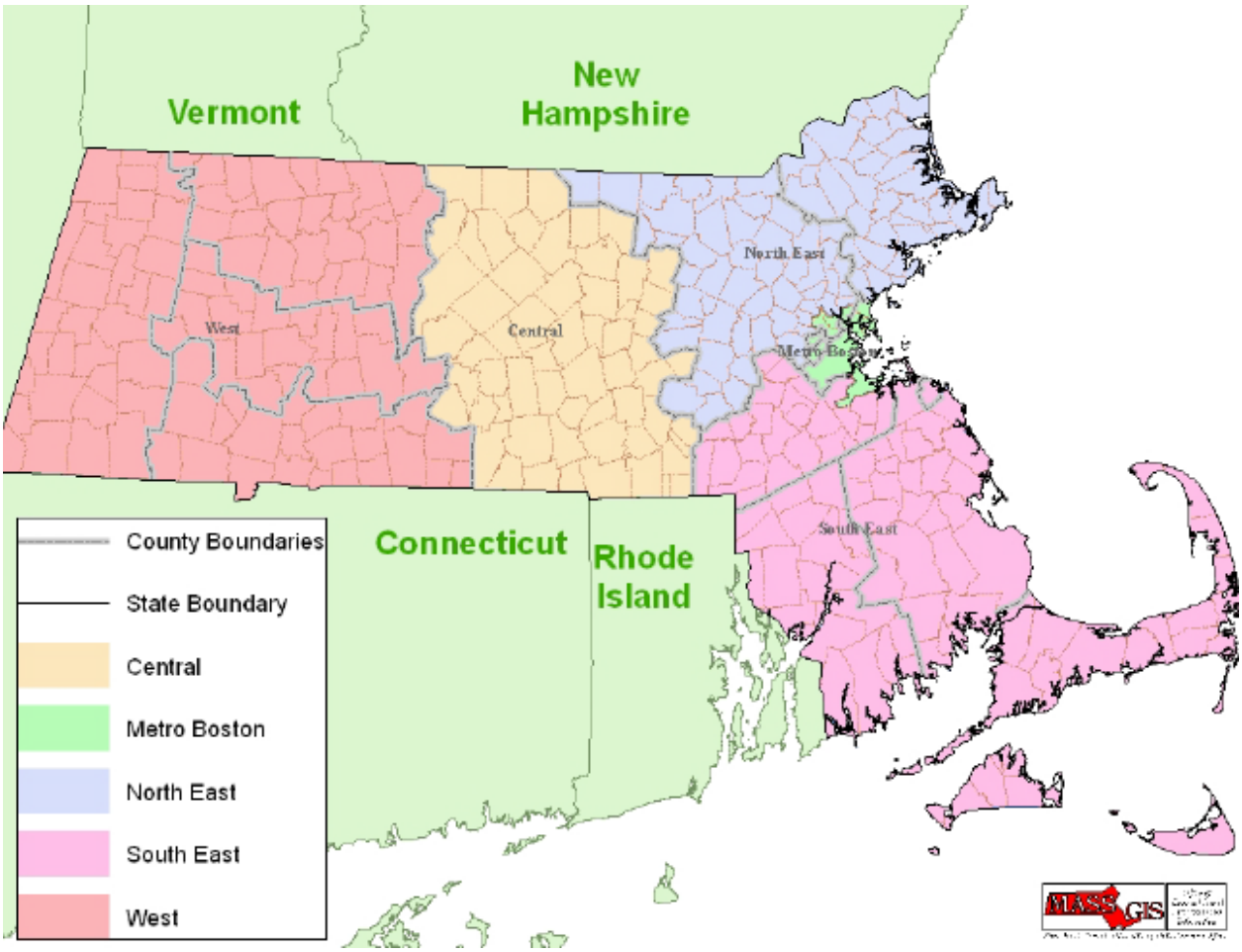


Figure 8.1.1-5: Commonwealth of Massachusetts Five Homeland Security Regions

Source: (EOPSS, 2007)

Statewide Networks

There are two statewide wireless networks used by public safety organizations: (1) the Commonwealth of Massachusetts's digital Project-25 800 MHz network, and (2) the Massachusetts State Police Association of Public-Safety Communications Officials (APCO) P-25 800 MHz network. The Commonwealth's P-25 800 MHz network is a digital system serving[6] all regions of the state and is used by public safety agencies and other state agencies such as MassDOT and the Department of Public Works. The network provides police and fire dispatch and tactical communications, interoperable local public safety talk group capability and EMS/hospital talk-group and dispatch communications. (Massachusetts Executive Office of Public Safety and Security, 2007)

The Massachusetts State Police operate the APCO P-25 800 MHz network, which supports statewide communications, mutual aid talk groups, and local police and fire/EMS communications, as well as a variety of non-public safety agency communications including the

[6] An APCO digital communications standard based on Frequency Division Multiplexing.

Mass Water Resources Authority. The Massachusetts State Police also maintain an older analog trunked system east of the Connecticut River and Greylock, which provides multi-county coverage (Massachusetts Executive Office of Public Safety and Security, 2007).

Regional Networks

The Greater Boston Police Council, Inc. (GPC) maintains the regional Boston Area Police Emergency Radio Network (BAPERN), which serves eastern Massachusetts. The BAPERN is a key regional public safety inter-operational radio system in eastern Massachusetts serving a wide range of public safety users at the city/town and county/regional level (Plymouth County Sheriff's Dept, 2015). Figure 8.1.1-6 presents the BAPERN network's coverage. The BAPERN network supports over 120 member agencies with wide area and local tactical communications (Plymouth County Sheriff's Dept, 2015). The network operates in the UHF frequency band (VA, 2015).

Another key regional network in Massachusetts is the Coordinated Medical Direction (CMED) system, which provides radio links to connect ambulances with wireline hospital links. The system is maintained by the Regional CMED organization. According to the Massachusetts 2007 SCIP, the CMED provides communication between ambulances and hospitals in Massachusetts and is controlled and facilitated by a communications center in each EMS Region referred to as CMED. "Each CMED region is responsible for maintaining and operating CMED capability in its respective area. Each CMED Center acts as a switchboard, or router, connecting the wireless. Ambulance radio link with a wireline (telephone) hospital link." (Massachusetts Executive Office of Public Safety and Security, 2007). The CMED wireless network operates on VHF and UHF frequencies and, in 2007, its network operated on 44 radio transmitter sites supporting 57 base stations using 8 UHF pairs and two VHF channels (VA, 2015).

Regional networks have been upgraded individually over time, resulting in a somewhat uneven application of technology across the state. For example, in 2010, the Massachusetts Technology Park received a Broadband Technologies Opportunity Program (BTOP) grant for Western Massachusetts, which resulted in the deployment of 949 miles of new fiber and an additional 231 miles of leased fiber. The grant benefited 370 public safety Community Anchor Institution (CAI) agencies which were upgraded with 1 Gigabit Ethernet high-speed service (BLS, 2015a).

Local City and Town Networks

The majority of police and fire agencies operate on high-band VHF (150-162 MHz) and UHF low band (450-470 MHz) frequencies. A number of jurisdictions use 800 MHz systems either citywide, as is the case with the city of Worchester, or take advantage of regional systems such as the Massachusetts State Police 800 MHz system or the VHF low band system.

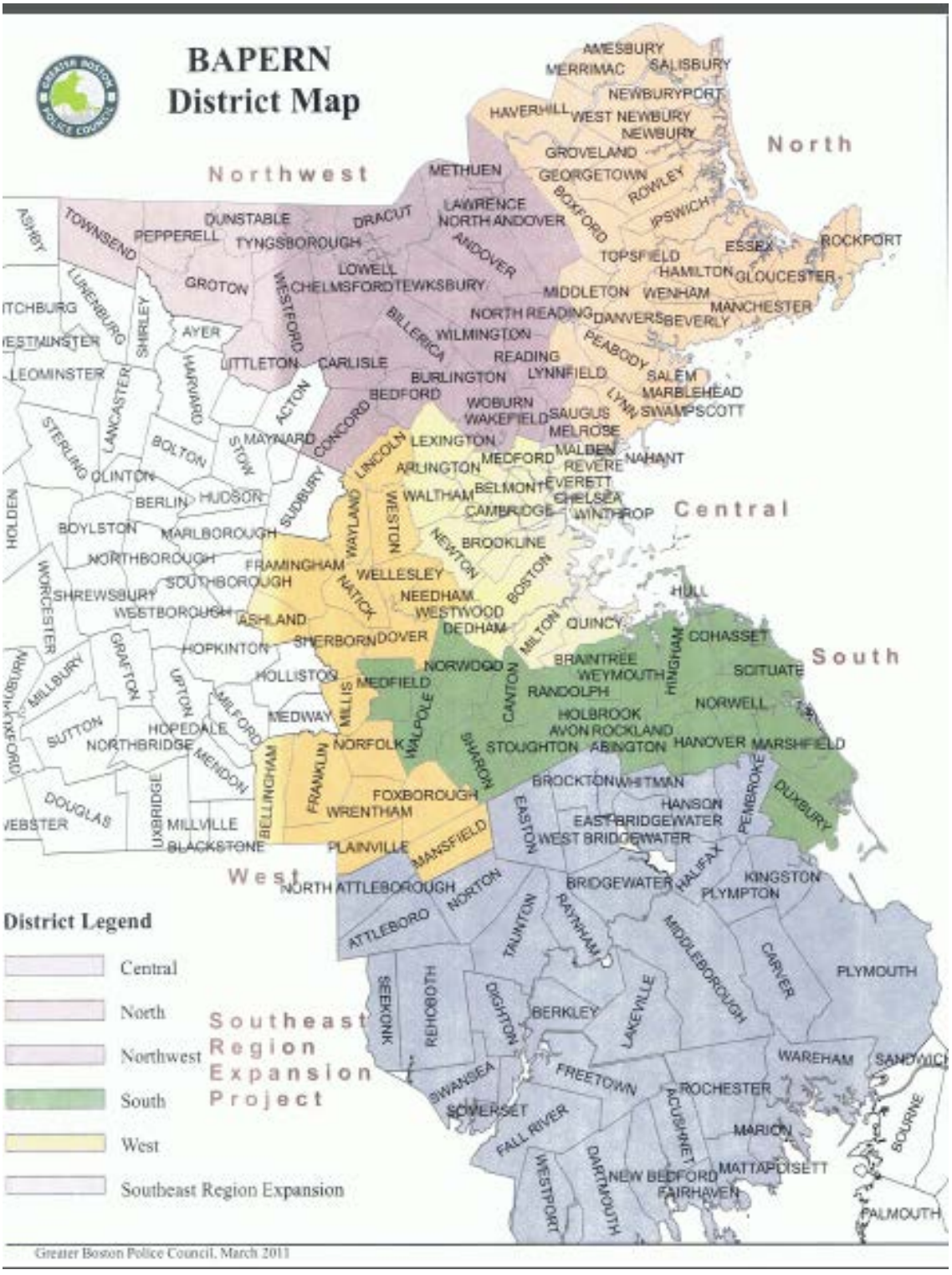


Figure 8.1.1-6: BAPERN Areas Served

Source: (Plymouth County Sheriff's Dept, 2015)

Public Safety Answering Points (PSAP)

Similar to most other states, 9-1-1 dispatch and PSAP system oversight is the responsibility of the Executive Office of Public Safety, but dispatch and system responsibility lies with a combination of local police/emergency communications centers, the Massachusetts State Police, and city/town personnel. According to the Federal Communication Commission's (FCC) Master PSAP registry, there are 270 Primary PSAPs in Massachusetts (FCC, 2015b). These centers are operated through by a combination of State Police, local police, county emergency services, and military emergency communications dispatch facilities throughout the state.

Commercial Telecommunications Infrastructure

Massachusetts' 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 Massachusetts' 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

Massachusetts'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. Table 8.1.1-7 presents the number of providers of switched access[7] lines, Internet access[8], and mobile wireless services including coverage.

Table 8.1.1-7: Telecommunications Access Providers and Coverage in Massachusetts as of December 31, 2013

Commercial Telecommunications Access Providers	Number of Service Providers	Coverage
Switched access lines	145	98% of households
Internet access	52	79% of households
Mobile Wireless	7	103% of population

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

Table 8.1.1-8 shows the wireless providers in Massachusetts along with their geographic coverage. The following four maps, Figure 8.1.1-7, Figure 8.1.1-8, Figure 8.1.1-9, and Figure 8.1.1-10, show: i) the combined coverage for the top two providers, AT&T and Verizon

[7] "A service connection between an end user and the local telephone company's switch; the basis of plain old telephone services. (POTS)" (FCC, 2014a)
[8] Internet access includes DSL, cable modem, fiber, satellite, and fixed wireless providers.

Wireless; ii) USAT's coverage; iii) Sprint's and T-Mobile's coverage; and iv) MetroPCS's and the coverage of all other providers with less than 5% coverage area, respectively.

Table 8.1.1-8: Wireless Telecommunications Coverage by Providers in Massachusetts

Wireless Telecommunications Providers	Coverage
AT&T Mobility	100%
Verizon Wireless	94%
USAT	94%
Sprint Nextel	74%
T-Mobile	61%
MetroPCS	56%
Other[a]	6.17%

Source: (NTIA, 2014)

[a] Other: Provider with less than 5% coverage area. Providers include: WiSpring; USAi.net; Warwick Broadband Service; Country Road Networks, Inc; PMLDnet.com; netBlazr; Chappy WISP.

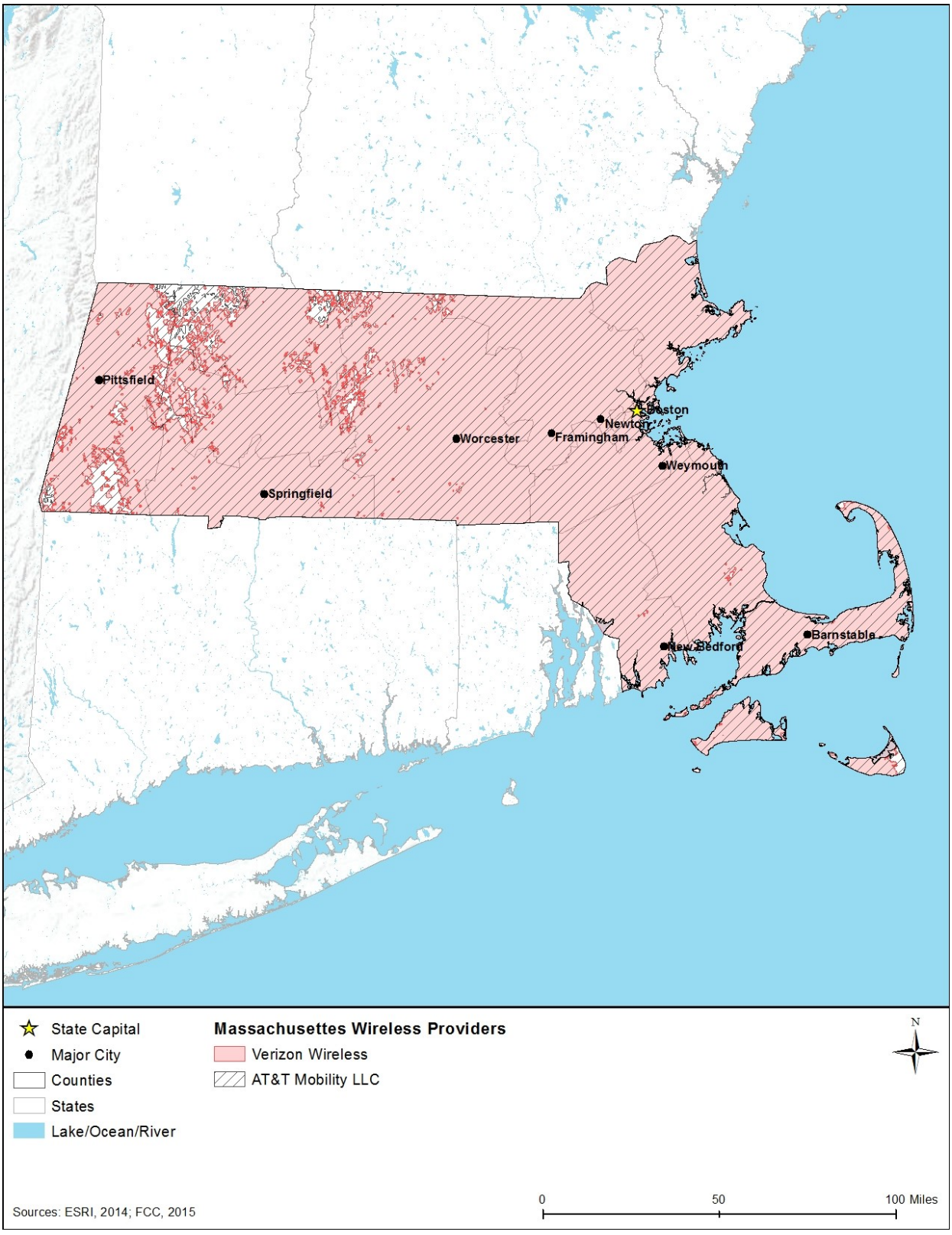


Figure 8.1.1-7: AT&T and Verizon Wireless Availability in Massachusetts

Source: (NTIA, 2014)

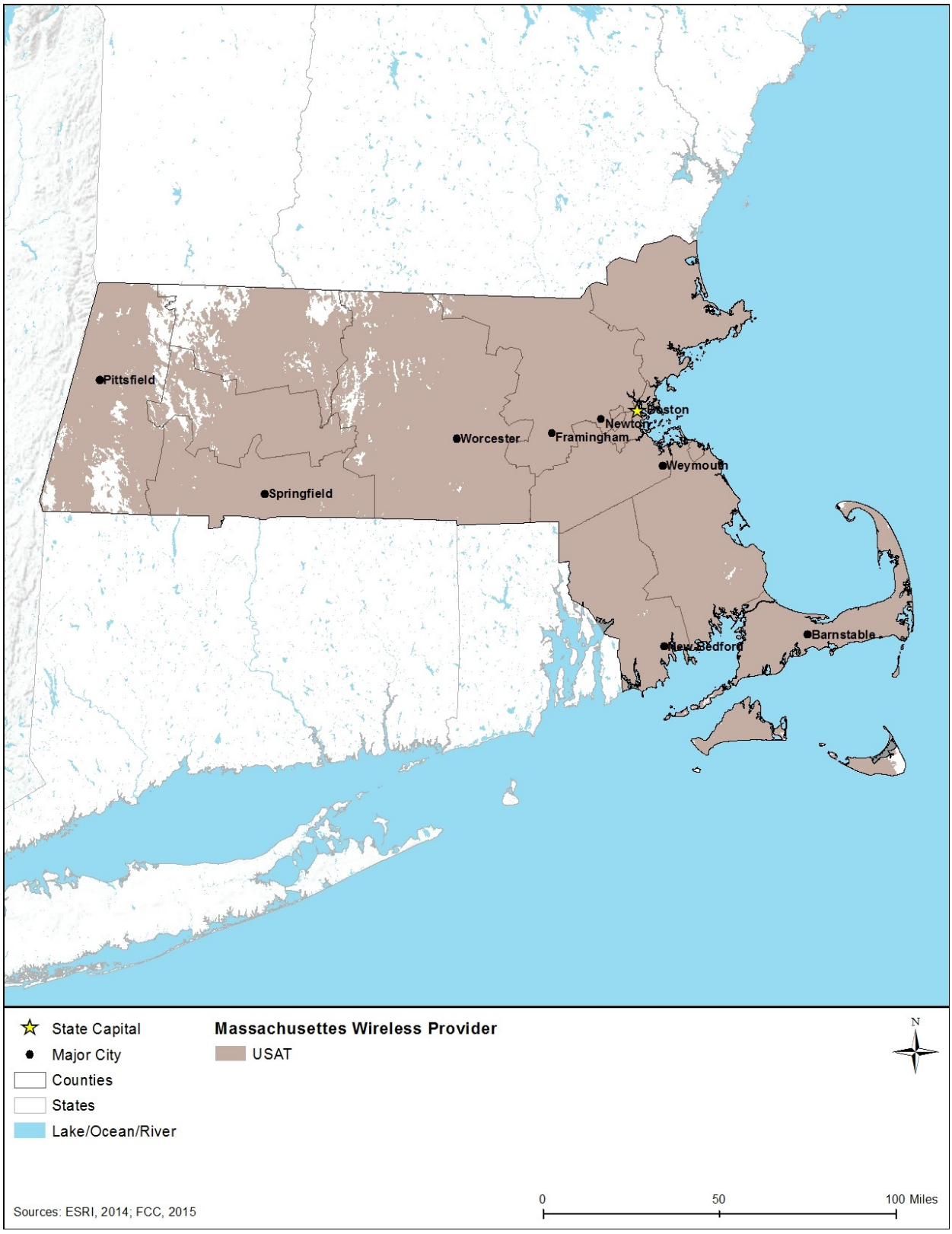


Figure 8.1.1-8: USAT Wireless Availability in Massachusetts

Source: (NTIA, 2014)

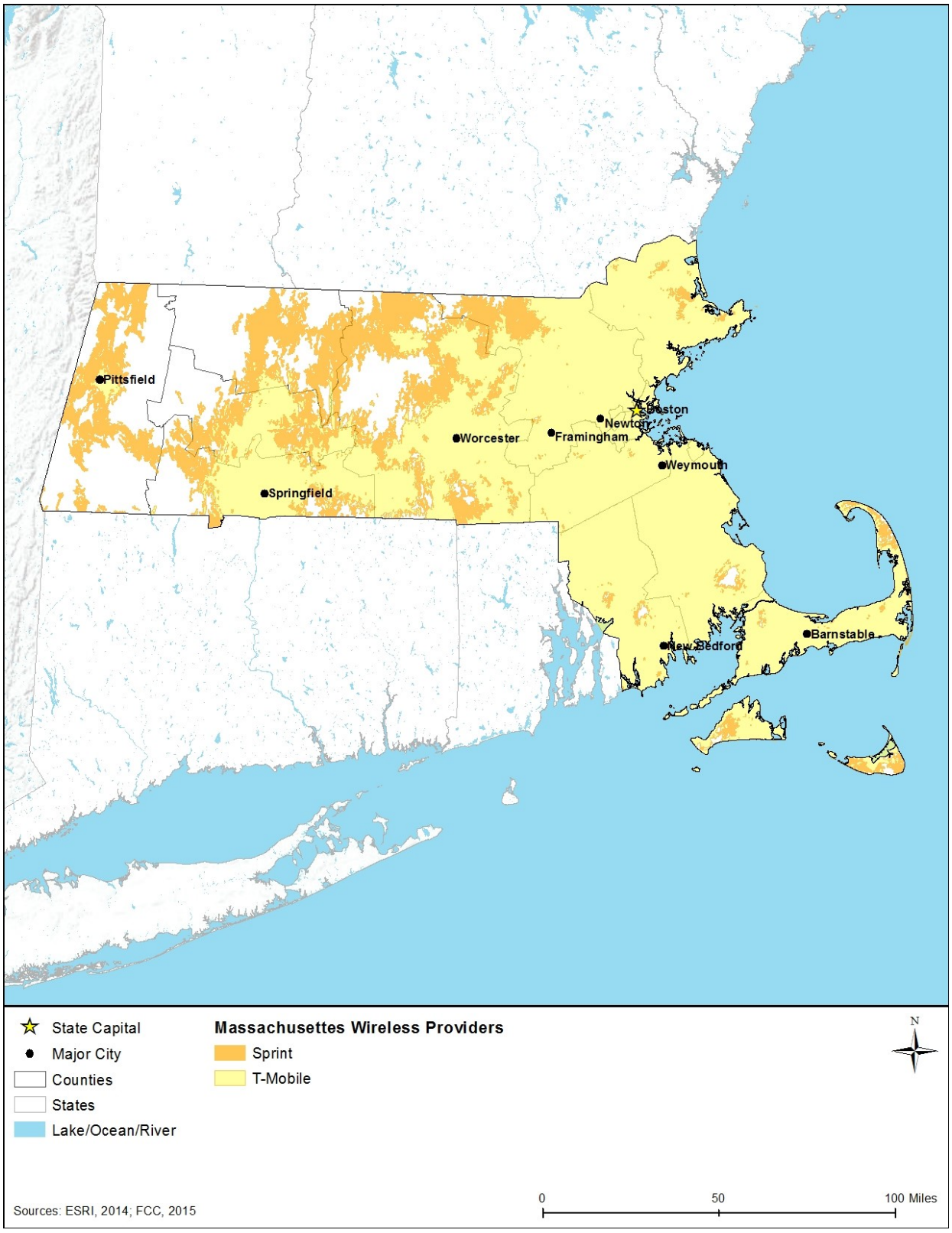


Figure 8.1.1-9: Spring and T-Mobile Wireless Availability in Massachusetts

Source: (NTIA, 2014)

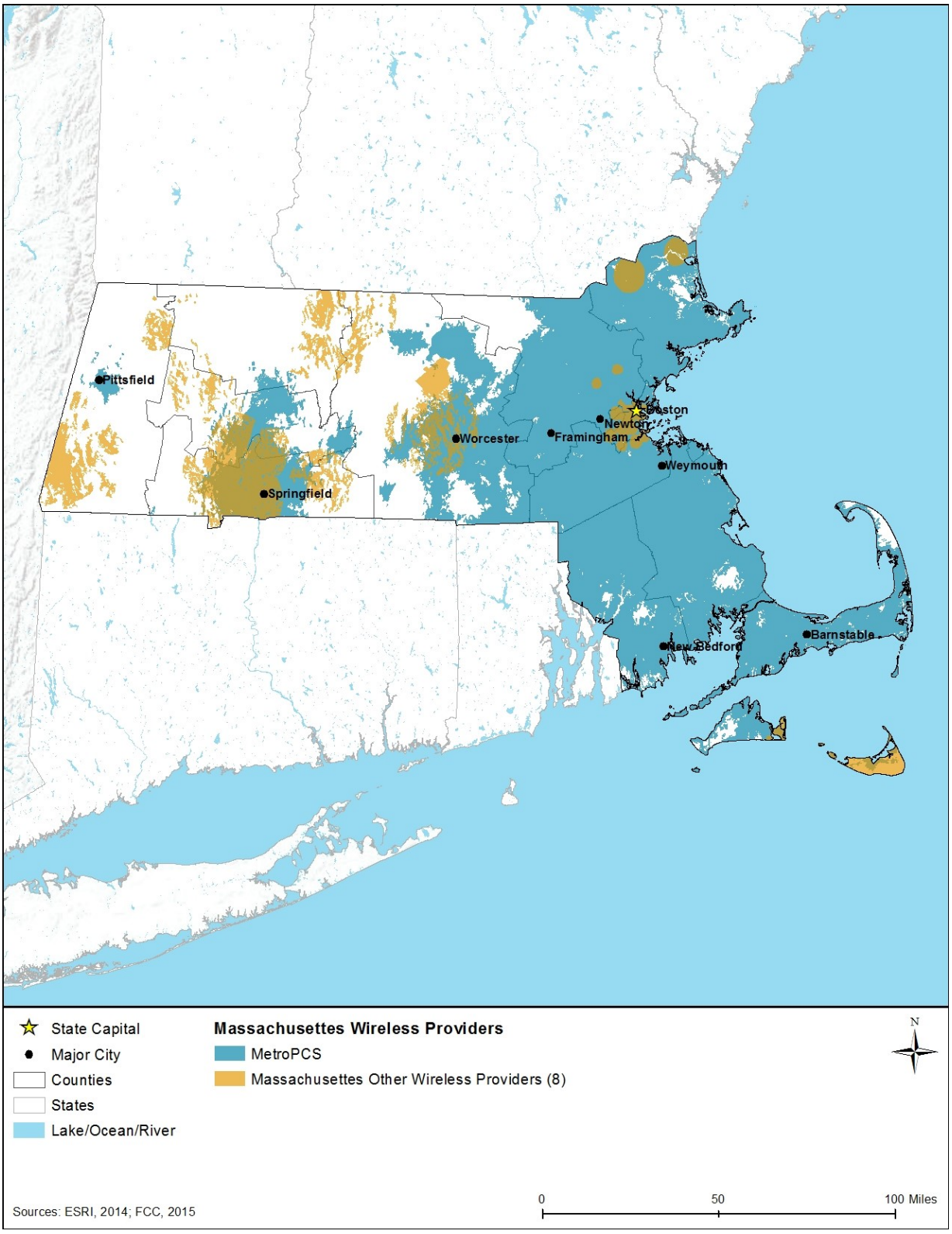


Figure 8.1.1-10: MetroPCS and Other Providers Wireless Availability in Massachusetts

Source: (NTIA, 2014)

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 8.1.1-11 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 8.1.1-11: Types of Towers

Telecommunications tower infrastructure can be found throughout Massachusetts, although tower infrastructure is concentrated in the higher and more densely populated areas of Boston and Springfield. Owners of towers and some types of antennas are required to register those infrastructure assets with the FCC (FCC, 2016b). [9] Table 8.1.1-9 shows the number of towers (including broadcast towers) registered with the FCC in Massachusetts. Figure 8.1.1-12 presents the location of those 844 structures, as of June 2015.

[9] 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. (FCC, 2016b)

Table 8.1.1-9: Number of Commercial Towers in Massachusetts by Type

Constructed[a] Towers[b]		**Constructed Monopole Towers**	
100ft and over	181	100ft and over	0
75ft – 100ft	155	75ft – 100ft	0
50ft – 75ft	195	50ft – 75ft	12
25ft – 50ft	149	25ft – 50ft	34
25ft and below	23	25ft and below	0
Subtotal	**703**	**Subtotal**	**46**
Constructed Guyed Towers		**Buildings with Constructed Towers**	
100ft and over	14	100ft and over	1
75ft – 100ft	9	75ft – 100ft	3
50ft – 75ft	4	50ft – 75ft	3
25ft – 50ft	3	25ft – 50ft	2
25ft and below	0	25ft and below	1
Subtotal	**30**	**Subtotal**	**10**
Constructed Lattice Towers		**Multiple Constructed Structures[c]**	
100ft and over	4	100ft and over	10
75ft – 100ft	13	75ft – 100ft	0
50ft – 75ft	15	50ft – 75ft	0
25ft – 50ft	5	25ft – 50ft	0
25ft and below	1	25ft and below	0
Subtotal	**38**	**Subtotal**	**10**
Constructed Tanks[d]			
Tanks	5		
Subtotal	**5**		
Total All Tower Structures		**842**	

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 2013).
[b] Free standing or guyed structure used for communication purposes (FCC 2013).
[c] Multiple constructed structures per antenna registration (FCC 2013).
[d] Any type of tank – water, gas, etc. with a constructed antenna (FCC 2013).

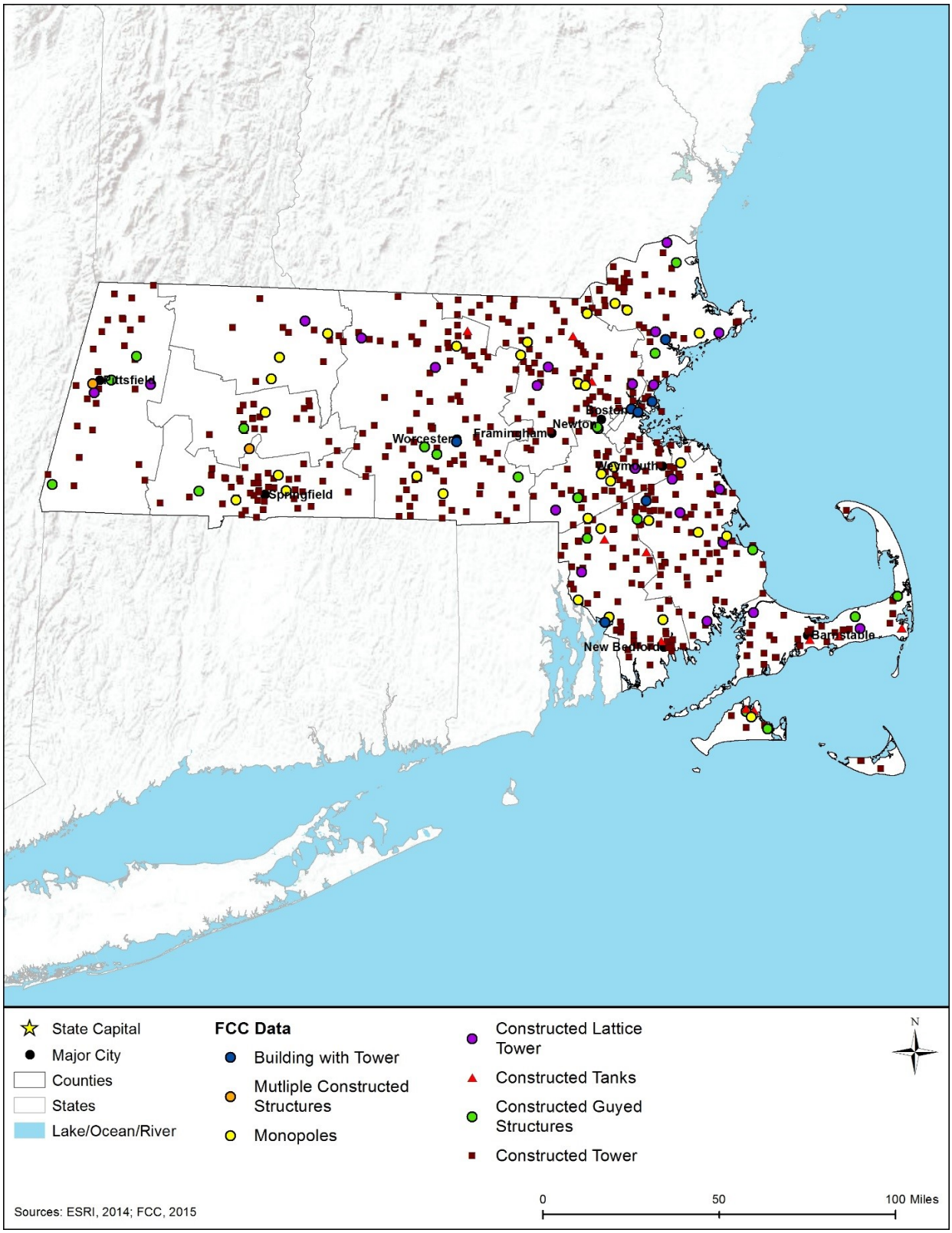
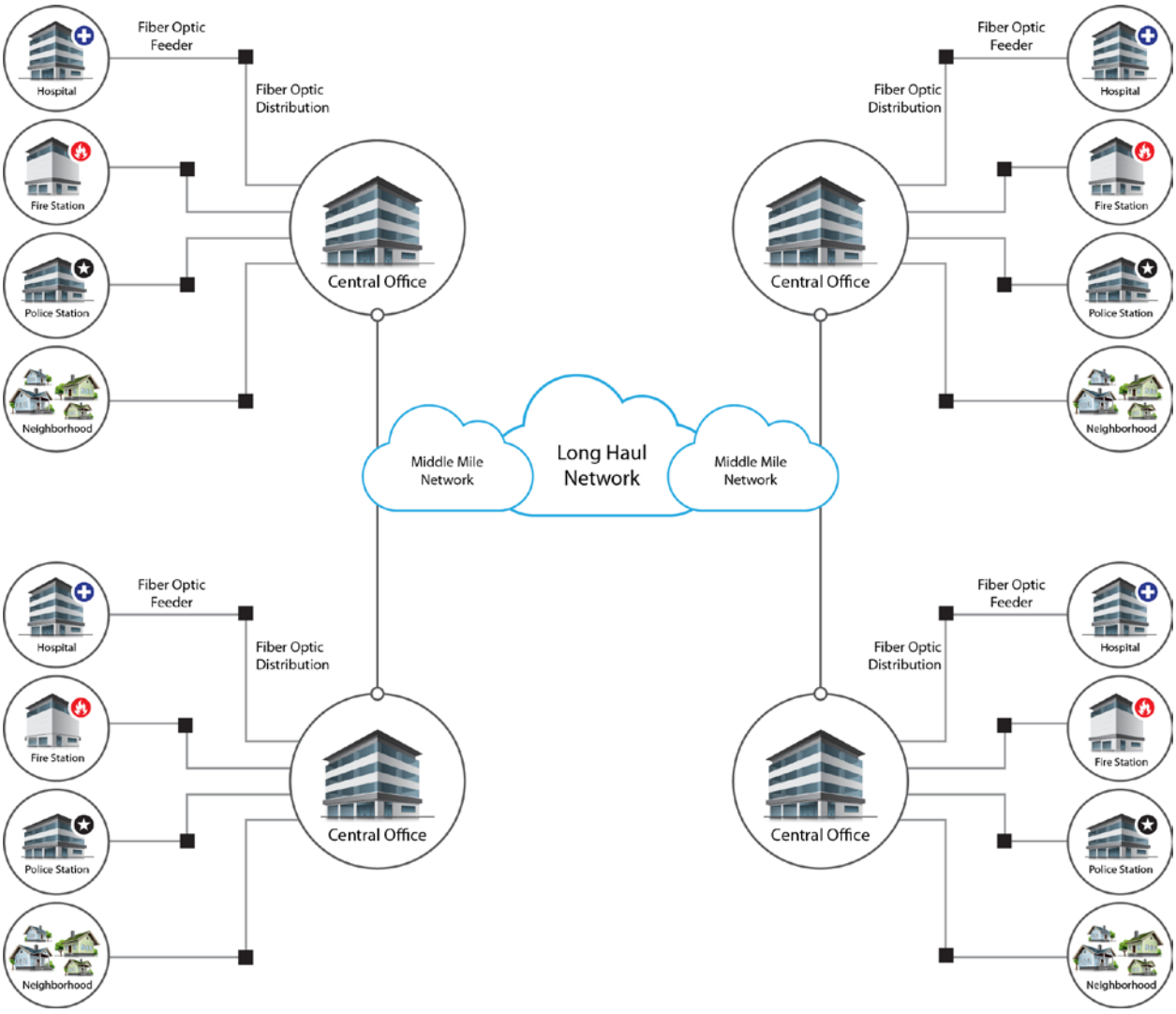


Figure 8.1.1-12: FCC Tower Structure Locations in Massachusetts

Source: (FCC, 2015c)

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 8.1.1-13. 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 8.1.1-13: Typical Fiber Optic Network in Massachusetts

Last Mile Fiber Assets

In Massachusetts, fiber access networks are concentrated in the highest population centers as shown in the figures below. In Massachusetts, there are eight fiber providers that offer service in the state, as listed in Table 8.1.1-10. Figure 8.1.1-14 presents coverage by Verizon; Figure 8.1.1-15 presents coverage by Comcast, MegaPath, and Charter Communications; and Figure 8.1.1-16 presents coverage provided by other companies.

Table 8.1.1-10: Fiber Provider Coverage

Fiber Provider	Coverage
Verizon	72.98%
Comcast	51.49%
MegaPath Corporation	19.29%
Charter Communications	14.67%
Other[a]	8.35%

Source: (NTIA, 2014)

[a] *Other: Provider with less than 5% coverage area. Providers include: Time Warner Cable; RCN; Level 3 Communications, LLC; OTT Communications; Shrewsbury Electric and Cable Operations; Richmond Telephone Company; BELD Broadband; Norwood Light Broadband; Cox Communications; Russel Municipal Cable T.V.; FairPoint Communications; HE.net Fiber Optic Internet; TMLP Online; Cogent Communications; Fibertech*

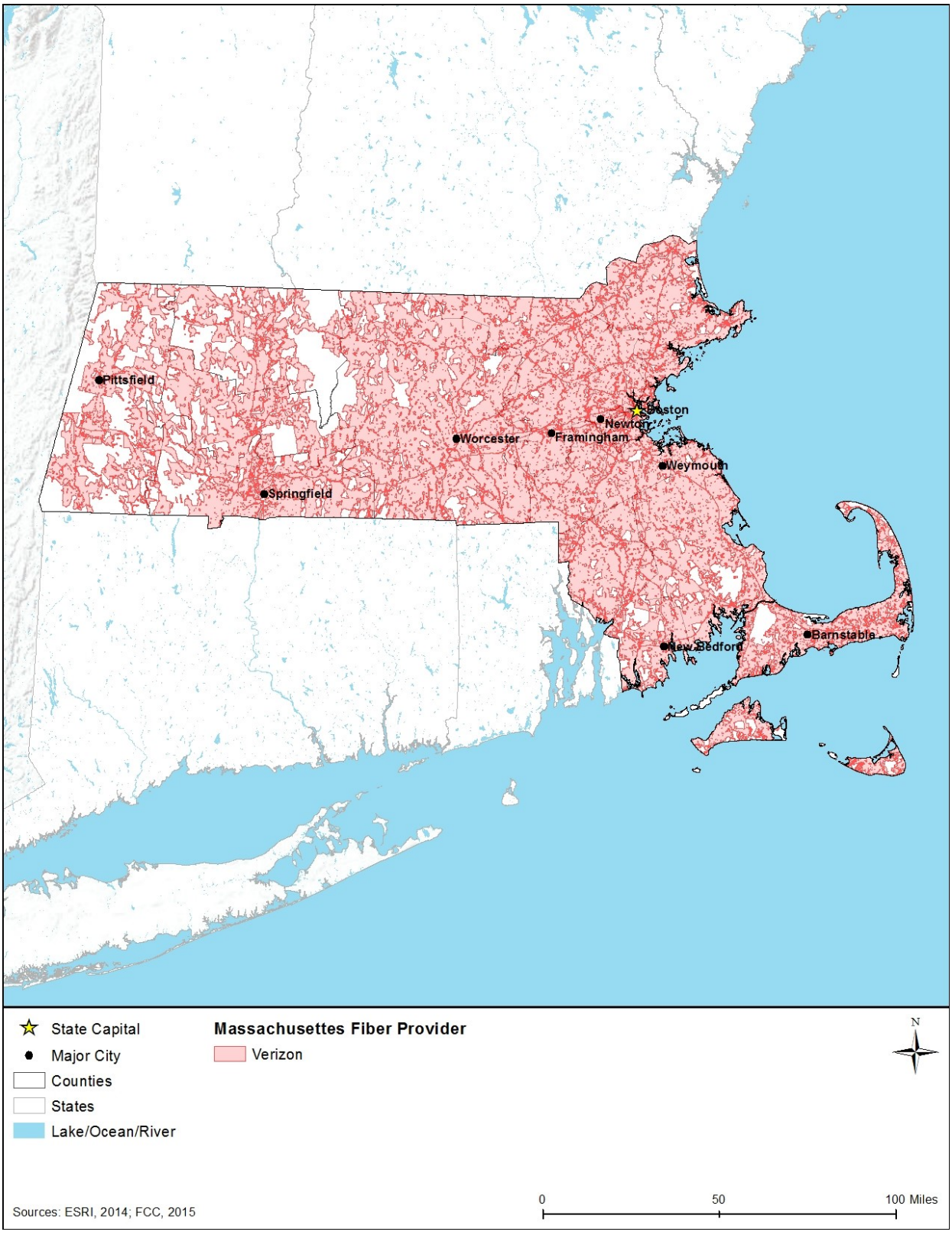


Figure 8.1.1-14: Verizon Fiber Availability in Massachusetts

Source: (NTIA, 2014)

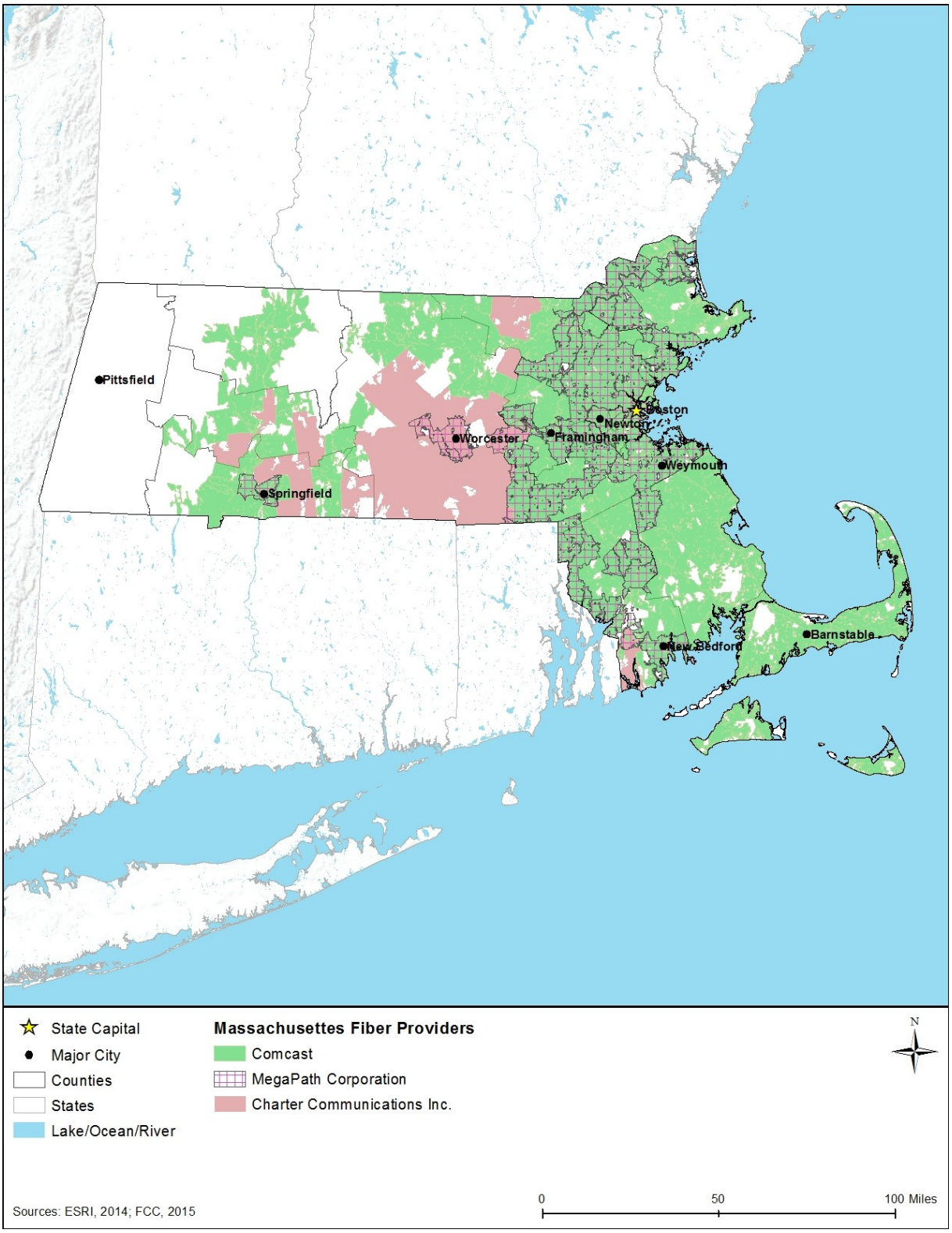


Figure 8.1.1-15: Comcast, MegaPath, and Charter Communications Fiber Availability in Massachusetts

Source: (NTIA, 2014)

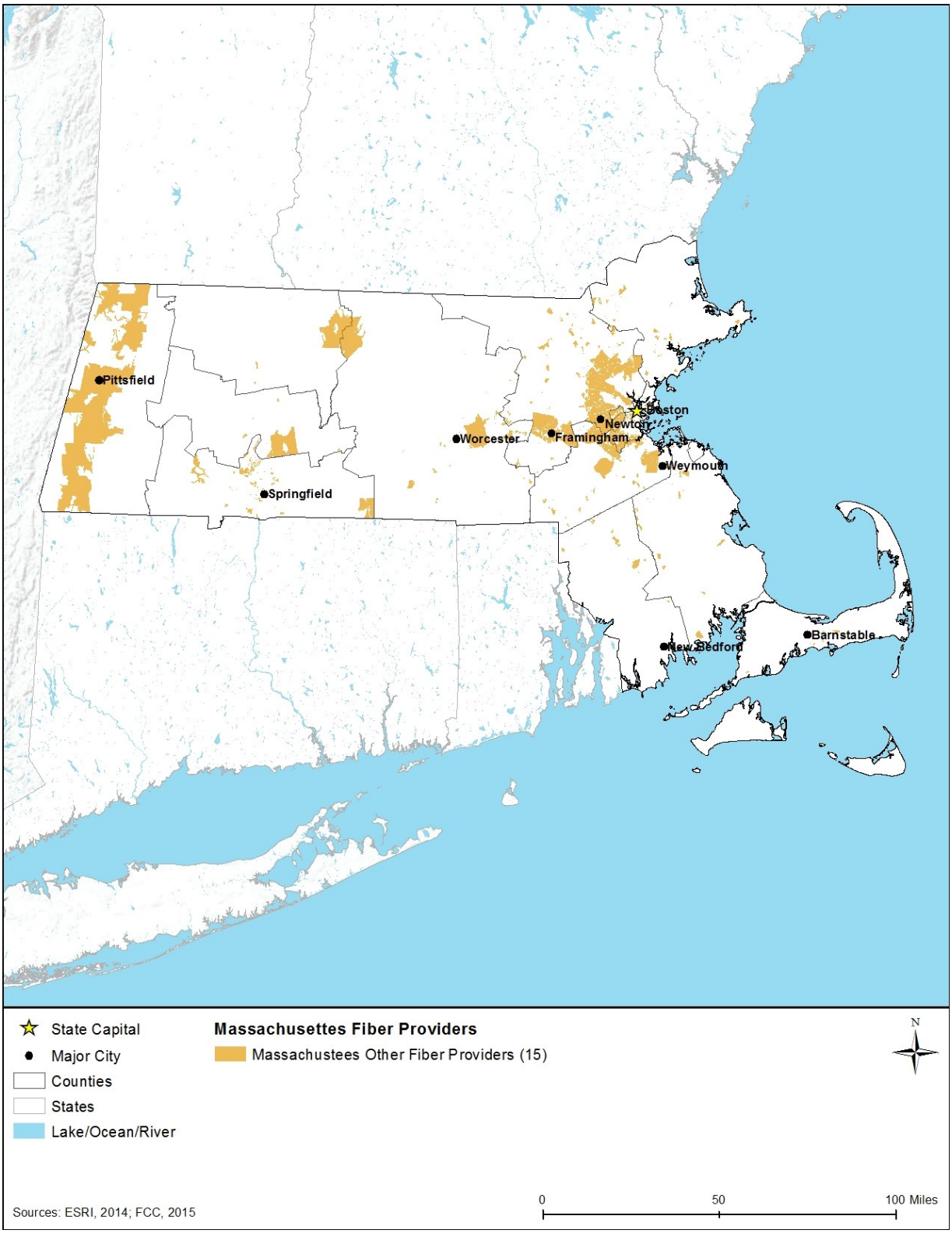


Figure 8.1.1-16: Fiber Availability in Massachusetts for All Other Coverage Providers

Source: (NTIA, 2014)

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).

8.1.1.6. Utilities

Utilities are the essential systems that support daily operations in a community and cover a broad array of public services, such as electricity, water, wastewater, and sewage. Section 8.1.4, Water Resources, describes the potable water sources in the state.

Electricity

The four investor-owned electricity utilities in Massachusetts are overseen by the Electric Power Division of the Department of Public Utilities, which itself is a part of the Executive Office of Energy and Environmental Affairs. The responsibilities of the Electric Power Division include ensuring energy is cost efficient and reliable, establishing methods of modernizing the distribution grid, and reviewing agreements between the distribution companies and renewable resources (Electric Power Division, 2015a). The four companies regulated by the Division are Fitchburg Gas and Electric Light Company, National Grid, NSTAR Electric, and Western Massachusetts Electric Company. These investor owned companies operate as distributers for competitive suppliers and electricity brokers, companies that sell electricity to residential, commercial, and industrial customers (EEA, 2015a). As distribution companies, it is their responsibility to maintain the infrastructure of the distribution grid, as well as ensuring that electricity is delivered from the source to the customer. If a customer so chooses, they can obtain their electricity from a competitive supplier or electricity broker and pay them for the generation of the energy; but the electricity broker (the distribution company) is still responsible for the delivery of the electricity (Electric Power Division, 2015b). The Electric Power Division issues licenses to competitive suppliers and electricity brokers. The Division's website lists 293 companies as either competitive suppliers or electricity brokers. Of these, 70 are competitive suppliers and 223 are electricity brokers. Thirty-seven serve only commercial customers and one serves only industrial, while 145 serve both, but do not serve residential customers. One company serves only residential customers, while thirty-four serve both residential and commercial customers and the remaining seventy-two companies serve residential, commercial, and industrial customers. The site lists three competitive suppliers whose customer type is not listed (Electric Power Division, 2015c). In 2014, 59 percent of the state's electricity came from natural gas, 9.5 percent from coal burning and 9.1 percent came from renewable resources (EIA, 2015a). The remaining 22.4 percent came from petroleum and nuclear resources (EIA, 2015a). This 59% amounted to 18,197,000 megawatthours of electricity, of the 31,124,000

megawatthours produced in the state that year.[10] Historically, most of Massachusetts' electricity has been produced by natural gas. In 2013, it was responsible for the production of 65 percent, in 2012 for 68 percent and, in 2011; it was the source of 68 percent of the state's electricity (EIA, 2015b). This trend appeared to continue, as 84 percent of the state's electricity came from natural gas between January and April of 2015 (EIA, 2015a).

Water

Due to its status as Massachusetts' capitol and largest city, the Massachusetts Water Resources Authority (MWRA) provides water services to Boston and the surrounding area communities. The MWRA severs about 2.5 million people across 61 communities in the Boston Metropolitan area. It also serves about 5,500 large industrial customers (MWRA, 2015a). The water that MWRA supplies to its customers comes from the Quabbin and Wachusett Reservoirs. The levels of the Wachusett Reservoir remain relatively constant, but the water levels of the Quabbin Reservoir fluctuate. By 2015, the MWRA used an average 235.33 million gallons of water each day. Use has been on the rise, as averages from 2013 and 2014 indicate that the Authority used 202.8 million gallons/day and 200.85 million gallons/day respectively (MWRA, 2015b). MWRA performs water quality tests both annually and monthly. These tests are performed on untreated waters from the source reservoirs as well as from samples taken after the treatment process and from water lines (MWRA, 2015c).

Investor-owned water utilities in Massachusetts are regulated by the Water Division, which falls under the auspice of the Office of Energy and Environmental Affairs (EEA) and the Department of Public Utilities (DPU). This includes "every person, partnership, association or corporation, other than a municipal corporation, and other than a landlord supplying his tenant, engaged in the distribution and sale of water in the Commonwealth through its pipes or mains" (DPU, 2015). The Water Division does not regulate homeowner associations (HOA) that provide water services to their members, so long as all of the service's customers are members of the HOA (DPU, 2015).

Wastewater

The Massachusetts Department of Environmental Protection (MassDEP) oversees and regulates wastewater treatment facilities in the state. These facilities range in size and description from small homeowner association centers that treat sanitary wastewater to larger scale plants that treat industrial wastewater (MassDEP, 2015a). The state has permitted and graded some 1,830 wastewater treatment plants since 1984, though the number of plants currently in operation is unpublished (MassDEP, 2015b). Of these, 337 plants have active permits that allow them to discharge treated water into the state's groundwater supplies (MassDEP, 2015c). The DEP also certifies and grades treatment plant operators (MassDEP, 2015a).

In addition to water services, the MWRA has supplied wastewater and sewer services to the city of Boston and its surrounding communities since 1984. Over the last eleven years, MWRA has

[10] One Megawatthour can be defined as "One thousand kilowatt-hours or 1 million watt-hours," where one watthour is "The electrical energy unit of measure equal to one watt of power supplied to, or taken from, an electric circuit steadily for one hour." (EIA, 2015d).

made major additions to the wastewater systems in its jurisdiction. These renovations include the combining of the North and South sewer systems, the building of a treatment plant on Deer Island, and the completion of a facility that turns sludge to fertilizer. The effluent Outfall Tunnel was built to allow treated wastewater that had once been discharged into the shallow Boston Harbor to be discharged into the Massachusetts Bay instead (MWRA, 2015d). One high level priority of the MWRA has been closing the Combined Sewer Overflows (CSO) that were popular in older sewer systems such as Boston's. CSO's are sewer pipes that carry both wastewater and storm water, with the intention of bringing it to treatment facilities. In times of heavy rainfall, these pipes would overflow at the designated CSO area, which could cause issues with water quality. Since its 1987, the MWRA has closed 32 of the city's 84 CSOs. The volume of water that moves through the CSO annually has been cut down by 84%, helping to improve the quality of water in the Boston Harbor (MWRA, 2015e).

Solid Waste Management

The Massachusetts DEP oversees the disposal of solid waste for the state. As of June 2013, Massachusetts was home to 21 active landfills, disposing of 2,227,794 tons of material each year (MassDEP, 2015d). In 2012, the state had seven combustion facilities that were used to dispose of 3,459,135 tons of material, turning it from waste to fuel (MassDEP, 2015e). The state has closed a number of landfills, and offers permits to use this land for renewable energy projects, such as wind and solar. There are 65 of these locations in Massachusetts (MassDEP, 2015f).

The state 2010-2020 Solid Waste Master Plan was designed as a long-term roadmap to help Massachusetts decrease its waste, increase recycling and reuse, and improve its waste management facilities. By 2020, Massachusetts hopes to reduce the amount of solid waste it disposes of by 30%. This would include a decrease of 4,550,000 tons of waste between 2008 and 2020. With regard to long-term goals, the state hopes to reduce waste generated by the residential and commercial sectors by 80%. They also hope to no long need to use state facilities to dispose of products with toxic components. Overall, the plan strives to increase recycling and composting across the business, industrial and residential sectors (MassDEP, 2013a).

8.1.2. Soils

8.1.2.1. 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, 2015a)

(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, 2015a)

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

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

8.1.2.2. Specific Regulatory Considerations

The Proposed Action must meet the requirements of the National Environmental Policy Act (NEPA) and other applicable laws and regulations. Applicable federal laws and regulations that apply for Soils, such as the Farmland Protection Policy Act of 1981, are in Section 1.8. A list of applicable state laws and regulations is included in Table 8.1.2-1.

Table 8.1.2-1: Relevant Massachusetts Soil Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas (2003)[11]	MassDEP	Erosion and sediment measures must be designed in accordance with Best Management Practices and Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas (2003). An Erosion and Sediment Control Plan is generally required if the total land disturbance is equal to greater than one acre (check local regulations and requirements to verify)

[11] (MassDEP, 2003a)

8.1.2.3. Environmental Setting

Massachusetts is composed of two Land Resource Regions (LRR),[12] as defined by the Natural Resources Conservation Service (NRCS) (NRCS, 2006):

- Northeastern Forage and Forest Region and
- Northern Atlantic Slope Diversified Farming Region

Within and among Massachusetts' two LRRs are five Major Land Resource Areas (MLRA),[13] which are characterized by patterns of soils, climate, water resources, land uses, and type of farming (NRCS, 2006). The locations and characteristics of Massachusetts' MLRAs are presented in Figure 8.1.2-1 and Table 8.1.2-2, 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[14] such as bacteria, fungi, biological crusts, vegetation, animals, and climatic variables such as precipitation and temperature. For example, expansive soils[15] with wet and dry seasons alternately swell and shrink, which presents integrity risks to structural foundations (Rogers, Olshansky, & Rogers, 2004). Soils can also be affected by a variety of surface uses that loosen topsoil and damage or remove vegetation or other groundcover, which may result in accelerated erosion, compaction, and rutting[16] (discussed further in the subsections below).

Table 8.1.2-2: Characteristics of Major Land Resource Areas in Massachusetts

MLRA Name	Region of State	Soil Characteristics
Connecticut Valley	Western Central Massachusetts	Entisols[17] and Inceptisols[18] are the dominant soil orders, ranging from excessively drained to poorly drained. They are very deep, are clayey, loamy, or sandy.
Long Island-Cape Cod Coastal Lowland	Southeastern Massachusetts	Inceptisols and Entisols are dominant soil orders. They are deep, moderately coarse textured, or coarse textured, nearly level to sloping and well drained.

[12] Land Resource Region: "A geographical area made up of an aggregation of Major Land Resource Areas (MLRA) with similar characteristics." (NRCS, 2006).

[13] 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).

[14] The flora and fauna of a region.

[15] 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).

[16] Rutting is indentations in soil from operating equipment in moist conditions or soils with lower bearing strength (USFS, 2009b).

[17] 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)

[18] 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)

MLRA Name	Region of State	Soil Characteristics
New England and Eastern New York Upland, Northern Part	Central and Western Massachusetts	Inceptisols and Spodosols[19] are the dominant soil orders. The soils here are shallow to very deep, generally excessively drained to poorly drained, and are loamy or sandy.
New England and Eastern New York Upland, Southern Part	Western, Central, and Eastern Massachusetts	Entisols, Histosols,[20] and Inceptisols are the dominant soil orders, and they are very deep, somewhat excessively drained to poorly drained, and loamy or sandy.
Northeastern Mountains	Western Massachusetts	Inceptisols and Spodosols are dominant soil orders. The soils in this area range from shallow to very deep, somewhat excessively drained to poorly drained, and are loamy.

Source: (NRCS, 2006)

[19] 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)

[20] Histosols: "Soils that have a high content of organic matter and no permafrost. Also known as bogs, moors, peats, or mucks, these soils are saturated year round and form in decomposed plant remains. If exposed to air and drained, the microbes will decompose and the soils can subside dramatically. They make up nearly 1% of the world's ice-free land surface." (NRCS, 2015d)

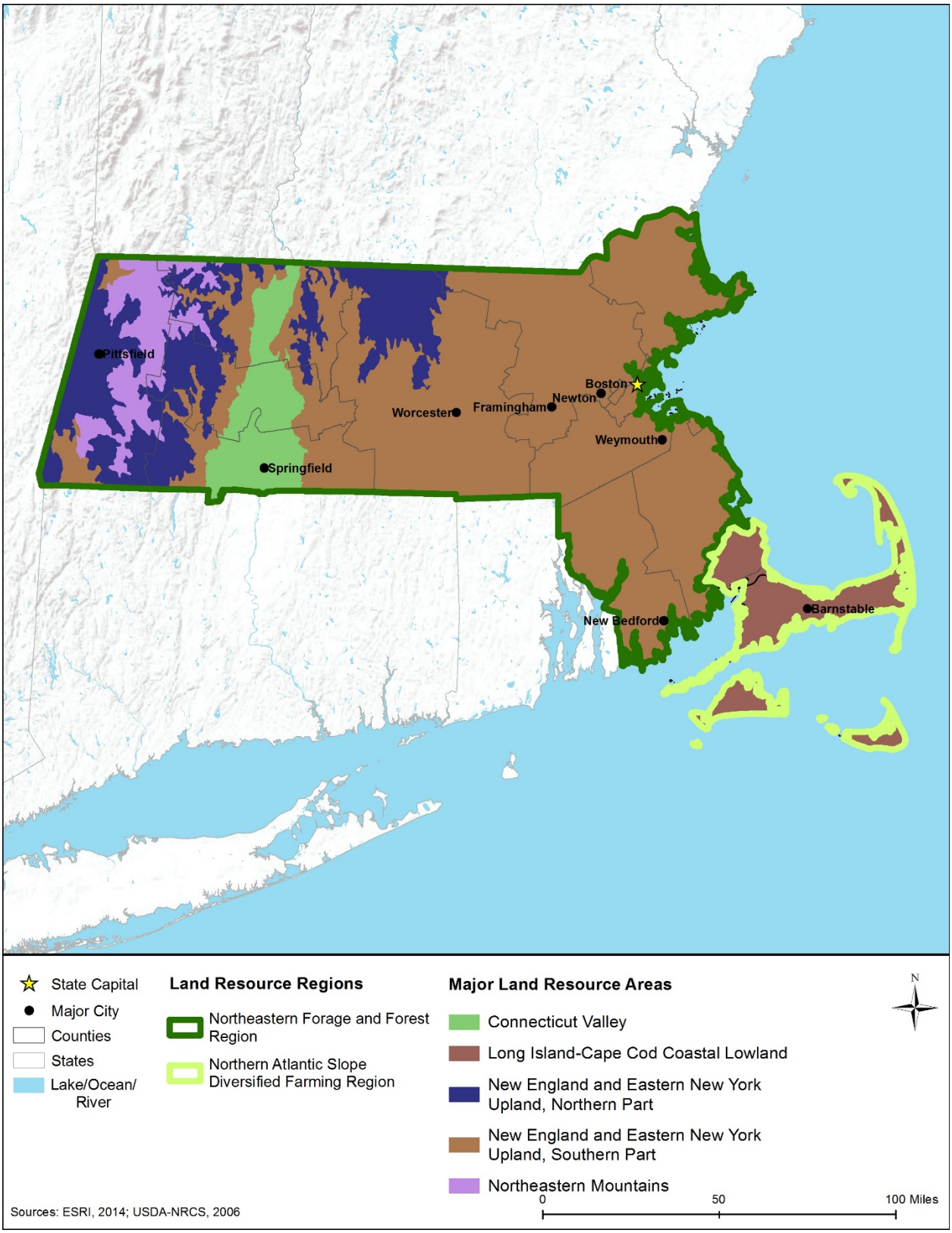


Figure 8.1.2-1: Locations of Major Land Resource Areas in Massachusetts

8.1.2.4. Soil Suborders

Soil suborders are part of the soil taxonomy (a system of classification used to make and interpret soil surveys). Soil orders are the highest level in the taxonomy; there are twelve soil orders in the world and they are characterized by both observed and inferred[21] 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, 2015b). The STATSGO2[22] soil database identifies nine different soil suborders in Massachusetts (NRCS, 2015c). Figure 8.1.2-2 depicts the distribution of the soil suborders, and Table 8.1.2-3 provides a summary of the major physical-chemical characteristics of the various soil suborders found.

8.1.2.5. Runoff Potential

The NRCS uses four Hydrologic Soil Groups (A, B, C, and D) [23] that are based on a soil's runoff potential.[24] Group A generally has the smaller runoff potential, whereas Group D generally has the greatest (Purdue University, 2015). Table 8.1.2-3 provides a summary of the runoff potential for each soil suborder in Massachusetts.

Group A. Sand, loamy sand or sandy loam soils. This group of soils has "low runoff potential and high infiltration rates[25] 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). Hemists, Orthents, Orthods, Psamments, and Udepts fall into this category in Massachusetts.

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. Fluvents, Orthods, and Udepts fall into this category in Massachusetts.

[21] "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, 2015b)

[22] STATSGO2 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.

[23] Classifying soils is highly generalized and it is challenging to differentiate orders as soil properties can change with distance or physical properties. The soil suborders are at a high level, therefore soil groups may be found in multiple hydrologic groups within a state, as composition, topography, etc. varies in different areas.

[24] Classifying soils is highly generalized and it is challenging to differentiate orders as soil properties can change with distance or physical properties. The soil suborders are at a high level, therefore soil groups may be found in multiple hydrologic groups within a state, as composition, topography, etc. varies in different areas.

[25] 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)

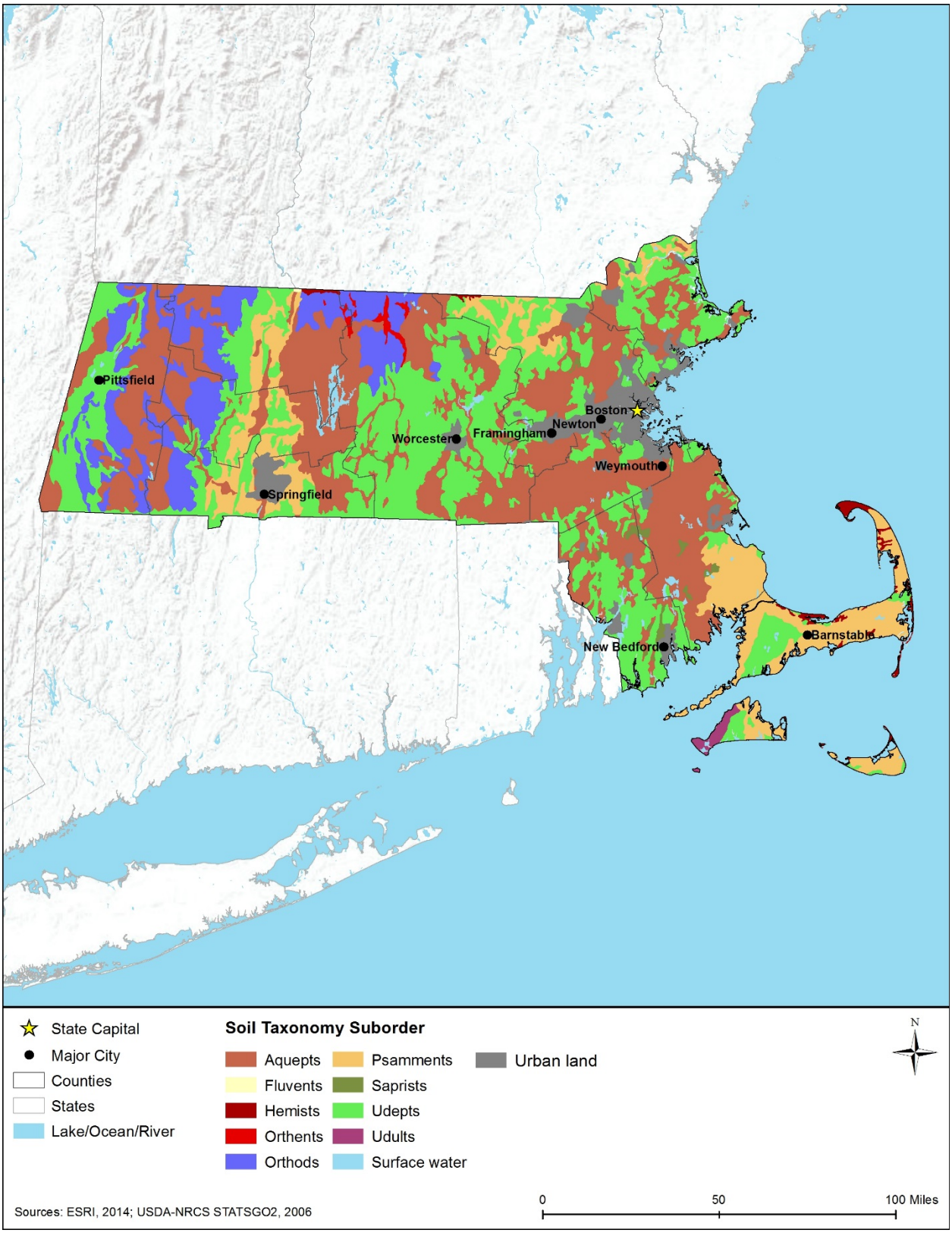


Figure 8.1.2-2: Massachusetts Soil Taxonomy Suborders

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, Orthods, Udepts, and Udults fall into this category in Massachusetts.

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). Aquepts, Hemists, Orthods, Saprists, and Udepts fall into this category in Massachusetts.

8.1.2.6. Soil Erosion

"Soil erosion involves the breakdown, detachment, transport, and redistribution of soil particles by forces of water, wind, or gravity" (NRCS, 2015e). 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, resulting in fewer 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 8.1.2-3 provides a summary of the erosion potential for each soil suborder in Massachusetts. Soils with the highest erosion potential in Massachusetts include those in the Aquepts, Fluvents, Hemists, Orthods, Saprists, Udepts, and Udults suborders, which are found throughout the state (Figure 8.1.2-2).

8.1.2.7. 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, 2009a). 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 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 8.1.2-3 provides a summary of the compaction and rutting potential for each soil suborder in Massachusetts. Soils with the highest potential for compaction and rutting in Massachusetts include those in the Aquepts, Hemists, and Saprists suborders, which are found throughout the state (Figure 8.1.2-2).

Table 8.1.2-3: Major Characteristics of Soil Suborders Found in Massachusetts, as Depicted in Figure 8.1.2-2

Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Drainage Class	Hydric Soil[26]	Hydrologic Group	Runoff Potential	Permeability[27]	Erosion Potential	Compaction and Rutting Potential
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.	Fine sandy loam, loam, loamy sand, silt loam, silty clay loam, stratified very gravelly coarse sand to loamy fine sand, stratified very gravelly sand to loamy fine sand	0-8	Very poorly drained to somewhat poorly drained	No, Yes	C, D	Medium to High	Low to Very Low	Medium to High, depending on slope	High, due to hydric soil and poor drainage conditions
Entisols	Fluvents	Fluvents are mostly freely drained soils that form in recently deposited sediments on flood plains, fans, and deltas located along rivers and small streams. Unless protected by dams or levees, these soils frequently flood. Fluvents are normally utilized as rangeland, forest, pasture, or wildlife habitat, with some also used for cropland.	Silt loam	0-3	Moderately well drained	No	B	Medium	Moderate	Medium	Low
Histosols	Hemists	Hemists are usually found in broad, flat areas, such as coastal plains and outwash plains as well as closed depressions. They are typically under natural vegetation and uses for rangeland, woodlands, and/or wildlife habitat, although some large areas have been cleared and drained, and utilized for cropland.	Mucky peat, peat, silty clay loam	0-2	Very poorly drained	Yes	A, D	Low to High	High to Very Low	Low to High, depending on slope	High, due to hydric soil and poor drainage conditions
Entisols	Orthents	Orthents are commonly found on recent erosional surfaces and are used primarily as rangeland, pasture, or wildlife habitat.	Loamy fine sand	0-3	Excessively drained	No	A	Low	High	Low	Low
Spodosols	Orthods	Orthods have a moderate accumulation of organic carbon, and are relatively freely drained. Most of these soils are either used as forest or have been cleared and are used as cropland or pasture. Although they are naturally infertile, they can be highly responsive to good management.	Fine sandy loam, gravelly sandy loam, loam, silt loam	8-75	Well drained to excessively drained	No	A, B, C, D	Low to High	High to Very Low	Low to High, depending on slope	Low
Entisols	Psamments	Psamments are sandy in all layers. In some arid and semi-arid climates, they are among the most productive rangeland soils, and are primarily used as rangeland, pasture, or wildlife habitat. Those Psamments that are nearly bare are subject to wind erosion and drifting, and do provide good support for wheeled vehicles.	Loamy fine sand, loamy sand	0-15	Excessively drained	No	A	Low	High	Low	Low
Histosols	Saprists	Saprists have organic materials that are well decomposed, and many support natural vegetation and are used as woodland, rangeland, or wildlife habitat. Some Saprists, particularly those with a mesic or warmer temperature regime, have been cleared, drained, and used as cropland.	Muck	0-1	Very poorly drained	Yes	D	High	Very Low	High	High, due to hydric soil and poor drainage conditions
Inceptisols	Udepts	Udepts have an udic or perudic (saturated with water long enough to cause oxygen depletion) moisture regime, and are mainly freely drained. Most of these soils currently support or formerly supported forest vegetation, with mostly coniferous forest in the Northwest and mixed or hardwood forest in the East. Some also support shrub or grass vegetation, and in addition to being used as forest, some have been cleared and are used as cropland or pasture.	Channery loam, channery silt loam, fine sandy loam, gravelly fine sandy loam, gravelly loam, gravelly sandy loam, loam, sandy loam, silt loam, silty clay loam, stratified sand and gravel, stratified very gravelly coarse sand to	0-35	Somewhat excessively drained to moderately well drained	No	A, B, C, D	Low, Medium, High	Very Low, Low, Moderate, High	Low to High, depending on slope	Low

[26] 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, 2015f).
[27] Based on Runoff Potential, described in Section 8.1.2.4.

Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Drainage Class	Hydric Soil[26]	Hydrologic Group	Runoff Potential	Permeability[27]	Erosion Potential	Compaction and Rutting Potential
			gravelly loamy fine sand, stratified very gravelly coarse sand to sand, unweathered bedrock, very fine sandy loam								
Ultisols	Udults	Udults are more or less freely drained, relatively humus poor, and have an udic moisture regime. Most of these soils currently support or formerly supported mixed forest vegetation, and many have been cleared and used as cropland (mostly with the use of soil amendments).	Sandy loam	3-8	Well drained	No	C	Medium	Low	Medium	Low

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

8.1.3. Geology

8.1.3.1. 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 groundwater availability. Several of these elements are discussed in other sections of this Programmatic Environmental Impact Statement (PEIS), including Water Resources (Section 8.1.4), Human Health and Safety (Section 8.1.15), and Climate Change (Section 8.1.14).

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

- Section 8.4.3, Major Physiographic Regions and Provinces[28][29]
- Section 8.4.4, Surface Geology
- Section 8.4.5, Bedrock Geology[30]
- Section 8.4.6, Paleontological Resources[31]
- Section 8.4.7, Fossil Fuel and Mineral Resources
- Section 8.4.8, Potential Geologic Hazards[32]

8.1.3.2. Specific Regulatory Considerations

The Proposed Action must meet the requirements of the NEPA and other applicable laws and regulations. Applicable federal laws and regulations that apply to 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 8.1.3-1 below.

Table 8.1.3-1: Relevant Massachusetts Geology Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Massachusetts General Law Chapter 266 Section 120	State of Massachusetts	Landowner's consent is required for collection on private land.
780 CMR: State Board of Building Regulations and Standards	Massachusetts Executive Office of Public Safety and Security	Provisions for earthquake-resistant design
Massachusetts Load and Resistance Factor Design (LRFD) Bridge Manual	MassDOT	Bridges must be designed with consideration of seismic motion

[28] Physiographic regions: Areas of the United States that share commonalities based on topography, geography, and geology. (Fenneman, 1916)

[29] Physiographic provinces: Subsets within physiographic regions. (Fenneman, 1916)

[30] Bedrock: Solid rock beneath the soil and superficial rock. (USGS, 2015a)

[31] Paleontology: "Study of life in past geologic time based on fossil plants and animals." (USGS, 2015b)

[32] 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)

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

Massachusetts is within two physiographic regions: Appalachian Highlands and Atlantic Plain (USGS, 2003a) (Figure 8.1.3-1). The general characteristics of these regions and their respective provinces 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. Erosion from the Appalachian Mountains, which began to form 480 to 440 million years ago (MYA), dislodged sediments, which were subsequently deposited by rivers to form the Atlantic Plain. Sedimentary strata are thin in the western side of the region, and thicken to several thousand feet along the coast. The Atlantic Plain is characterized by gentle topography and a transition zone between the land and sea, often having marshes, lagoons, swamps, sand bars, and reefs. (NPS, 2015a)

Within Massachusetts, the Atlantic Plain Region is confined to Cape Cod, Martha's Vineyard, and Nantucket. The area is characterized by plains and low hills underlain by a layer of unconsolidated sediment (USGS, 1985). From Cape Cod northeast toward the Gulf of Maine, sediment thickness does not exceed roughly 330 feet; sediment thickness increases dramatically to the south of Cape Cod, reaching depths of more than 1,100 feet near Nantucket Island (Denny, 1982).

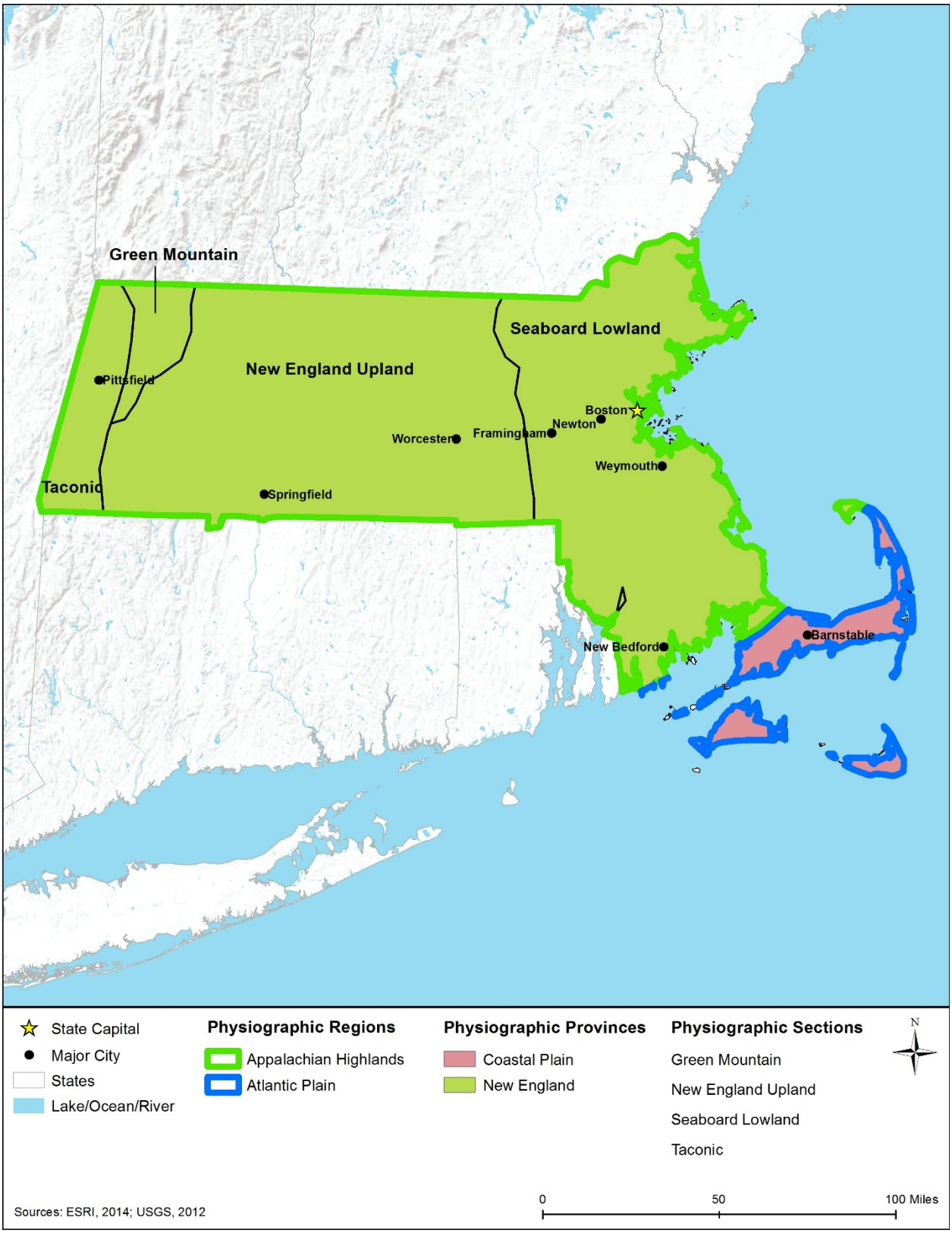


Figure 8.1.3-1: Physiographic Regions, Provinces, and Sections of Massachusetts

Appalachian Highlands Region

The Appalachian Highlands Region extends from Canada to Alabama. This region is composed of layers of folded sedimentary rock,[33] created when the North American plates collided with the Eurasian and African plates more than 500 MYA. Once similar in height to the present-day Rocky Mountains,[34] the Appalachian Highlands have eroded considerably, and most peaks are now under 5,000 feet above sea level (ASL). The current Appalachian Highlands Region is characterized by prime and unique farmlands and is rich in mineral resources. (USGS, 2003a)

As reported above, the Appalachian Highlands Region within Massachusetts is composed of one physiographic province: the New England Province (USGS, 2003a).

New England Province – The New England Province spans between Canada and New Jersey. Elevations generally decrease from west to east across the New England Province in Massachusetts. The predominant topography of the province is a broad plateau interspersed with narrow valleys. Within Massachusetts, the New England Province can be further sub-divided into several physiographic sections: Taconic Mountains, Green Mountains, New England Upland, and Seaboard Lowland (USGS, 2003a).

The Taconic Mountains are in western Massachusetts (Dale, 1905) contain several peaks that rise to nearly 2,500 feet ASL (Denny, 1982). A very small portion of the Green Mountains, which predominantly lie in Vermont, is included in western Massachusetts as well (USGS, 2003a).

The New England Upland section is predominantly rolling hills that range from below 1,000 feet to above 2,000 feet ASL (USGS, 1999a). Eroded bedrock surfaces in this section are covered by coastal plain sediments (MassDCR, 2012). The New England Upland section transitions to the Seaboard Lowlands at roughly 1000 feet ASL; the east-facing scarp[35] extends from near Worcester north to the New Hampshire border (Denny, 1982).

The Seaboard Lowlands section has relatively low topographic relief and encompasses the area east of the New England Uplands to the Atlantic shoreline (with the exception of Cape Cod) (MHC, 1982a). This section is generally below 330 feet ASL, and covers a 30 to 40 mile wide band along the Massachusetts coast (Thompson & Higbee, 1952).

8.1.3.4. Surface Geology

Surficial geology is characterized by materials such as till,[36] 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

[33] 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, 2014a)
[34] The Rocky Mountains exceed 14,000 feet above sea level (NPS, 2015b).
[35] Scarp: "A relatively steep face or slope of considerable linear extent, irrespective of origin." (Verbeek, Ratzlaff, & Clanton, 2005)
[36] 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, 2013b)

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,[37] subsidence,[38] and erosion. (Thompson W. , 2015)

The surface geology of Massachusetts has been strongly influenced by glaciers that covered the state during the ice age. During the most recent ice age, the Late Wisconsinan period, all of current Massachusetts was covered by the Laurentide Ice Sheet (NOAA, 2003). The glacier reached its maximum advance near the islands of Nantucket and Martha's Vineyard around 23,000 years ago. By 18,000 years ago, the last glaciers retreated from Cape Cod and into the Gulf of Maine, and by 15,000 years ago, the ice had receded from the Gulf of Maine and all of southern New England (USGS, 2015c).

Cape Cod's bedrock is presently covered by 200 to 600 feet of very fine to very coarse glacial sediments. On Cape Cod, most glacial deposits take the form of either moraines[39] or outwash aprons;[40] the Buzzards Bay and Sandwich moraines formed when an advancing glacier overtopped previously deposited sediments, creating a large ridge in front of the glacier. Most of Cape Cod, however, is made up of outwash aprons, which are comprised of sand and gravel deposited by glacial meltwater streams that flowed across the plain in a braided pattern, along with kames[41] and kettles.[42] Other geomorphological features on Cape Cod that are attributable to glaciation include large boulders (e.g., Doane Rock in Eastham) and small valleys eroded in the outwash plains. (USGS, 2015c)

Figure 8.1.3-2 shows the generalized illustration of the surface geology for Massachusetts.

8.1.3.5. Bedrock Geology

Bedrock geology analysis, and "the study of distribution, position, shape, and internal structure of rocks" (USGS, 2015d) reveals important information about a region's surface and subsurface characteristics (i.e., 3-dimensional geometry), including dip (slope of the formation),[43] rock composition, and regional tectonism.[44] These structural aspects of bedrock geology are often

[37] Slope failure, also referred to as mass wasting, is the downslope movement of rock debris and soil in response to gravitational stresses.

[38] Subsidence: "Gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials." (USGS, 2000)

[39] Moraine: "A general term for unstratified and unsorted deposits of sediment that form through the direct action of, or contact with, glacier ice." (USGS, 2013b)

[40] Outwash Plain: "A broad, low-slope angle alluvial plain composed of glacially eroded, sorted sediment (termed outwash), that has been transported by meltwater. The alluvial plain begins at the foot of a glacier and may extend for miles." (USGS, 2013b)

[41] Kame: "A knoll or hill composed of outwash deposits, which originally filled a hole in the ice." (USGS, 2015c)

[42] Kettle: "A geological hole that formed when outwash was deposited around and over an ice block. When the ice block melted away, the outwash collapsed to form a hole." (USGS, 2015c)

[43] Dip: "A measure of the angle between the flat horizon and the slope of a sedimentary layer, fault plane, metamorphic foliation, or other geologic structure." (NPS, 2000)

[44] Tectonism: “Structure forces affecting the deformation, uplift, and movement of the earth’s crust.” (USGS, 2015e)

indicative of regional stability, as it relates to geologic hazards such as landslides, subsidence, earthquakes, and erosion (USGS, 2013c).

Accreted terranes[45] dominate the bedrock of eastern Massachusetts, with three distinct landmasses (listed from west to east), including the Merrimack, Nashoba, and Avalon Terranes,[46] underlying the eastern portion of the state. Each block of land is separated from the subsequent terrane by a geologic fault.[47] (Thornberry-Ehrlich, 2008)

- The Merrimack Terrane is the westernmost landmass in eastern Massachusetts. The eastern edge of the Merrimack belt "overlies the Nashoba Terrane along the Clinton-Newberry Fault." This landmass is composed of metasedimentary and plutonic[48] rocks. (Kopera & Walsh, 2014)
- The Nashoba Terrane is between the Avalon and Merrimack Terranes, separated from each by the Bloody Bluff Fault Zone and Clinton-Newberry Fault Zone, respectively. Rocks in this area include metamorphosed volcanic (in the eastern portion of this zone) and sedimentary (in the eastern and western portions of this zone) rocks. (Kopera & Walsh, 2014)
- The Avalon Terrane "include[s] weakly metamorphosed shelf and shallow marine sediments of the Boston Bay Group, arc volcanics, gabbroic[49] intrusions, and granites[50]." (Thornberry-Ehrlich, 2008)

Western Massachusetts is bordered to the east by the Connecticut River Valley and to the west by the Housatonic and Hoosic Rivers. During the early Cambrian Period (542 MYA to 488 MYA), "horizontal beds of gravels, sands, clays, and marls, [became] consolidated into conglomerates, sandstones, shales, and limestones." During the Carboniferous Period (359 MYA to 299 MYA), these rocks metamorphosed due to several tectonic collisions occurring to the east. Metamorphic rocks dominate western portions of Massachusetts, including crystalline schists.[51] (Emerson, 1897) Figure 8.1.3-3 displays the general bedrock geology for Massachusetts.

[45] Accretion: "A process that adds part of one tectonic plate to a larger plate along a convergent (collisional) plate boundary." (NPS, 2000)

[46] Terrane: "A rock formation or assemblage of rock formations that share a common geologic history. A geologic terrane is distinguished from neighboring terranes by its different history, either in its formation or in its subsequent deformation and/or metamorphism." (NPS, 2000)

[47] Fault: "A fracture in the Earth along which one side has moved in relative to the other." (NPS, 2000)

[48] Pluton: "A large body of intrusive igneous rock that solidified within the crust." (NPS, 2000)

[49] Gabbro: "A dark, coarse-grained intrusive igneous rock. Gabbro is made of calcium-rich plagioclase, with amphibole and/or pyroxene, and is chemically equivalent to basalt." (NPS, 2000)

[50] Granite: "A coarse-grained intrusive igneous rock with at least 65% silica." (NPS, 2000)

[51] Schist: Metamorphic rock usually derived from fine-grained sedimentary rock such as shale. (NPS, 2000)

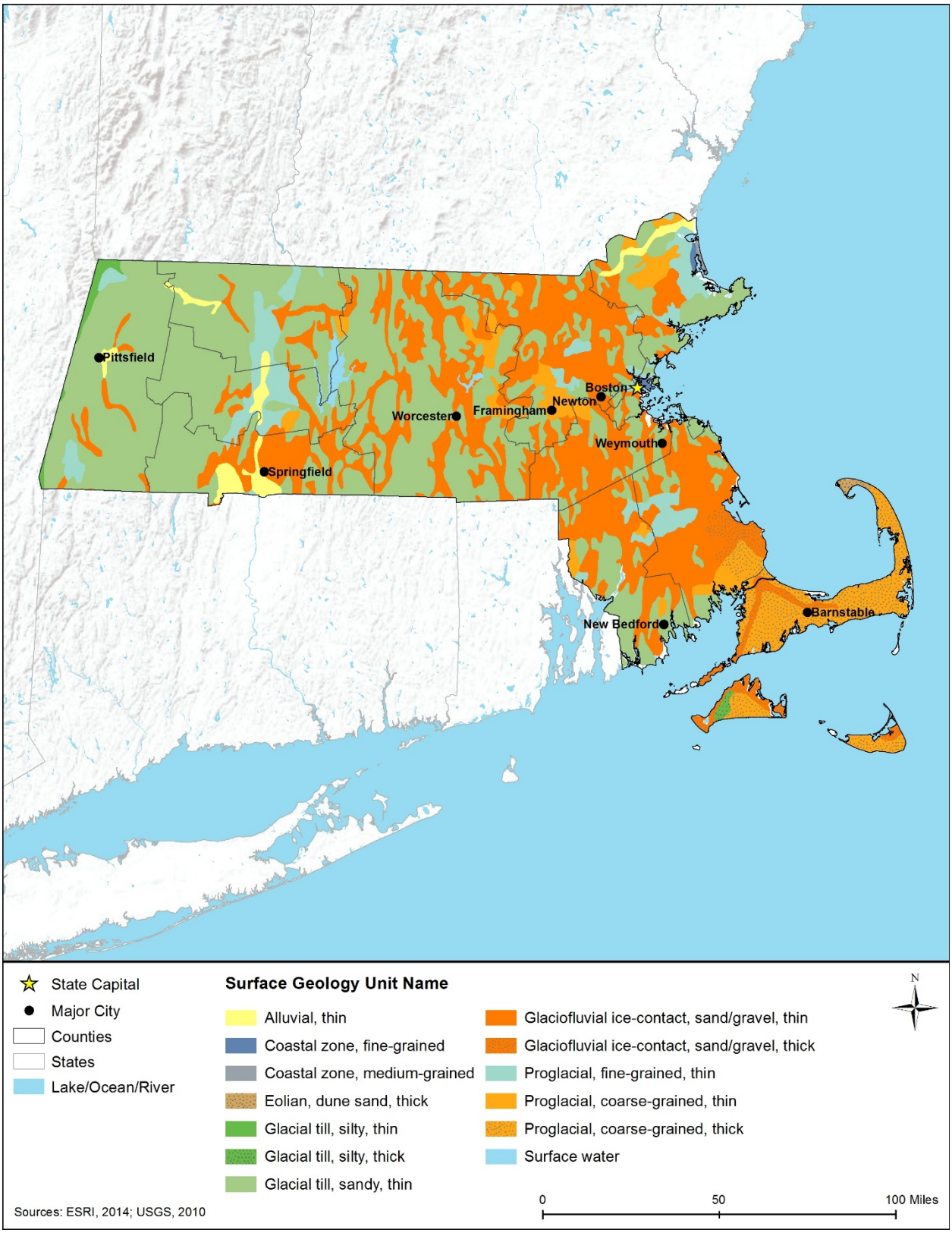


Figure 8.1.3-2: Generalized Surface Geology for Massachusetts

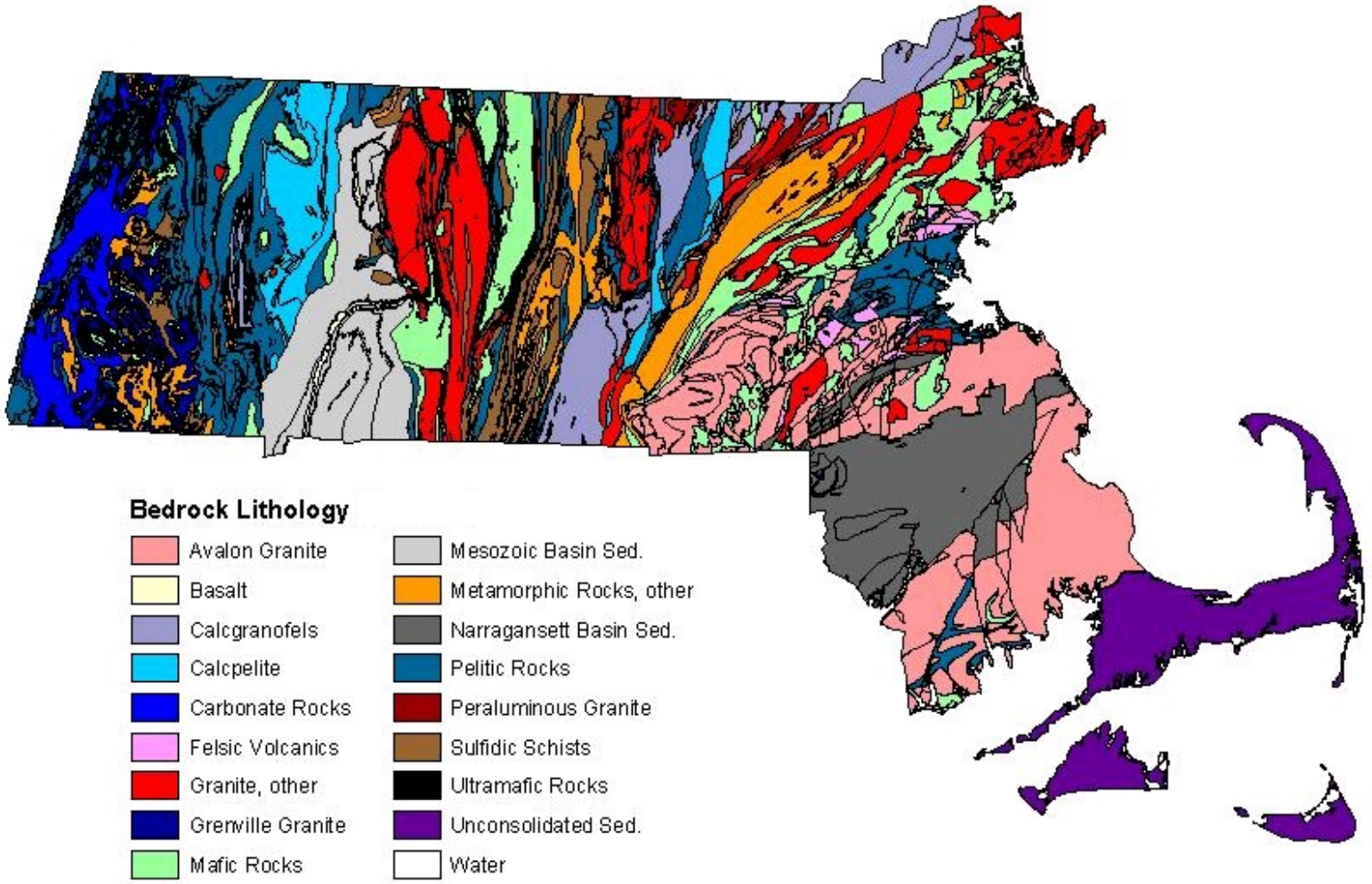


Figure 8.1.3-3: Generalized Bedrock Geology for Massachusetts

Source: (MassGIS, 2004)

8.1.3.6. Paleontological Resources

Some marine fossils from the early Paleozoic era (542 to 251 MYA) have been recorded in central and northeastern Massachusetts, indicating that the state was covered by an ocean at some point during this period. During the Mesozoic Era (251 to 66 MYA), sedimentary rocks formed from deposits in lakes, streams, and alluvial fans; invertebrate trace fossils, dinosaur tracks, and fossil plants have been recorded in these rocks (Paleontology Portal, 2015). As the Ancient Connecticut River Valley (Figure 8.1.3-4) formed, sediments washed in from rivers, resulting in the formation of lakes with sandy shorelines and muddy bottoms in the valley flats (Little, 1997). Trace fossils, along with fossils from plants and fish have been found within the layer of black bituminous shale in the valley (Eisa & Bellard, 2006). The number of trace fossils, including footprints and impressions left by living organisms, in the Valley far outnumbers animal and plant remains; footprints number in the tens of thousands, whereas fossil plants and fishes number in the thousands, and fossil bones of reptiles only number in the dozens (Colbert, 1970).

Paleozoic fossils in Massachusetts include trilobites, brachiopods, and other marine organisms (Paleontology Portal, 2015). Mesozoic Era dinosaur tracks from the theropod dinosaurs are found in the Ancient Connecticut River Valley, along with hundreds of fish fossils recovered in the black shales near Sunderland and Turner's Falls. Dinosaur tracks, which were first found in North America in Granby, MA, in the mid-1800s, were designated as the state's fossil in 1980 (Commonwealth of Massachusetts, 2015b). Although many dinosaur tracks have been recorded, very few dinosaur body fossils have been discovered. Most of the tracks in the Ancient Connecticut River Valley were from dinosaurs with three-toed species, such as the *grallator* and *otozoum*, although some were small, two-footed relatives of the *Apatosaurus,* perhaps made by the dinosaur known as the *hypsilophodon* (Pratt Museum, Amherst College, 1997). Dilophosaurus, Ceolophysis, and related species are also believed to have been in the valley as well (Little, 1997). There are dinosaur tracks near Holyoke, as well as near Mount Tom. The Mount Tom track-makers include *grallator* and *eubrontes* (Johns Hopkins, 1996). Additionally, flower and pine needle fossils have been preserved in Cretaceous (146 to 66 MYA) rocks formed from seafloor sediments off the southwestern end of Cape Cod and Martha's Vineyard; and, Cenozoic (66 MYA to present) fossils from the Pleistocene (2.6 MYA to 11,700 years ago) include mollusk fossils and mastodon bones also found in sediments on Cape Cod (Paleontology Portal, 2015).

Massachusetts Dinosaur Tracks
Eubrontes

Source: (Arnold Arboretum of Harvard University, 2015)

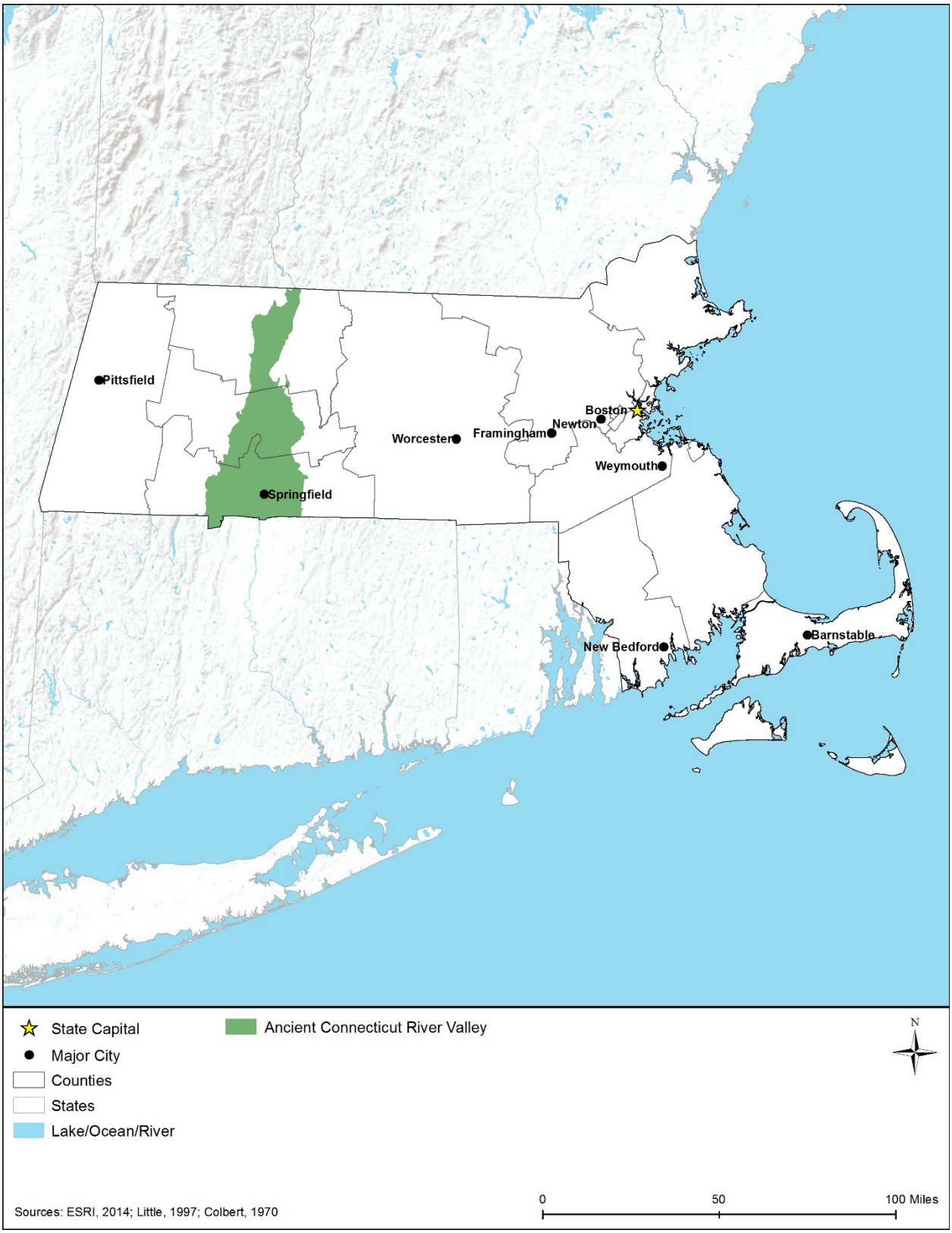


Figure 8.1.3-4: Ancient Connecticut River Valley

8.1.3.7. Fossil Fuel and Mineral Resources

Oil and Gas

Massachusetts does not produce petroleum or natural gas. The state relies on imports of these products from other areas. (EIA, 2015c)

Minerals

As of 2015, Massachusetts' nonfuel mineral production was valued at $305M, ranking 39th in the nation by total value. In 2015, Massachusetts's leading nonfuel mineral commodities (in descending order of production value) were crushed stone, construction sand and gravel, dimension stone, lime, and common clays. (USGS, 2016a) Massachusetts ranked seventh nationwide (out of 36 producing states) in the production of dimension stone (USGS, 2015f). Massachusetts is also a producer of vermiculite (USGS, 2003b), perlite (USGS, 2003c), lime, common clay, and gemstones (USGS, 2015f).

8.1.3.8. Geologic Hazards

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

Earthquakes

Between 1973 and March 2012, there were 19 earthquakes of a magnitude-2.5 (on the Richter scale[52]) or greater in Massachusetts (USGS, 2014b). Earthquakes are the result of large masses of rock moving against each other along fractures called faults. Earthquakes occur when landmasses on opposite sides of a fault suddenly slip past each other; the grinding motion of each landmass sends out shock waves. The vibrations travel through the Earth and, if they are strong enough, they can damage manmade structures on the surface (USGS, 2012a).

Notable Massachusetts Earthquakes

The largest earthquake ever recorded in Massachusetts was an estimated magnitude 6.0 to 6.9 event that occurred in November 1755 near Cape Ann and Boston, resulting in damage to more than 1,000 chimneys. This severe earthquake was felt from Halifax (Nova Scotia, Canada) south to the Chesapeake Bay Region (USGS, 2014d). More recently, a magnitude-3.6 earthquake occurred off the Massachusetts coast in 2003 near Cape Ann (USGS, 2012b).

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." (Oregon Department of Geology, 2015). Subduction zones are

[52] 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.

found off the coast of Washington, Oregon, and Alaska (U.S. Geological Survey 2014). 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) Massachusetts is not located on a tectonic plate, although it is part of the Mesozoic rift[53] through central Massachusetts (Kafka, 2004).

Figure 8.1.3-5 depicts the seismic risk throughout Massachusetts. The map indicates levels of horizontal shaking (measured in Peak Ground Acceleration) that have a 2 percent chance of being exceeded in a 50-year period. Units on the map are measured in terms of acceleration due to gravity (% g). Most pre-1965 buildings are likely to experience damage with exceedances of 10% g.[54] (USGS, 2010)

Landslides

There are four types of landslides in Massachusetts: 1) construction related, 2) steep slopes undercut by flooding or wave action, 3) geologic conditions, and 4) slope saturation (Commonwealth of Massachusetts, 2013a). "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, 2003d). 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, 2003d)

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, 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, 2003d)

[53] Mesozoic rifts “are believed to be buried beneath sediments along continental margins of the United States.” (Kafka, 2004)
[54] Post-1985 buildings (in California) have experienced only minor damage with shaking of 60% g. (USGS, 2010)

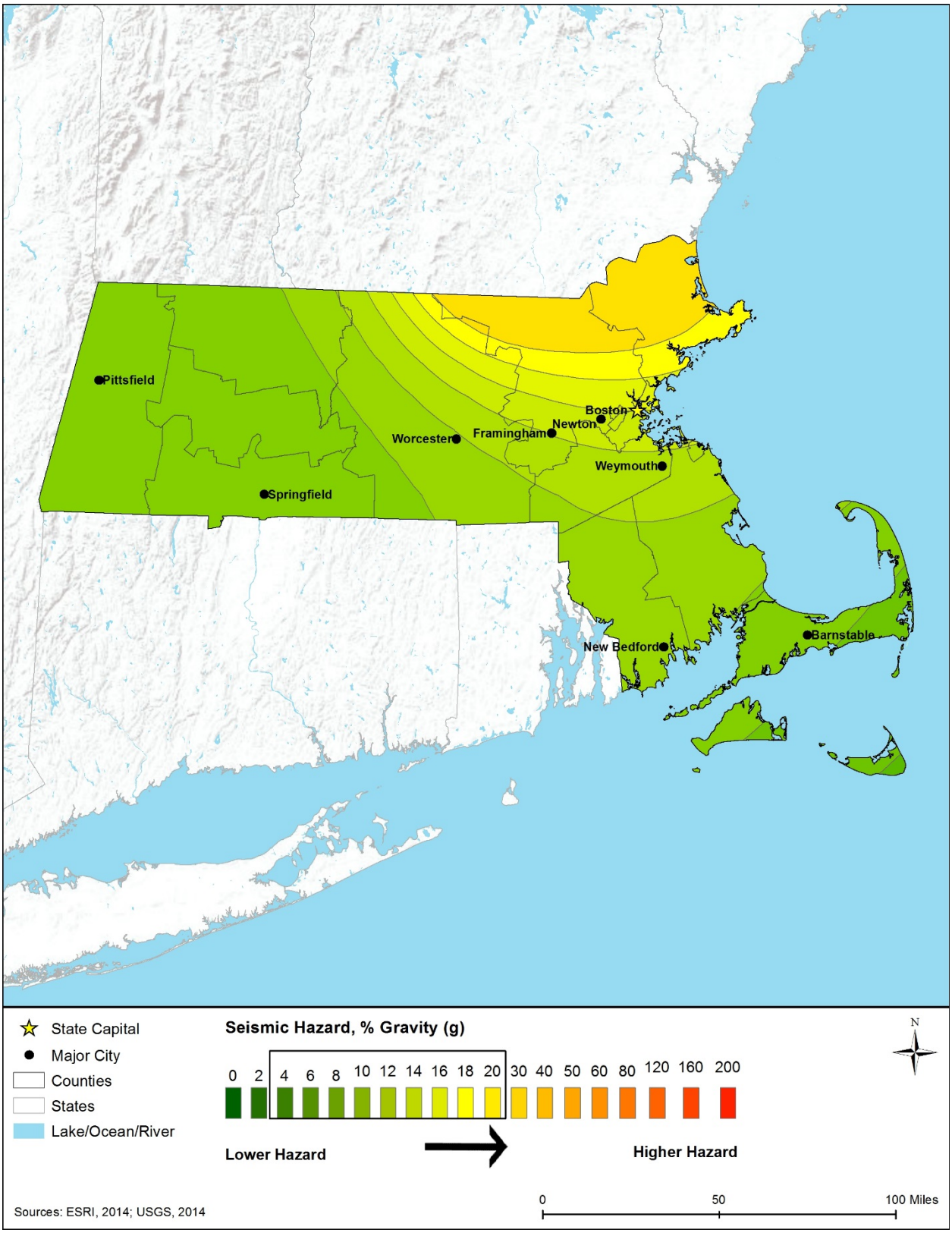


Figure 8.1.3-5: Massachusetts 2014 Seismic Hazard Map

Road construction that involves excavation into glacial deposits can result in landslides, especially in cases where excavated materials have been placed on top of the till. The contrast of materials with different permeability can cause failures along the intersection of the two layers. This type of failure is common along the Massachusetts Turnpike and in utility trenches. Landslides are also typical in Massachusetts's coastal areas where slopes are undercut during coastal storms, or along stream banks during flooding; this type of failure is problematic in locations that are underlain by unconsolidated glacial deposits, particularly in Cape Cod, Nantucket, Martha's Vineyard, Scituate, Newbury, and along some of the major river valleys. Landslides attributable to adverse geologic conditions can occur in areas that are underlain by clay soils, including the deepest parts of many of the glacial lakes (e.g., Bascom, Hitchcock, Nashua, Sudbury, Concord, and Merrimack). The fourth cause of landslides in Massachusetts, slope saturation, is most prevalent on steep slopes underlain by glacial till or bedrock, especially following heavy rains. (Commonwealth of Massachusetts, 2013a)

Figure 8.1.3-6 displays the landslide incidence and susceptibility for Massachusetts.

Subsidence

Land subsidence is a "gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials." The main triggers of land subsidence can be aquifer compaction, drainage of organic soils, mining, and sinkholes. 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. 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 causes slow drainage of water from the clay and silt beds. The reduced water pressure compromises support for the clay and silt beds, causing them to collapse on one another. The effects of this compression are seen in the lowering of the land surface elevation, which is permanent (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, 2013a)

Land subsidence throughout Massachusetts is estimated to be about 1.00 mm per year (EEA, 2011). Recent vertical land movement values for the National Oceanic and Atmospheric Administration (NOAA) Boston long-term tide gauge station has been measured at a decline of 0.84 mm per year (CZM, 2013). Another study suggests that land subsidence over the last century is estimated to have been 1.50 mm per year in Boston and 2.00 mm per year in nearby Revere (Kirshen, Knee, & Ruth, 2008).

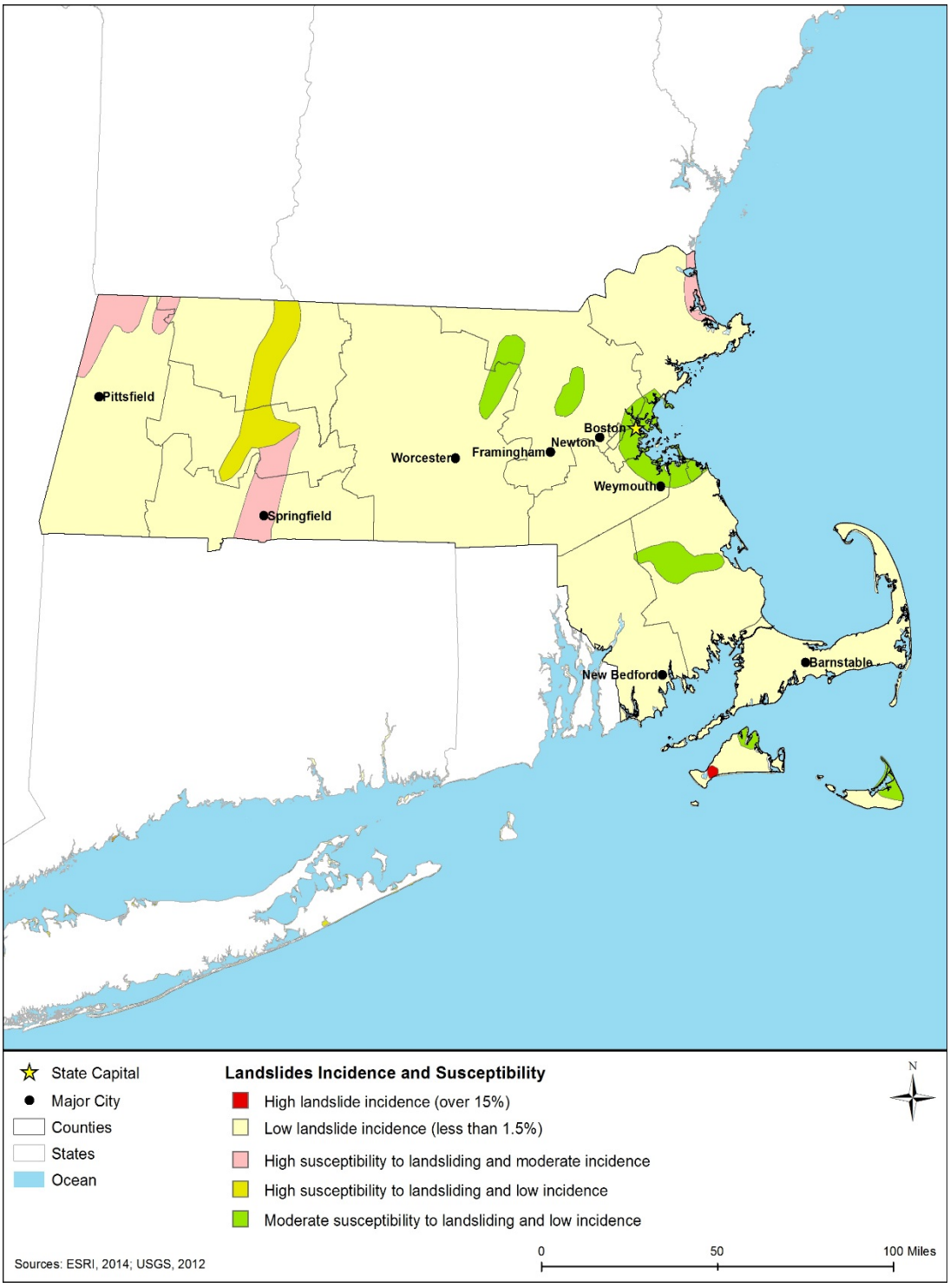


Figure 8.1.3-6: Massachusetts Landslide Incidence and Susceptibility Hazard Map[55]

[55] Susceptibility hazards not indicated in Figure 8.1.3-6 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, 2014e)

8.1.4. Water Resources

8.1.4.1. Definition of the Resource

Water resources are defined as all surface waterbodies and groundwater systems including streams, rivers, lakes, estuarine waters, floodplains, aquifers, and other aquatic habitats (wetlands are discussed separately in Section 8.1.5). 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 requirements. (USGS, 2014c)

8.1.4.2. Specific Regulatory Considerations

Federal laws relevant to protecting the quality and use of water resources are summarized in Appendix C. Table 8.1.4-1 summarizes the major Massachusetts laws and permitting requirements relevant to the state's water resources.

Table 8.1.4-1: Relevant Massachusetts Water Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Massachusetts Chapter 91 Waterways	MassDEP – Coastal Zone Management Program	Proposed activities or projects not involving construction or any work on structures or fill in publicly owned waterways including tidelands, Great Ponds,[56] and non-tidal rivers and streams (MassDEP, 2014a).
Massachusetts Watershed Protection Act	Massachusetts Department of Conservation and Recreation (MassDCR)	Regulates land use and activities within critical areas of the Quabbin Reservoir, Ware River, and Wachusett Reservoir watersheds. Within 400 ft. of the reservoirs and 200 ft. of tributaries and surface waters (the "Primary Protection Zone"), any alteration is prohibited. Between 200 and 400 ft. of tributaries and surface waters, and on land within flood plains, over some aquifers, and within bordering vegetated wetlands (the "Secondary Protection Zone"), certain activities are specifically prohibited (350 CMR 11.04) (MassDCR, 1994).
Massachusetts Water Management Act	MassDEP	Withdrawal of water from ground or surface sources for purposes in excess of an annual average of 100,000 gallons per day or 9 million gallons in any three-month period (MassDEP, 2013b).
Massachusetts Clean Waters Act	MassDEP	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 MassDEP indicating that the proposed activity will not violate water quality standards (MassDEP, 2014b).

[56] A Great Pond "is defined as any pond or lake that contained more than 10 acres in its natural state. Ponds that once measured 10 or more acres in their natural state, but which are now smaller, are still considered great ponds." (MassDEP, 2015g)

State Law/Regulation	Regulatory Agency	Applicability
North River Scenic and Recreational River Protective Order	MassDEP and North River Commission	Regulated activities within the North River Corridor, includes the North River, marshes, and the 300 ft. wide upland area on both sides of the River as well as parts of associated tributaries in the towns of Scituate, Marshfield, Pembroke, Norwell, Hanover, and Hanson (North River Commission, 2015a).
Massachusetts Groundwater Discharge Permit Program	MassDEP	Direct or indirect discharge of pollutants to groundwaters of the Commonwealth, including storm water discharges (MassDEP, 2009).
Massachusetts Surface Water Discharge Permit Program	MassDEP	Point source discharges of pollutants to surface waters of the Commonwealth under the provisions of state and federal clean-water legislation (MassDEP, 2007).

8.1.4.3. Environmental Setting: Surface Water

Surface water resources are lakes, ponds, rivers, and streams, as well as estuarine[57] and coastal waters. Massachusetts has 4,230 miles of rivers and more than 3,000 lakes and ponds, in addition to more than 1,500 miles of coastline (Commonwealth of Massachusetts, 2013a). 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 (Commonwealth of Massachusetts, 2012).

Watersheds

Watersheds, or drainage areas, consist of surface water and all underlying groundwater, and encompass an area of land that drains streams and rainfall to a common outlet (e.g., reservoir, bay). Massachusetts's waters (lakes, rivers, and streams) are divided into 27 major watersheds, or drainage basins (Figure 8.1.4-1). Massachusetts Appendix A, Table A-1: Characteristics of Massachusetts's Watersheds, provides detailed information on the state's major watersheds, as defined by MassDEP. Visit www.mass.gov/eea/waste-mgnt-recycling/water-resources/preserving-water-resources/mass-watersheds/ for information and additional maps about each MassDEP watershed's location, size, and water quality. (MassDEP, 2015h)

The Hudson, Housatonic, Deerfield, Westfield, Farmington, and Connecticut Watersheds cover western Massachusetts. The Chicopee Watershed is located in central Massachusetts and is the largest watershed in the state. It includes the Quabbin Reservoir, one of the largest manmade reservoirs in the United States (MassDEP, 2015i). Millers, Quinebaug and French, Nashua, Blackstone, and Charles Watersheds cover the remainder of central Massachusetts. Merrimack, SuAsCo, Shawsheen, Parker, Ipswich, and North Coastal Watersheds encompass the northeastern portion of Massachusetts. The eastern and southeastern coastline of Massachusetts include Boston Harbor, South Coastal, and Buzzards Bay. To the north of Buzzard Bay Watershed lies the Taunton Watershed, the second largest watershed in the state with wetlands, lakes, and ponds (MassDEP, 2015j). The Narragansett Bay/Mount Hope Bay Shores and Ten

[57] 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, 2015d)

Mile Watersheds lie along the Massachusetts/Rhode Island border. The far southeastern portion of Massachusetts includes the Cape Cod and Martha's Vineyard Island Watersheds. The salt waters of Buzzards Bay, Cape Cod Bay, the Atlantic Ocean, and Nantucket Sound surround the Cape Cod Watershed (MassDEP, 2015k).

Freshwater

As shown in Figure 8.1.4-2, there are eight major rivers in Massachusetts: Blackstone, Charles, Connecticut, Hoosic, Housatonic, Merrimack, Mystic, and Taunton. The Connecticut River is the largest river in the state and flows from north to south in the western half of Massachusetts. The Merrimack River in the northeastern part of the state empties into the Atlantic Ocean. South of the Merrimack River lies the Charles River which flows into Boston Harbor (Commonwealth of Massachusetts, 2015c). The Housatonic River flows south through a valley between the Berkshire Hills of western Massachusetts and the Taconic Mountain Range of eastern New York (MassDEP, 2015l). Massachusetts also contains more than 3,000 natural and manmade lakes and ponds, ranging from 1 acre to more than 24,000 acres in size (Aquatic Habitat Restoration Task Force, 2008). Some of the state's large lakes and dammed reservoirs provide flood control, hydropower[58] generation, and drinking water sources (USEPA, 2009a).

Major lakes and ponds in Massachusetts include Quabbin Reservoir, Wachusett Reservoir, and Assawompsett Pond (Figure 8.1.4-2).

- Quabbin Reservoir, in central Massachusetts.is "one of the largest manmade public water supplies in the United States." The reservoir covers approximately 24,469 acres and is fed by the Swift and Ware Rivers (MassDCR, 2016). The reservoir was created by constructing two dams and flooding the Swift River Valley. The Quabbin Reservoir is a major water supply to Metropolitan Boston and a popular fishing site. (MassDEP, 2015i)
- Wachusett Reservoir is northeast of Worcester in central Massachusetts, and is the second largest waterbody in the state, and a primary water supply for the Boston area (MassDEP, 2015m). Wachusett Reservoir is approximately 4,135 acres and was created by damming the South Branch of the Nashua River. The reservoir currently receives water from the Quabbin Reservoir via the Quabbin Aqueduct. (MassDCR, 2015a)
- The Assawompsett Pond is a large natural lake in the southeastern Massachusetts towns of Lakeville and Middleborough. Assawompsett Pond is approximately 2,656 acres and drained by the Taunton River (Commonwealth of Massachusetts, 2015c). Assawompsett Pond and Long Pond (a large natural pond in Massachusetts) share waters and act as an emergency water supply for the New Bedford area (MassDEP, 2001).

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

Figure 8.1.4-1: Major Massachusetts Watersheds, Defined by MassDEP

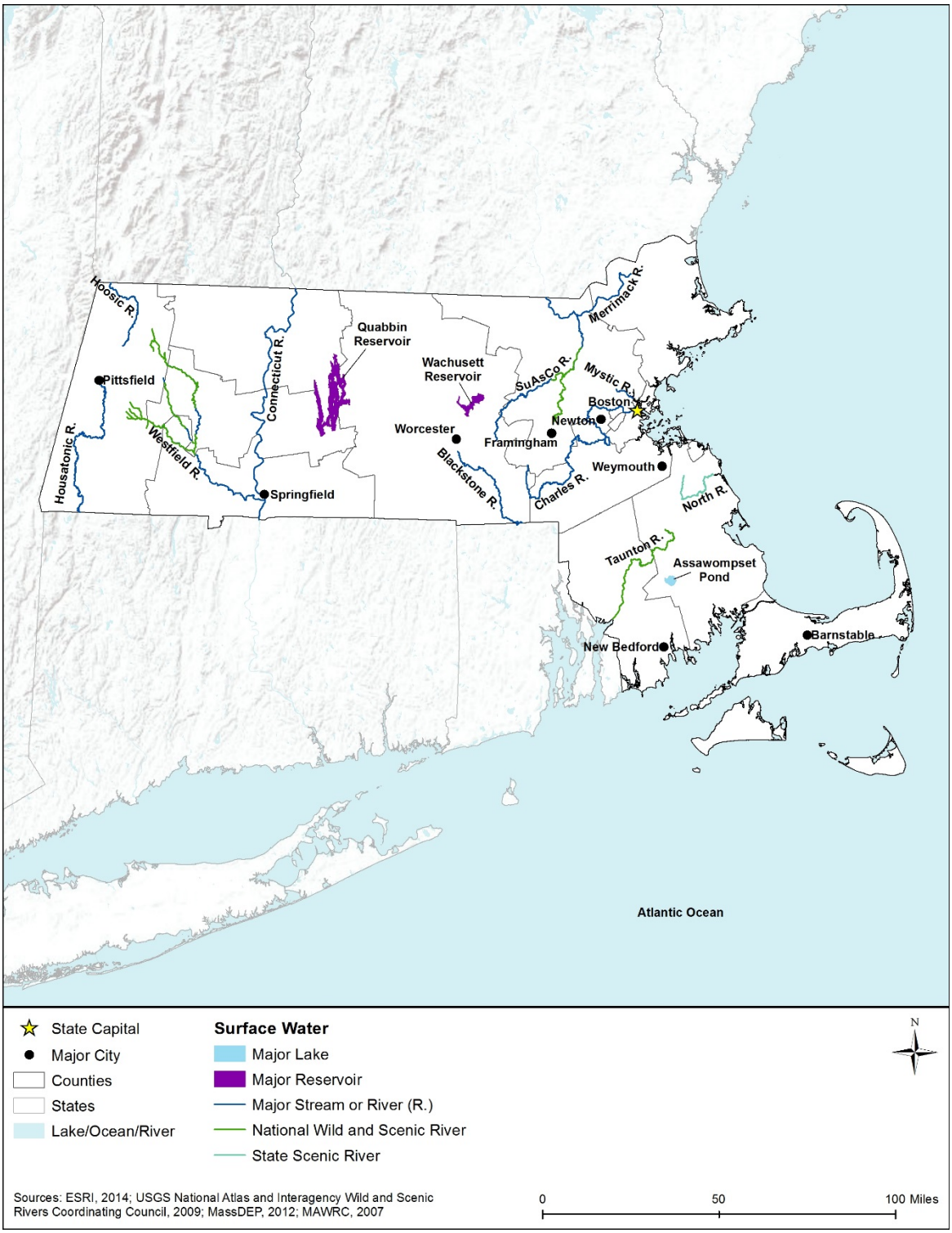


Figure 8.1.4-2: Major Massachusetts Surface Waterbodies

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 Massachusetts, from ocean waves and storms. Massachusetts'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)

According to the 2013 State Hazard Mitigation Plan, Massachusetts has six coastal zones: North Shore, Boston Harbor/Massachusetts Bay, South Shore, Cape Cod and Islands, and South Coast. These zones vary in topography with "rocky shores, sandy beaches, and salt marshes on the east coast, through rolling hills and fertile valleys, to wooded hills in the western part of the state" (Commonwealth of Massachusetts, 2013a). The Buzzards Bay and Massachusetts Bay National Estuary Programs (NEPs) are administered by the Massachusetts Office of Coastal Zone Management (MCZM), and funded by the Massachusetts EEA and the U.S. Environmental Protection Agency (USEPA). The USEPA, MCZM, and other state agencies, and local municipalities have developed management plans to address areas of concern and to develop protection and restoration strategies for these estuarine systems (MCZM, 2015a). Information on Massachusetts's estuaries is available on the MCZM National Estuary Program (NEP) site: www.mass.gov/eea/agencies/czm/national-estuary-programs.

The two major estuarine systems in Massachusetts are Buzzards Bay and Massachusetts Bays region (Figure 8.1.4-3):

- The **Buzzards Bay Estuary** encompasses approximately 280 miles of shoreline in southeastern Massachusetts with an "approximate length of 28 miles and width of 8 miles." The western shore of the bay receives freshwater input via several streams and major rivers, while groundwater and small streams on the eastern shore feed into Cape Cod and Elizabeth Islands. The Buzzards Bay Estuary is an ideal habitat for commercially important marine life such as finfish and shellfish species that use the eelgrass for food and shelter. (NOAA, 2015a) In 1987, the USEPA's NEP recognized Buzzards Bay as an Estuary of National Significance (MCZM, 2015b). Water quality within the Buzzards Bay Estuary is degrading due to nitrogen increases from various sources such as wastewater and coastal development. Current management goals for the estuary focus on reducing nitrogen inputs from "septic systems, agricultural lands, and point sources." (USEPA, 2009b) More information on the Buzzards Bay Estuary Program is available at www.mass.gov/eea/agencies/czm/national-estuary-programs/buzzards-bay/.
- The **Massachusetts Bays region** includes **Massachusetts Bay** and **Cape Cod Bay** with "over 800 miles of coastline, from the tip of Cape Cod Bay to the New Hampshire border" (MCZM, 2015c). The region extends more than 1,000 miles and forms the southern end of the Gulf of Maine. In 1990, USEPA's NEP recognized the Massachusetts Bays region as an

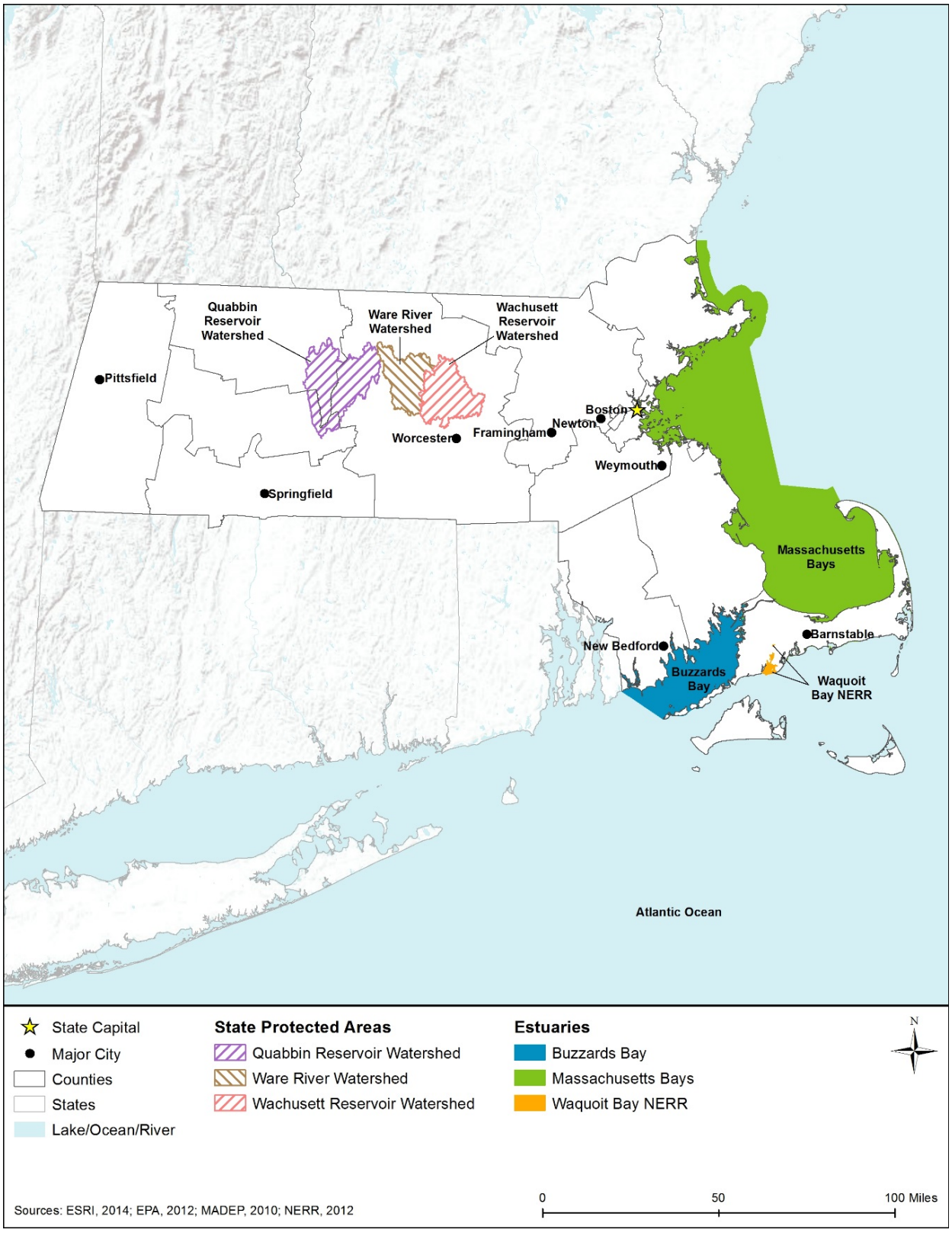


Figure 8.1.4-3: Massachusetts's Estuaries and Protected Waterbodies

Estuary of National Significance (MCZM, 2015d). Due to its size and complexity, Massachusetts has divided the area into five coastal subregions: Upper North Shore, Lower North Shore, Metro Boston, South Shore, and Cape Cod (MCZM, 2015c). Within these subregions, the Massachusetts Bays NEP has identified 47 nearshore estuaries (MCZM, 2015e). In 1996, the Massachusetts Bays NEP's (MassBays) Comprehensive Conservation and Management Plan (CCMP) identified areas of concern within the estuary, including shellfish, storm water, marine invasive species, and marine monitoring (MCZM, 2015f). For more information on the Massachusetts Bays region and CCMP, see www.mass.gov/eea/agencies/mass-bays-program/ccmp/.

Additionally, the Waquoit Bay National Estuarine Research Reserve (NERR) (Figure 8.1.4-4) is on the south shore of Cape Cod. The reserve encompasses "2,700 acres of open waters, barrier beaches, marshlands and uplands" (MassDCR, 2015b). The shallow waters of Waquoit Bay provide habitats for many fish and vegetative communities. The reserve is managed by the MassDCR in partnership with the NOAA, and is an important site for commercial and recreational activities (MassDCR, 2015c). More information is available at www.mass.gov/eea/agencies/dcr/massparks/region-south/waquoit-bay-national-estuarine-research-reserve.html.

Figure 8.1.4-4: Aerial View of Waquoit Bay National Estuarine Research Reserve, MA

Source: (Crawford, 1995)

8.1.4.4. Environmental Setting: Sensitive or Protected Waterbodies

Wild and Scenic Rivers

Three rivers in the state are designated as National Wild and Scenic Rivers (National Wild and Scenic Rivers System, 2015a): the Sudbury/Assabet/Concord (SuAsCo), the Taunton, and the Westfield Rivers (Figure 8.1.4-2).

- In April 1999, segments of the **SuAsCo Rivers** were designated as National Wild and Scenic Rivers. The designation includes a total of 29 miles of river with 10 miles within the Great Meadows National Wildlife Refuge. Located approximately 25 miles west of Boston, the rivers are largely undeveloped and include diverse aquatic and riparian habitats. (NPS, 2015c)
- In March 2009, the 40-mile main stem of the **Taunton River** was designated as a National Wild and Scenic River. The designation includes a segment in southern Massachusetts extending from the Taunton River headwaters to Mount Hope Bay. The river is the "largest freshwater contributor to the Narragansett Bay estuary in Rhode Island" and the longest undammed coastal river in New England. (NPS, 2015d)
- In November 1993 and October 2004, the **Westfield River** was designated as a National Wild and Scenic River for a total of 78 miles; the river features "historic villages, prime farmland, pristine wilderness areas, and waterfalls." (NPS, 2015e).

In addition to federally designated Wild and Scenic Rivers, Massachusetts passed the Scenic and Recreational Rivers Act in 1978 for protecting "irreplaceable wild, scenic and recreational river resources." The North River is a state scenic river and protected under the North River Commission in the Scenic and Recreational River Protective Order, restricting use and development of the North River and associated tributaries. (North River Commission, 2015b)

State Designated Protected Areas

The Quabbin Reservoir, Ware River, and Wachusett Reservoir watersheds are protected under the Massachusetts Watershed Protection Act (Figure 8.1.4-3). These watersheds comprise the MassDCR/Massachusetts Water Resource Authority (MWRA) system and supply an "estimated 2.2 million residents in three western Massachusetts and 39 eastern Massachusetts communities." (MassDEP, 2002a)

The Quabbin Reservoir watershed is located in central Massachusetts. The reservoir is found within the valley of Swift River. In addition to its role as a "terminal supply reservoir for the Chicopee Valley Aqueduct system in central Massachusetts," the Quabbin Reservoir is storage reservoir for the Quabbin Aqueduct system for Boston in the east. The Ware River watershed is located within north central Massachusetts, and does not have a permanent reservoir but functions as a tributary to the Quabbin Reservoir. The Wachusett Reservoir watershed is located in central Massachusetts, east of the Ware River. The Quabbin and Wachusett Reservoirs are ideal drinking water supplies as their waters are clear and rich in oxygen due to low nutrient levels and limited plant growth. (MassDCR, 2013)

Additionally, Massachusetts established Areas of Critical Environmental Concern (ACECs) Program in 1975 for those areas recognized for their "quality, uniqueness, and significance of their natural and cultural resources." As of 2010, Massachusetts has designated approximately 268,000 acres as ACECs (MassDCR, 2015d). Visit www.mass.gov/eea/docs /dcr/stewardship/acec/listacec.pdf for a complete list of ACECs in Massachusetts.

Massachusetts also protects Outstanding Resource Waters, such as designated waters within ACECs, Cape Cod National Seashore, protected shoreline, public water supply watersheds, retired public water supplies, scenic/protected rivers, and wildlife refuges (MassDEP, 2010a). Waters are designated for protection based on their "outstanding socioeconomic, recreational, ecological, and/or aesthetic values." (MassDEP, 2015n) For more information on Massachusetts' Outstanding Resource Waters, see www.mass.gov/anf/research-and-tech/it-serv-and-support.

8.1.4.5. 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,[59] the causes of impairment, and probable sources. Table 8.1.4-2 summarizes the water quality of Massachusetts's assessed major waterbodies by category, percent impaired, designated use,[60] cause, and probable sources. Figure 8.1.4-5 shows the Section 303(d) waters in Massachusetts as of 2012.

As shown in Table 8.1.4-2, various sources affect Massachusetts's waterbodies, causing impairments. According to the USEPA, 64 percent of Massachusetts's assessed rivers and streams are impaired. Designated uses of the impaired rivers and streams include fish and wildlife habitat, fish consumption, and recreation. (USEPA, 2015a). For example, the Charles River is impaired due to elevated nutrient levels, specifically phosphorus. MassDEP and USEPA work to reduce these levels by limiting stormwater runoff entering the river (USEPA, 2015b). Approximately 98 percent of the waters assessed for Massachusetts's lakes, reservoirs, and ponds are impaired, with designated uses including fish and wildlife habitat, fish consumption, and recreation. Lake Rohunta's waters are threatened by non-native aquatic vegetation and elevated mercury levels in fish (Millers River Watershed Advisory Committee, 2004). Approximately 88 percent of the state's estuaries and bays used for fish and wildlife habitat, primary and secondary contact recreation, and shellfish harvesting, are impaired. (USEPA, 2015a) More information on Massachusetts impaired waters is available from the USEPA's and MassDEP's water programs (USEPA, 2015c) (MassDEP, 2015o).

MassDEP has developed and implemented the Massachusetts Watershed Management Approach, a comprehensive approach to water quality management in Massachusetts.

59 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, 2015d)
60 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, 2015d)

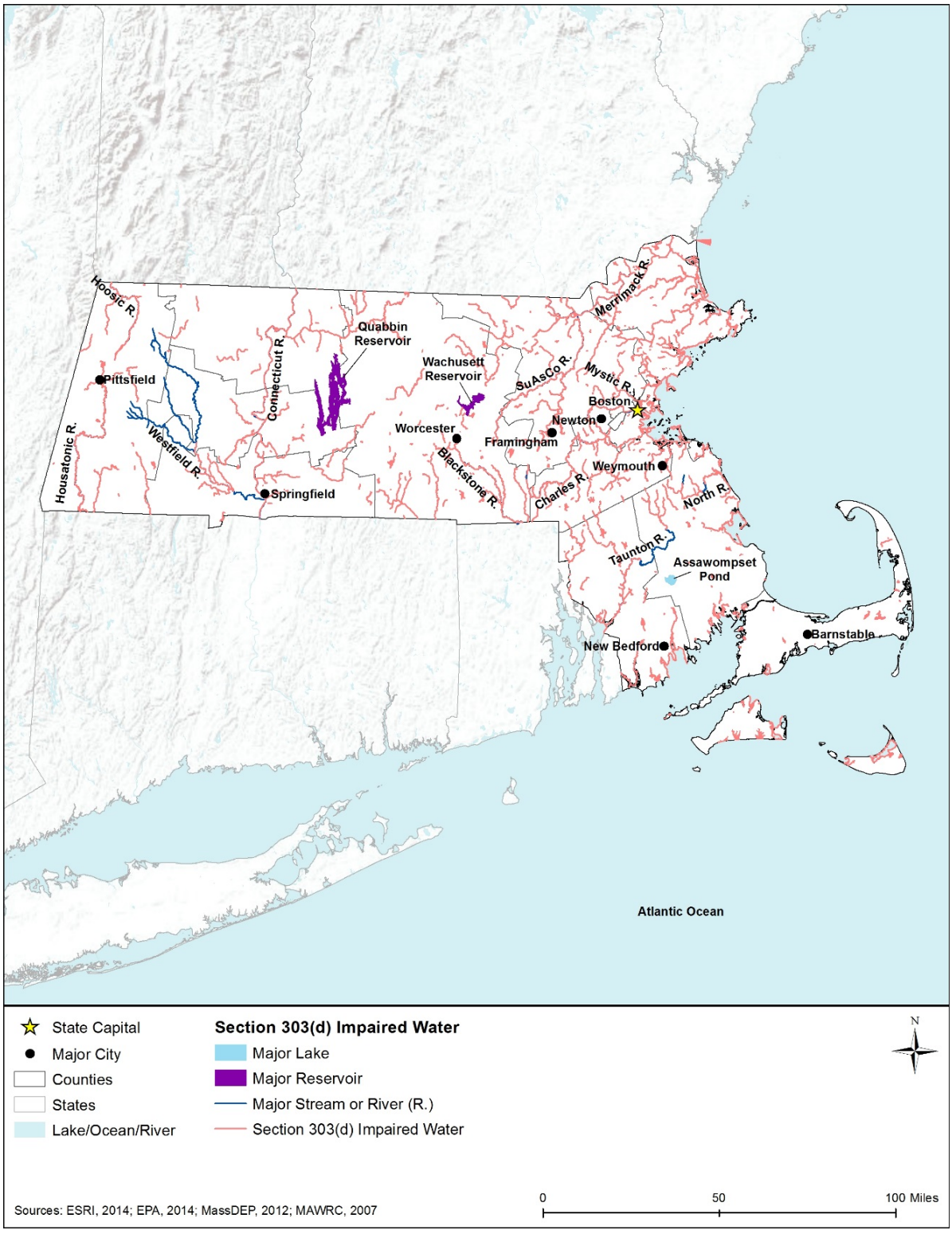


Figure 8.1.4-5: Section 303(d) Impaired Waters of Massachusetts, 2012

Table 8.1.4-2: Section 303(d) Impaired Waters of Massachusetts, 2012

Water Type[a]	Amount of Waters Assessed[b] (Percent)	Amount Impaired (Percent)	Designated Uses of Impaired Waters	Top Causes of Impairment	Top Probable Sources for Impairment
Rivers and Streams	28%	64%	aquatic life, fish consumption, and recreation	nutrients, polychlorinated biphenyls (PCBs), pathogens[c]	municipal point source discharges, urban storm water, introduction of non-native organisms
Lakes, Reservoirs, and Ponds	57%	97.5%	aquatic life, fish consumption, and recreation	Non-native aquatic plants and mercury in fish	atmospheric deposition[d] and introduction of non-native organisms
Estuaries and Bays	97.8%	87.5%	aquatic life, fish consumption, recreation, and shellfish harvesting	pathogens, PCBs, nutrients such as nitrogen and phosphorus	urban runoff/storm sewers, municipal point source discharges, and legacy pollutants

Source: (USEPA, 2015a)

[a] Some waters may be considered for more than one water type.
[b] Massachusetts 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).

Massachusetts citizens, along with industries, environmental groups, and community officials work to identify watershed concerns and develop plans to address these issues. The approach occurs in phases and includes watershed-based assessment, Total Maximum Daily Load evaluation, permitting, and implementation. For more information on this approach, visit www.mass.gov/eea/agencies/massdep/water/watersheds/the-watershed-management-approach.html. (MassDEP, 2015p)

8.1.4.6. 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 Code of Federal Regulations [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 Massachusetts:

- **Riverine and lake floodplains:** Occur along rivers, streams, or lakes where overbank flooding may occur, inundating adjacent land areas. In Massachusetts, riverine floodplains are located along major rivers such as the Connecticut and Housatonic Rivers, and smaller rivers such as the Ipswich and Three Mile Rivers (MDFW, 2007). High slope areas in western Massachusetts with minimal soil cover are prone to flash flooding. Heavy precipitation and spring snowmelt in these areas can cause floodwaters to build and recede quickly, with fast moving and deep water (Commonwealth of Massachusetts, 2013a). 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:** 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, as was the case during Hurricane Carol. The south coastal Cape Cod and Island basins in eastern Massachusetts have lower elevation and relief, and are more prone to coastal flooding (Commonwealth of Massachusetts, 2013a).

Flooding is the leading cause for disaster declaration by the President in the U.S. and results in significant damage throughout the state annually (NOAA, 2015b). There are several causes of flooding in Massachusetts, often resulting in loss of life and damage to property, infrastructure, agriculture, and the environment. These include heavy rainstorms, rapid snowmelt, hurricanes, tropical storms, and nor'easters.[61] (Commonwealth of Massachusetts, 2013a)

Based on historical flooding and flood disaster declarations, flood problems are most severe in Massachusetts counties within the Parker River, Ipswich River, North Coastal, Boston Harbor, and South Coastal watersheds. Massachusetts has experienced 20 major flood events over the past half century (Commonwealth of Massachusetts, 2013a). The storm surge from Hurricane Bob was 10 to 15 feet at Buzzards Bay, destroying homes and boats and causing significant erosion along the Massachusetts southern-facing coastline. (MCZM, 2015g)

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 350 communities in

[61] Macro-scale storm that usually impacts the northeast coast of the U.S. and has northeast winds that approach ahead of the storm.

Massachusetts through the National Flood Insurance Program (NFIP) (FEMA, 2014c). Established to reduce the economic and social cost of flood damage by subsidizing insurance payments, the NFIP encourages communities "to adopt and enforce floodplain management regulations and to implement broader floodplain management programs" and allows property owners in participating communities to purchase insurance protection against losses from flooding (FEMA, 2015b). 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 National Flood Insurance Program (NFIP) requirements for floodplain management. As of May 2014, Massachusetts had 18 communities participating in the CRS (FEMA, 2014d).[62]

Hurricane Bob

In 1991, Hurricane Bob affected North Carolina, Mid-Atlantic States, New England, and Atlantic Canada. In Massachusetts, this storm struck the southern coast with damaging winds and heavy rainfall. Estimated losses totaled $900 million in property damage from Westport east to New Bedford, Buzzards Bay, Cape Cod, and the Islands. Hurricane Bob also affected over 500 docked boats along the Massachusetts' coastline and caused approximately $10M in crop damage within the state (Commonwealth of Massachusetts, 2013a). The photograph below depicts the deposited sand from Hurricane Bob's storm surge at the Waquoit Bay NERR (NOAA, 1991).

Source: (NOAA, 1991)

8.1.4.7. 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, 1999b). 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.

Principal aquifers in the state consist of glacial deposits of stratified drift[63] and fractured bedrock. The majority of Massachusetts residents (approximately two-thirds) receive their drinking water from surface water supplies, while groundwater is the water supply for nearly all of Cape Cod and the Islands, as well as small communities throughout the state (MassDEP, 2012a). Statewide, the most serious threats to groundwater quality include nitrate contamination from

[62] A list of the 18 CRS communities can be found in the most recent FEMA CRS report dated May 1, 2014 (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).

[63] Stratified drift aquifers are comprised of layers of gravel and sand that were deposited by melting glaciers as the glaciers retreated. (Ayotte, Nielsen, Gilpin R. Robinson, & Moore, 1999)

point and nonpoint sources; trace element contamination (radon, arsenic, iron, manganese, mercury, chromium, and other metals) from both natural and human sources, including industrial facilities; pesticide contamination from agricultural and residential applications; and volatile organic compound contamination from military and industrial operations, and waste disposal activities. (USGS, 1997)

Table 8.1.4-3 provides details on aquifer characteristics in the state; Figure 8.1.4-6 shows Massachusetts's principal and sole source aquifers.

Table 8.1.4-3: Description of Massachusetts's Principal Aquifers

Aquifer Type and Name	Location in State	Groundwater Quality
New York and New England carbonate-rock aquifers Consolidated bedrock of limestone, dolomite, and marble and are generally soluble.	Western part of the state (particularly in Berkshire County)	Groundwater is very hard and slightly alkaline, with moderately high concentrations of dissolved solids Overall, the water is suitable for most uses. Where exposed, carbonate-rock aquifers are susceptible to contamination from the land surface because of their permeability. Groundwater is the principal source of water for small business or homes in the area.
Aquifers of Alluvial and Glacial Origin These aquifers consist mainly of the sand, gravel, and bedrock eroded by the glaciers.	Underlies much of the state	Suitable for most uses. Most widely used and most productive. Stratified-drift aquifers are susceptible to contamination as they are near the land surface in urbanized areas, less than 100 feet thick, and permeable. Groundwater is slightly acidic and has low concentrations of dissolved solids.
Early Mesozoic Basin Consolidated bedrock made up of sedimentary and crystalline (non-carbonate) rock.	Central part of the state	Water quality is generally good to excellent, and the groundwater is suitable for drinking and most uses. Water is generally slighting alkaline, low in dissolved solids, and moderately hard. Although these aquifers are the least productive of the principal aquifers, they are important sources of domestic water supplies in areas where the surficial and aquifer system is not present.

Source: (USGS, 1992), (USGS, 1997)

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, 2015e). Massachusetts has seven designated SSAs within the state (as shown in Figure 8.1.4-6). The majority of the Massachusetts population who live outside of major urban areas obtain their drinking water from wells within the designated SSAs (USGS, 1997). Designating a groundwater resource as an SSA helps to protect the drinking water supply in that area and requires reviews for all federally funded proposed projects to ensure that the water source is not jeopardized (USEPA, 2015e).

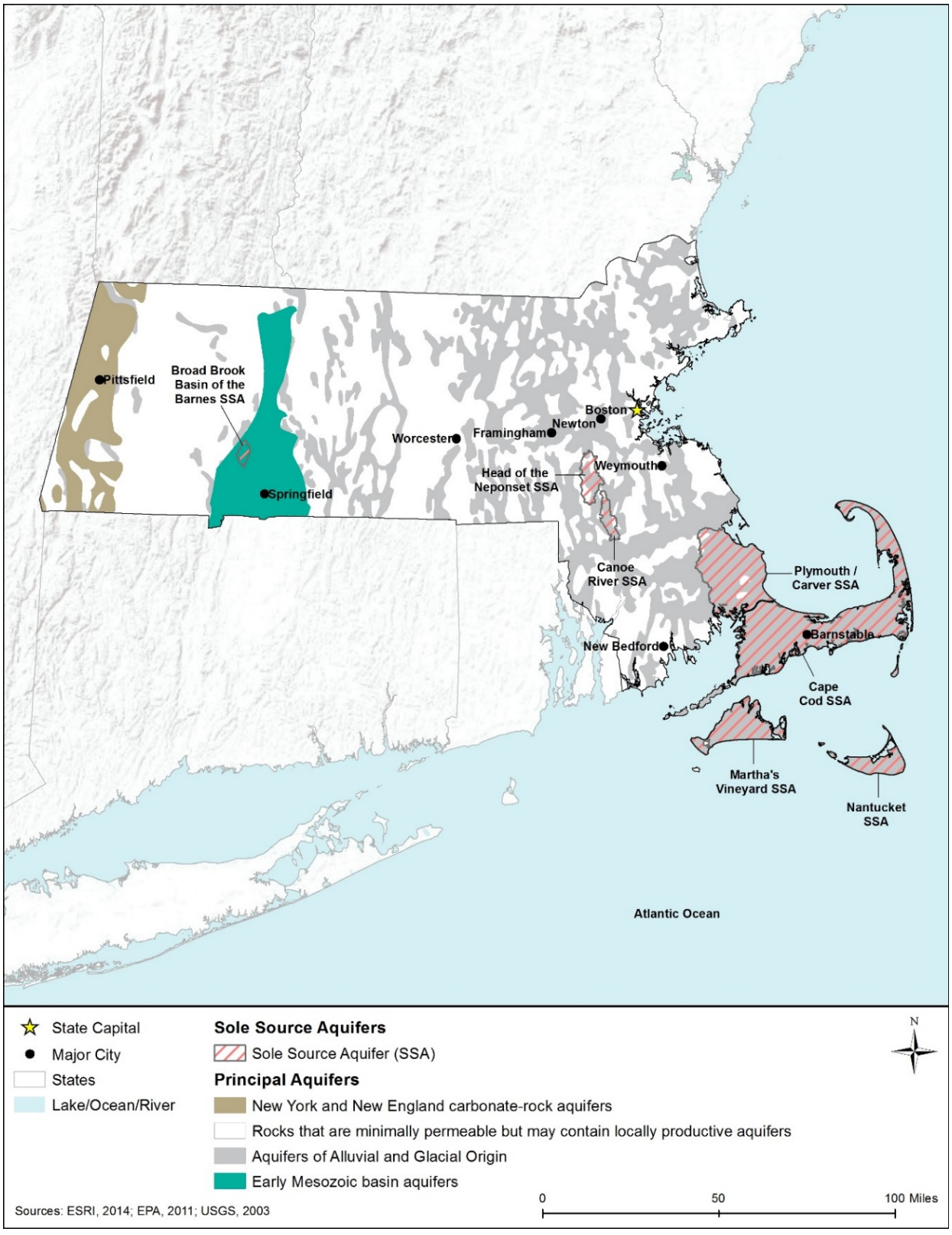


Figure 8.1.4-6: Principal and Sole Source Aquifers of Massachusetts

8.1.5. Wetlands

8.1.5.1. 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" (GPO, 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.

8.1.5.2. Specific Regulatory Considerations

Appendix C explains the pertinent federal laws to protecting wetlands in detail. Table 8.1.5-1 summarizes the major Massachusetts state laws and permitting requirements relevant to the state's wetlands.

Table 8.1.5-1: Relevant Massachusetts Wetlands Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
The Wetlands Protection Act (WPA) and Rivers Protection Act	MassDEP	Prohibits the removal, dredging, filling, or altering of wetlands without a permit. Protects not only wetlands, but also other resource areas, such as land subject to flooding (100-year floodplains), riverfront areas, and land under waterbodies, waterways, salt ponds, and the ocean.[64] In addition, a 100-foot buffer zone around any resource listed above is subject to jurisdiction. Projects that affect wetlands are required to avoid impacts where possible, minimize unavoidable impacts, and mitigate for unavoidable impacts (MassDEP, 2014a).
Inland and Coastal Wetlands Restriction Acts	MassDEP	Permanent restriction orders have been placed on selected wetlands in over 50 communities, for approximately 46,000 acres of coastal and 8,000 acres of inland wetlands, under this Act. The restriction orders provide added protection for selected wetlands by prohibiting certain activities in advance of any work being proposed. Affected municipalities have copies of the community's restricted wetlands plans and restriction orders. Restriction orders are implemented through the WPA permitting process. A list of towns with registered wetlands is available www.mass.gov/eea/agencies/massdep/water/watersheds/communities-with-previously-registered-wetlands.html (MassDEP, 2015q).

[64] Wetland resources include land under the ocean, coastal banks, coastal beaches and tidal flats, coastal dunes, barrier beaches, rocky intertidal, salt marshes, land under salt ponds, Designated Port Areas, land-containing shellfish, and land on the banks of fish runs.

State Law/Regulation	Regulatory Agency	Applicability
Areas of Critical Environmental Concern (ACEC) program	Massachusetts Department of Conservation and Recreation (DCR)	ACECs are complexes of natural resources that have been judged to be of statewide significance, and any project proposed in an ACEC is subject to a heightened regulatory review (MassDEP, 1987).
Section 401 of the Clean Water Act Water Quality Certification for Dredging	The Division of Wetlands and Waterways in the MassDEP	In accordance with Section 401 of the CWA, any activity that would result in a discharge of dredged material, dredging, or dredged material disposal greater than 100 cubic yards, that is also subject to federal regulation must obtain a 401 Water Quality Certification. Activities that may result in a discharge to waters of the U.S. require a Water Quality Certification from MassDEP indicating that the proposed activity will not violate water quality standards. (MassDEP, 2014b)

In addition, over 100 communities have their own wetlands protection bylaws in addition to state and federal laws (MassDEP, 2015r)

8.1.5.3. Environmental Setting: Wetland Types and Functions

The U.S. Fish and Wildlife Service's (USFWS) National Wetlands Inventory (NWI) mapping adopted a national Wetlands Classification Standard (WCS) that classifies wetlands according to shared environmental factors, such as vegetation, soils, and hydrology, as defined in (Cowardin, Carter, Golet, & LaRoe, 1979). The WCS includes five major wetland systems: Marine, Estuarine, Riverine, Lacustrine, and Palustrine (as detailed in Table 8.1.5-2). 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 Massachusetts, 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 the Atlantic shoreline, bays, and barrier islands. Riverine and lacustrine[65] wetlands comprise approximately one percent of the wetlands in the state. Therefore, they are not discussed in this PEIS. (EEA, 2015b)

Table 8.1.5-2 uses 2014 NWI data to characterize and map Massachusetts 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 that may be conducted, as appropriate, at the site-specific level once those locations are known. As shown in Figure 8.1.5-1, palustrine wetlands are throughout Massachusetts, while estuarine/marine wetlands are along the coast. The map codes and colorings in Table 8.1.5-2 correspond to the wetland types in the figure.

Table 8.1.5-2: Massachusetts 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.	Occur as large patches throughout the state, more in southeast	353,871
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 found along rivers and streams.	
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[66], prairie potholes, and sloughs.	Throughout the state, common in low-lying areas in floodplains.	88,236
Palustrine unconsolidated bottom	PUB	PUB and Palustrine Aquatic Bed (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	27,885
Palustrine aquatic bed	PAB	PAB wetlands include wetlands vegetated by plants growing mainly on or below the water surface line.		

[65] Associated with lakes.

[66] Fens are nutrient-rich, grass- and sedge-dominated emergent wetlands that are recharged from groundwater and have continuous running water. (et al. Edinger 2014)

Wetland Type	Map Code and Color	Description[a]	Occurrence	Amount (acres)[b]
Other Palustrine wetland	Misc. Types	Farmed wetland, saline seep,[67] and other miscellaneous wetlands are included in this group.	Common in abandoned fields, depressions (seeps), along hillsides and highways	4,689
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	750
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.	Throughout the state	5,622
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.	Along the coast and on barrier islands	58,829

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, et.al, 1979, some data has been revised based on the latest scientific advances. The USFWS uses these standards as the minimum guidelines for wetlands mapping efforts. (FGDC, 2013)

[b] All acreages are rounded to the nearest whole number. The maps are prepared from the analysis of high altitude imagery. A margin of error is inherent in the use of imagery. The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. (USFWS, 2015b)

Palustrine Wetlands

In Massachusetts, palustrine wetlands include the majority of vegetated freshwater wetlands (freshwater marshes, swamps, bogs, and ponds). Common tree types found in palustrine forested wetlands (PFO) in Massachusetts are red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), Atlantic white cedar (*Chamaecyparis thyoides*), and elms (U*lmus*). Palustrine scrub-shrub wetlands (PSS) in Massachusetts consist of dominant tree species such as alders (*Alnus sp.*), buttonbush (*Cephalanthus occidentalis)*, winterberry (*Ilex verticillata*), swamp azalea (*Rhododendron viscosum*), dogwoods (*Cornus*), hollies (*Ilex*), and highbush blueberries (*Vaccinium corymbosum*), fetterbush (*Lyonia*), and poison sumac (*Toxicodendron vernix*). PFO

[67] Saline seep is an area where saline groundwater discharges at the soil surface. Saline soils and salt tolerant plants characterize these wetland types. (City of Newton, Massachusetts, 2015)

and PSS are the most common type of palustrine wetlands within Massachusetts. Palustrine emergent wetlands (PEM), or freshwater marsh, fen, and slough[68], in Massachusetts support diverse plant and animal populations. Common PEM marsh plants in Massachusetts include cattails/bulrushes (*Typha*), loosestrifes (*Lythrum salicaria*), and arrowheads (*Sagittaria latifolia*). (MDFW, 2015a)

Based on the USFWS NWI 2014 analysis, PFO/PSS are the dominant wetland type (79 percent), followed by PEM (14 percent), PUB/PAB (ponds) (6 percent), and other palustrine wetlands (1 percent) (USFWS, 2014a). There are currently about 475,000 acres of palustrine (freshwater) wetlands in the state (USFWS, 2014a). Almost one-third of Massachusetts wetlands have been destroyed since the 1770s. Main threats to palustrine wetlands in Massachusetts include agricultural conversion and urbanization and associated impacts (road construction). Concerned about the historic loss of wetlands, the Massachusetts Legislature adopted the nation's first wetlands protection laws in the early 1960s. (MassDEP, 2015r)

Commercial and residential development are the main threats to palustrine wetlands in Massachusetts, despite strong environmental regulations. Additional threats include impaired water quality, conversion to agriculture, filling for development, and pollutants in runoff.

Vernal Pools

Vernal pools are a type of small, temporary palustrine wetland present in forested areas, though the pools themselves lack trees. The pools occur in shallow depressions that fill from spring or fall precipitation, and are usually dry by late summer or during droughts since they are not connected to a permanent water source. Woodland pools fill from rain, snowmelt, or groundwater. These small wetlands contribute to storage and filtration of surface water and help recharge aquifers. (Edinger, et al., 2014) Vernal pools can be found in wooded areas throughout the state. In 2000, a state inventory identified and cataloged approximately 30,000 potential vernal pools statewide. Specialists anticipate that the inventory underestimates the true amount of state vernal pools, since they can be small, hidden by trees, and are seasonal. To view locations of potential vernal pools, visit www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-ofgeographic-information-massgis/datalayers/pvp.html (MDFW, 2015a).

[68] Slough: “swamp or shallow lake system, usually a backwater to a larger body of water.” (NOAA, 2014)

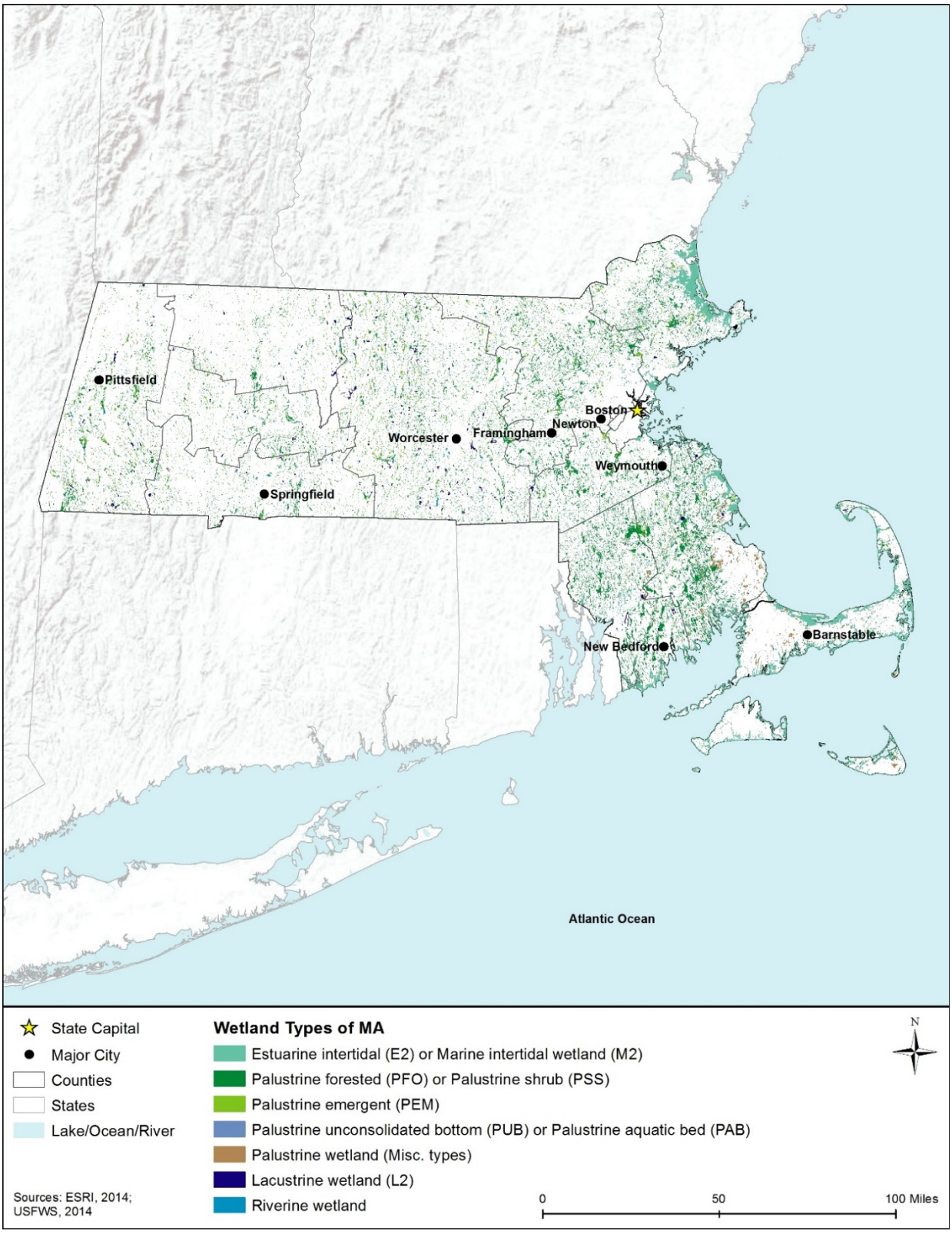


Figure 8.1.5-1: Wetlands by Type, in Massachusetts, 2014

Peatlands

Peatlands are freshwater wetlands where plants grow on partially decomposed plant remains. Peatland areas often include a mosaic of forested, shrub-covered, and open peatlands. Bogs are among the best-known peatlands and generally have the thickest peat. Bogs are acidic wetlands that form thick organic (peat) deposits up to 50 feet deep or more. (Edinger, et al., 2014) They have little groundwater influence and are recharged through precipitation. In cooler climate areas of the state, the stagnant, nutrient-poor, acidic water slows all processes in a bog, including nutrient recycling, making bogs very sensitive to external disturbance. Bogs are usually found in north central and in western Massachusetts, though they occur statewide. Most are dominated by dwarf shrub species growing on sphagnum moss, generally with pronounced hummock-hollow[69] topography (MDFW, 2015a).

Fens are nutrient-rich, grass- and sedge[70]-dominated emergent peatlands that are recharged from groundwater and have continuous running water. This wet meadow habitat supports distinctive plant communities, including many species that are restricted to Massachusetts. Calcareous fens (rich fens) in Massachusetts, found only in the western part of the state where groundwater carries calcium dissolved from surrounding limestone or marble, support a generally different flora than occurs in acidic fens. Calcareous fens are sedge-dominated wetlands occurring on slopes where there is calcareous[71] groundwater seepage. This type of fen supports many rare plant and animal species. (MDFW, 2015a)

Marshes and Wet Meadows

Marshes and wet meadows are some of the most important inland habitats for numerous species of animals, both rare and common. This habitat type includes deep and shallow emergent marshes, wet meadows, kettlehole wet meadows,[72] coastal interdunal marshes/swales,[73] calcareous sloping fens,[74] calcareous seepage marshes,[75] calcareous basin fens[76], and acidic graminoid fens.[77]

Palustrine wetlands also include the shallow water zones of lakes, rivers, and ponds and aquatic beds formed by water lilies and other floating-leaved or free-floating plants. These are the easiest wetlands to recognize and occur throughout the state (MDFW, 2015a).

[69] Characteristic of elevated, vegetated hummocks and lower elevation hollows.

[70] Sedge: an herbaceous plant with triangular cross-sectional stems and spirally arranged leaves (grasses have alternative leaves) typically associated with wetlands or poor soils.

[71] Containing calcium carbonate; chalky.

[72] Emergent herbaceous or mixed shrub/herbaceous communities that are restricted to small, usually less than five acres, seasonally inundated, kettle depressions in sandy glacial outwash.

[73] Small graminoid or shrub-dominated coast community occurring in shallow basins (swales) between sand dunes.

[74] Open, sedge-dominated wetlands occurring on slight to moderate slopes where there is calcareous groundwater seepage.

[75] Mixed herbaceous/graminoid/shrub wetlands that experience some calcareous groundwater seepage.

[76] Sedge-shrub peatlands occurring in well-defined basins that have calcareous groundwater, and sometimes surface water, inputs.

[77] Mixed graminoid/herbaceous acidic peatlands that experience some groundwater and/or surface water flow but no calcareous seepage.

Estuarine and Marine Wetlands

Coastal wetlands are directly adjacent to the ocean and include beaches, salt marshes, dunes, coastal banks, rocky intertidal shores, and barrier beaches. In Massachusetts, estuarine, or tidal fringe wetlands, can be vegetated (marshes) or unvegetated (mud and sand flats), and are found between the open saltwater of the bays or Atlantic Ocean and the uplands of the coastal plain and barrier islands. Estuarine wetlands include vegetated mudflats exposed at low tide, such as at Waquoit Bay, and salt marshes (tidally flooded grasslands) found in the near shore areas all around Cape Cod (Tiner, 2010).

Shoreline development is the greatest threat to coastal bays and estuaries in the state. Massachusetts has lost close to 30 percent of its coastal wetlands due to development. While wetland protection laws passed in the 1970s have reduced large-scale wetland loss, incremental loss continues. The increased amounts of impervious surface, with increased storm water runoff and accompanying potential for sedimentation and toxic contamination have led to impaired water quality within coastal and estuarine water quality. "Indirect sources, such as contamination from storm water runoff, oil and other toxic spills, and subsurface water withdrawal," also degrade wetlands in Massachusetts (MDFW, 2015a).

8.1.5.4. Wetlands of Special Concern or Value

In addition to protections under the state's Wetlands Protection Act and national CWA, Massachusetts considers certain wetland communities as areas of special value due to their global or regional scarcity, "unusual local importance," or habitat they support. These include wetlands associated with areas of critical environmental concern.

Massachusetts established the Areas of Critical Environmental Concern (ACECs) Program in 1975. ACECs receive "special recognition because of the quality, uniqueness, and significance of their natural and cultural resources." As of 2010, Massachusetts designated approximately 268,000 acres of ACECs (MassDCR, 2015d). See Section 8.1.4.4 for additional information regarding ACECs in Massachusetts.

Other Important Wetland Sites

Other important wetland sites in Massachusetts include the following:

- Massachusetts state parks are designated for outdoor recreation and many of these public lands have wetlands for birdwatching and other activities (MassParks, 2015). To learn more about Massachusetts state parks and wetlands for birdwatching, visit www.mass.gov/eea/agencies/dcr/massparks/.
- Eleven designated National Natural Landmarks in Massachusetts range in size from 20 acres to nearly 5,000 acres, and are owned by state organizations, the Wampanoag Tribe of Gay Head, The Nature Conservancy, counties, municipalities, and other conservation organizations and individuals (NPS, 2012a). Section 8.1.8, Visual Resources, describes Massachusetts'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 Natural

Resources Conservation Service (NRCS) Agricultural Conservation Easement Program, Farm Service Agency Conservation Reserve Program, and easements managed by natural resource conservation groups such as state land trusts, The Nature Conservancy and Wetlands America Trust. 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 3,600 acres in conservation easements in Massachusetts (NCED, 2015).

For more information on Massachusetts's wildlife management areas, National Natural Landmarks, conservation programs, and easements, see Section 8.1.8, Visual Resources, and Section 8.1.7, Land Use, Recreation, and Airspace.

8.1.6. Biological Resources

8.1.6.1. Definition of the Resource

This section describes the biological resources for Massachusetts. Biological resources include terrestrial[78] vegetation, wildlife, fisheries and aquatic habitats, and threatened and endangered species, and communities and species of conservation concern. Wildlife habitat and associated biological ecosystems are also important components of biological resources. Because of the topographic variation within the state, and its location along the Atlantic coast, Massachusetts supports biological resources ranging from marine[79] and estuarine habitat[80] settings along the coast near Massachusetts Bay, Cape Cod Bay, and Nantucket Sound in the east, to deciduous[81] and coniferous[82] forests in the montane Berkshire and Connecticut Valley regions of the west. Each of these topics is discussed in more detail below.

8.1.6.2. Specific Regulatory Considerations

The federal laws relevant to the protection and management of biological resources in Massachusetts are summarized in Appendix C. Table 8.1.6-1summarizes the major state laws relevant to the Massachusetts's biological resources.

Table 8.1.6-1: Relevant Massachusetts Biological Resources Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Massachusetts General Laws (MGL) Chapter 131 Inland Fisheries and Game and Other Natural Resources §1-181	Massachusetts Division of Fisheries and Wildlife (MDFW)	Provides a list of laws and regulations related to inland fisheries, wildlife management, the natural heritage and endangered species program, and hunting.

[78] Terrestrial: "Pertaining to the land." (USEPA, 2015f)

[79] Marine: "Any marine environment, from pond to ocean, in which plants and animals interact with the chemical and physical features of the environment." (USEPA, 2015f)

[80] Estuarine habitat: "An estuary is the area where a river or stream connects to the open sea or ocean, estuarine includes the estuary and its associated habitats such as seagrasses and shellfish beds." (USEPA, 2015f)

[81] Deciduous: "Trees such as oaks and maples that lose their leaves during part of the year. (USEPA, 2015f)

[82] Coniferous: "Cone-bearing trees, mostly evergreens that have needle-shaped or scale-like leaves. They produce wood known commercially as softwood." (USEPA, 2015f)

State Law/Regulation	Regulatory Agency	Applicability
MGL Chapter 128 Section 2 and §16 through 31A: Massachusetts Prohibited Plant List	Massachusetts Department of Agricultural Resources (MDAR)	All plants on the prohibited plant list are banned from importation, propagation, or sale within Massachusetts. The ban is limited to the importation, sale, trade, distribution, and related activities of these plants, and does not impact existing plantings.
Massachusetts Endangered Species Act (MESA) Chapter 131A §1 – 7; 321 Code of Massachusetts Regulations (CMR) 10.00 – 10.99	MDFW	Regulates the possession of plant and animal species listed as endangered, threatened[83], of special concern[84] or listed under the Federal Endangered Species Act (ESA). Also regulates the alteration of habitat and the passion, transfer, and sale of artifacts. It outlines exceptions to the regulation and outlines the criteria for determining endangered, threatened, or special concern status plant and animal species (EEA, 2016a). Currently, the MDFW lists: 10 fish, 4 amphibians, and 15 reptiles, 29 birds, 14 mammals, 106 invertebrates, and 260 plants (EEA, 2016a). The MESA list compares to 21 federally listed species that consists of 15 endangered species and 6 threatened species, including 5 mammals, 6 reptiles, 2 birds, 1 fish, 4 invertebrates, and 3 plants.

8.1.6.3. Terrestrial Vegetation

The distribution of flora within Massachusetts is a function of the characteristic geology,[85] soils, climate, and water of a given geographic area and correlates to distinct areas identified as ecoregions.[86] Ecoregions are broadly defined areas that share similar characteristics, such as climate, geology, soils, and other environmental conditions, and represent ecosystems contained within the region. The boundaries of an ecoregion are not fixed, but rather depict a general area with similar ecosystem types, functions, and qualities (NWF, 2015) (USDA, 2015a) (WWF, 2015).

Ecoregion boundaries often coincide with physiographic[87] regions of a state. The ecoregions mapped by the USEPA are the most commonly referenced, although individual states and organizations have also defined ecoregions that may differ slightly from those designated by the

[83] Threatened: "Any species of a plant or animal likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range including, but not limited to, species listed from time to time as "threatened" under the provisions of the Federal Endangered Species Act of 1973, as amended, and any species declining or rare as determined by biological research and inventory and likely to become endangered in the foreseeable future." (Commonwealth of Massachusetts, 2015a)

[84] Species of Concern: "Any species of plant or animal which has been documented by biological research and inventory to have suffered a decline that could threaten the species if allowed to continue unchecked or that occurs in such small numbers or with such a restricted distribution or specialized habitat requirements that it could easily become threatened within the commonwealth" (Commonwealth of Massachusetts, 2015a).

[85] 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.

[86] Ecoregion: "A relatively homogeneous ecological area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables." (USEPA, 2015f)

[87] Physiographic: "The natural, physical form of the landscape." (USEPA, 2015f)

USEPA. The USEPA 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 have 84 ecoregions. This section presents a discussion of biological resources for Massachusetts at USEPA Level III ecoregion (USEPA, 2015f).

As shown in Figure 8.1.6-1, the USEPA divides Massachusetts into three Level III ecoregions: Northeastern Highlands, Northeastern Coastal Zone, and Atlantic Coastal Pine Barrens. The Atlantic Coastal Pine Barrens is essentially Cape Cod. The Northeastern Highlands are mostly the Berkshires and Western Massachusetts, although it does also occur in Central Massachusetts.

Northeastern Coastal Zone encompasses the South Shore, Boston area, and North Shore and then goes west to intertwine with the Northeastern Highlands in Central Massachusetts.

These three ecoregions support a variety of different plant communities; all predicated on their general location within the state. Plant communities range throughout the state. There are coniferous spruce -fir at high elevations and northern hardwood forests at lower elevations in the northeast portion of the state. In contrast, there are rolling hills with hardwood forests and elm-ash red maple and red and white pine in the low lands in the northeastern portion of the state. Areas adjacent to the coast have a milder climate and consist of rivers, ponds, estuaries, wetlands, and cranberry bogs. Sandy beaches, grassy dunes, bays, marshes, and scrubby oak-pine forests also characterize the coastal area. Table 8.1.6-2 provides a summary of the general abiotic[88] characteristics, vegetative communities, and the typical vegetation found within each of the three Massachusetts ecoregions.

Communities of Concern

Massachusetts contains several vegetative communities of concern that include rare natural plant communities, plant communities with vulnerability or sensitivity to disturbance, and communities that provide habitat for both 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 generated by the proposed project. This ranking system also provides an indication as to the level of potential impact a particular community could experience from an action.

The Massachusetts Natural Heritage and Endangered Species Program (NHESP), part of the Massachusetts Division of Fisheries and Wildlife (MDFW) manages a statewide inventory that includes lists of all types of natural communities known to occur, or that have historically occurred, in the state. The 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 threat, as well as the species element ranking developed for the Natural Heritage system by The Nature Conservancy and maintained by NatureServe[89]. As with most state heritage programs, the Massachusetts NHESP ranking

[88] Non-living.

[89] NatureServe is a non-profit organization that provides high-quality scientific expertise for conservation projects with over 1,000 conservation professionals from the U.S., Canada, and Latin America (www.natureserve.org).

system assesses rarity using a state rank (S1, S2, S3, S4, S5) assigned by the state. The state rank indicates rarity within Massachusetts. Typically, this rank is based on the range of the community, the number of occurrences, the viability of the occurrences, and the vulnerability of the community. As new data become available, ranks are revised as necessary to reflect the most current information (Kearsley & Swain, 2001).

Massachusetts NHESP considers natural community types ranked S1, S2, and S3 to be priority for conservation, or priority natural communities. Community types ranked S4 and S5 are more common, and only exemplary examples of these are tracked in the NHESP database (EEA, 2016b). Natural community types assigned a rank of "S1" include critically imperiled species because of extreme rarity, where the species consist of five or fewer occurrences, or very few remaining individuals, acres, or miles of stream. Communities with an S1 rank may also be especially vulnerable to extirpation[90] in Massachusetts for other reasons (MDFW, 2013) (NatureServe, 2016).

There are 12 vegetative communities that are ranked as S1 communities[91] in Massachusetts; these communities represent the rarest terrestrial habitat in the state and comprise a small area of Massachusetts's total land area (EEA, 2016b). In Massachusetts, several S1-ranked communities occur in the far western highland areas of the state, but the majority of the communities are rare coastal communities in the Northeastern Coastal Zone and Atlantic Coastal Pine Barren ecoregions. Massachusetts Appendix B, Table B-1 provides a description of the S1 communities along with their distribution and associated USEPA Level III ecoregions.

Massachusetts also implements the 2005 Comprehensive Wildlife Conservation Strategy (CWCS), also known as the Massachusetts State Wildlife Action Plan (WAP). The WAP is a comprehensive document that helps guide wildlife conservation decision making for MDFW. The last Massachusetts WAP was completed in 2005 (EEA, 2016c). A Final Draft of the 2015 Massachusetts WAP was made available in July 2015 (MDFW, 2015a).

[90] Local extinction.

[91] S1 – Communities "at high risk because of extremely limited and/or rapidly declining population numbers, range and/or habitat, making it highly vulnerable to global extinction or extirpation in the state." (Montana Natural Heritage Program, 2016)

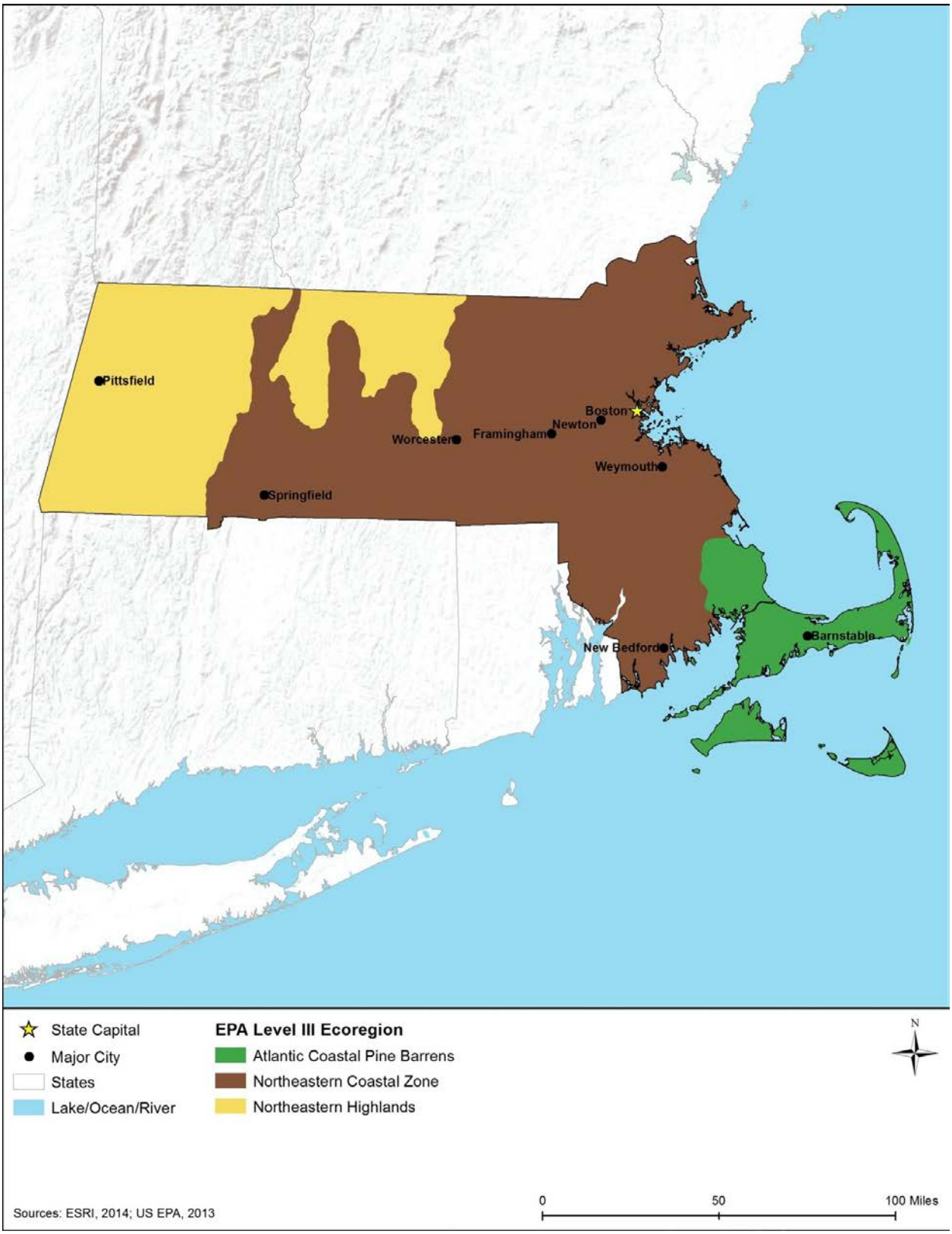


Figure 8.1.6-1: USEPA Level III Ecoregions in Massachusetts

Table 8.1.6-2: USEPA Level III Ecoregions of Massachusetts

Ecoregion Number	Ecoregion Description	Abiotic Characterization	General Vegetative Communities	Typical Vegetation
Geographic Region: Western Massachusetts/Berkshires/Central Massachusetts				
58	Northeastern Highlands	Composed mostly of forested hills and mountains on nutrient poor soils, with numerous high-gradient streams and glacial[92] lakes	Maple-Beech-Birch; Spruce-Fir; Oak-Hickory	• **Hardwoods** – maples (*Acer sp.)*; oaks (*Quercus sp.)*; bitternut hickory (*Carya cordiformis*); American beech (*Fagus grandifolia*); birches (*Betula sp.*); white walnut (*Juglans cinera*); spruces (*Picea asp.*); eastern hemlock (*Tsuga Canadensis*) • **Conifer Trees** – balsam fir (*Abies balsamea*); white pine (*Pinus strobus*) • **Shrubs** – highbush blueberry (*Vaccinium corymbosum*); mountain laurel (*Kalmia latifolia*)
Geographic Region: North Shore/Metro Boston/South Shore/Central Massachusetts				
59	Northeastern Coastal Zone	Composed of irregular plains and plains with high hills, on nutrient poor soils with numerous glacial lakes	Appalachian Oak Forest and Northeastern Oak-Pine Forest	• **Hardwoods** – oaks; sweetgum (*Liquidambar styraciflua*); persimmon (*Diospyrun sp.)*; red maple (*Acer rubrum*); black birch (*Betula lenta*); American chestnut (*Castanea dentate*); hickories (*Carya sp.*) • **Conifer Trees –** white pine; pitch pine (*Pinus rigida*) **Shrubs** – American holly (*Ilex opaca*); eastern dogwood (*Cornus florida*)
Geographic Region: Cape Cod				
84	Atlantic Coastal Pine Barrens	Transitional ecoregion, distinguished from the adjacent coastal ecoregion to the south by its coarser-	Dwarf Pine; Pitch Pine-Oak; Coastal Shrub	• **Hardwoods** – oaks; black gum (*Nyssa sylvatica*); eastern red cedar (*Juniperus virginiana*) • **Conifer Trees** – pitch pine

[92] Glacial: "Of or pertaining to distinctive processes and features produced by or derived from glaciers and ice sheets." (USEPA, 2015f)

Ecoregion Number	Ecoregion Description	Abiotic Characterization	General Vegetative Communities	Typical Vegetation
		grained soils, cooler climate, and oak-pine vegetation		• **Shrubs** – northern bayberry (*Myrica pensylvanica*); mountain laurel; sassafras (*Sassafras* spp.)

Sources: (Griffith, et al., 2009) (Elias, 1989) (Petrides, 1986) (USEPA, 2013a)

To manage the threats and conservation actions for over 555 Species of Greatest Conservation Need (SGCN) in the state – specifically 281plant species listed as SGCN – MDFW assigns each species to one or more of the 24 State WAP habitats (MDFW, 2015a). These State WAP habitats are general and do not correspond to the natural communities described above, rather they serve as categories to discuss the SGCN (MDFW, 2015a). The 24 State WAP habitats are broken into three categories: large-scale, medium-scale, and small-scale; these reflect the relative sizes in acreage of the State WAP habitats (MDFW, 2015a). The updated 2015 Massachusetts WAP large-scale habitats include: Connecticut and Merrimack Mainstems, Large and Mid-Sized Rivers, Marine and Estuarine Habitats, Northern Hardwoods-Spruce-Fire Upland Forest, Transition Hardwoods-White Pine Upland Forest, Central Hardwoods-White Pine Upland Forest, Pitch Pine-Oak Upland Forest, and Large Unfragmented Landscape Mosaics. Medium-scale habitats include: Small Streams; Shrub Swamps; Forested Swamps; Lakes and Ponds; Salt Marsh; Coastal Dunes; Beaches, and Small Islands; Grasslands; Young Forests and Shrublands; and Riparian Forest. Small-scale habitats include: Vernal Pools; Coastal Plain Ponds; Springs, Caves and Mines; Peatlands and Associated Habitats; Marshes and Wet Meadows; Rocky Coastlines; and Rock Cliffs, Ridgetops, Talus Slopes, and Similar Habitats (MDFW, 2015a).

The updated 2015 Massachusetts WAP includes the same list of the State WAP habitats in the 2005 Massachusetts WAP, with two exceptions. The Upland Forest habitat was broken into three major types of forests in Massachusetts. Also, the earlier Pitch Pine/Scrub Oak habitat was changed to Pitch Pine-Oak Upland Forest to better reflect the variety in this forest type (MDFW, 2015a).

Nuisance and Invasive Plants

Nuisance and invasive plants is a broad category that includes a large number of undesirable plant species that are non-native to areas with the potential to spread causing harm to the environment, local economy, and human health. Noxious weeds[93] are typically non-native species that have been introduced into an ecosystem inadvertently; however, on occasional native species can be considered a noxious weed. Noxious weeds greatly affect agricultural areas, forest management, natural, and other open areas (U.S. Legal, 2015). The U.S. government has designated certain plant species as noxious weeds in accordance with the Plant Protection Act of 2000 (7 United States Code [U.S.C.] 7701 *et seq.*). As of September 2014, 112 federally recognized noxious weed species have been catalogued in the United States (88 terrestrial, 19 aquatic, and 5 parasitic) (USDA, 2015b). Of the 2,263 plant species in Massachusetts documented as native or naturalized, approximately 725 (32 percent) are naturalized (or non-native). Of these, the MDAR recognizes 156 of these species as noxious weeds (MDAR, 2016). The Massachusetts Invasive Plant Advisory Group (MIPAG), which represents research institutions, non-profit organizations, and state and federal agencies recognizes 66 of the species as "invasive," "likely invasive," or "potentially invasive" (MIPAG,

[93] Noxious weeds: "any living stage (e.g., seeds and reproductive parts) of any parasitic or other plant of a kind, or subdivision of a kind, which is of foreign origin, is new to or not widely prevalent in the U.S., and can directly or indirectly injure crops, other useful plants, livestock, or poultry or other interests of agriculture, including irrigation, or navigation or the fish and wildlife resources of the U.S. or the public health." (USDA, 2011)

2005). Once the 66 invasive plant species were recognized by MIPAG, MDAR issued a rulemaking adding the invasive plants to the list of noxious weeds. As a result, Massachusetts maintains a *Prohibited Plant List* to regulate noxious weeds and invasive plants at the state level (MDAR, 2016).

Massachusetts state regulation prohibits the importation, sale, and trade of any plants on the list; it also covers the purchase and distribution of the plants, but it does not affect any existing plantings. While the 156 prohibited noxious weed species catalogued and regulated in Massachusetts (MDAR, 2016) (USDA, 2016) includes plants found to be invasive in Massachusetts, MDAR also lists species included on the U.S. Department of Agriculture's (USDA) Noxious Weed List since it is illegal to bring these species into the country and transport them across state lines. Therefore, MDAR has listed these species to compliment federal requirements. Table 8.1.6-3 includes the complete prohibited plant list for Massachusetts.

Table 8.1.6-3: Massachusetts Prohibited Plant List

Common Name	Scientific Name
Aeginetia	*Aeginetia spp.*
African boxthorn	*Lycium ferrocissimum*
African couch grass	*Digitaria abyssinica; D. scalarum*
African feathergrass	*Pennisetum macrourum*
Alectra	*Alectra spp.*
Alfombrilla	*Drymaria arenarioides*
Ambulia	*Limnophila sessiliflora*
Amur cork-tree	*Phellodendron amurense*
Amur honeysuckle	*Lonicera maackii*
Anchored water hyacinth	*Eichhornia azurea*
Animated oat	*Avena sterilis*
Argentine screwbean	*Prosopis strombulifera*
Arrowhead	*Sagittaria sagittifolia*
Asian sprangletop	*Leptochloa chinensis*
Autumn olive	*Elaeagnus umbellata*
Bell's honeysuckle	*Lonicera x bella [L. morrowii x L. tatarica]*
Benghal dayflower	*Commelina benghalensis*
Bishop's weed; goutweed	*Aegopodium podagraria*
Black locust	*Robinia pseudoacacia*
Black swallow-wort; Louise's swallow-wort	*Cynanchum louiseae*
Border privet	*Ligustrum obtusifolium*
Borreria	*Spermacoce alata*
Brazilian satintail	*Imperata brasiliensis*
Anacharis, Brazilian waterweed; Brazilian elodea	*Egeria densa; Elodea densa; Anacharis densa*
Brittle water-nymph; lesser naiad	*Najas minor*
Broad-leafed pepperweed; tall pepperweed	*Lepidium latifolium*

Common Name	Scientific Name
Broomrape	*Orobanche spp.*
Brownbeard rice; red rice	*Oryza rufipogon*
Burning bush; winged euonymus	*Euonymus alatus*
Bushy rock-cress; narrowleaf bittercress	*Cardamine impatiens*
Cape tulip	*Homeria spp.; Morea spp.*
Carolina Fanwort; fanwort	*Cabomba caroliniana*
Catclaw mimosa	*Mimosa pigra*
Cattail grass; yellow foxtail	*Setaria pallidifusca; S. pallidefusca; S. pumila*
Caulerpa	*Caulerpa taxifolia*
Chinese waterspinach	*Ipomoea aquatica*
Coat buttons	*Tridax procumbens*
Coltsfoot	*Tussilago farfara*
Common barberry; European barberry	*Berberis vulgaris*
Common buckthorn	*Rhamnus cathartica*
Common crupina	*Crupina vulgaris*
Common reed	*Phragmites australis*
Creeping buttercup	*Ranunculus repens*
Creeping Jenny; moneywort	*Lysimachia nummularia*
Crisped pondweed; curly pondweed	*Potamogeton crispus*
Crofton weed	*Ageratina adenophora*
Cypress spurge	*Euphorbia cyparissias*
Dames Rocket	*Hesperis matronalis*
Devil's thorn	*Emex spinosa*
Dodder	*Cuscuta spp.*
Duck-lettuce	*Ottelia alismoides*
Eurasian or European water-milfoil; Spike water-milfoil	*Myriophyllum spicatum*
European buckthorn; glossy buckthorn	*Frangula alnus; Rhamnus frangula*
Exotic bur-reed	*Sparganium erectum*
Forget-me-not	*Myosotis scorpioides*
Garlic mustard	*Alliaria petiolata*
Giant false sensitive plant; false sensitive plant	*Mimosa diplotricha; M. invisa*
Giant hogweed	*Heracleum mantegazzianum*
Giant salvinia; eared watermoss	*Salvinia auriculata*
Giant salvinia; kariba-weed	*Salvinia molesta*
Giant salvinia	*Salvinia biloba*
Giant salvinia	*Salvinia herzogii*
Goatsrue	*Galega officinalis*
Hair fescue; fineleaf sheep fescue	*Festuca filiformis*
Hairy joint grass; jointhead; small carpetgrass	*Arthraxon hispidus*
Hairy willow-herb; Codlins and Cream	*Epilobium hirsutum*
Horned poppy; sea poppy; yellow hornpoppy	*Glaucium flavum*

Common Name	Scientific Name
Hydrilla; water-thyme; Florida elodea	*Hydrilla verticillata*
Itchgrass	*Rottboellia cochinchinensis*
Japanese Barberry	*Berberis thunbergii*
Japanese honeysuckle	*Lonicera japonica*
Japanese hops	*Humulus japonicus*
Japanese knotweed	*Polygonum cuspidatum; Fallopia japonica*
Japanese sedge; Asiatic sand sedge	*Carex kobomugi*
Japanese stiltgrass; Nepalese browntop	*Microstegium vimineum*
Jointed prickly pear	*Opuntia aurantiaca*
Kiawe	*Prosopis pallida*
Kikuyugrass	*Pennisetum clandestinum*
Kodo-millet	*Paspalum scrobiculatum*
Kudzu; Japanese arrowroot	*Pueraria montana*
Kyasuma grass	*Pennisetum pedicellatum*
Leafy Spurge; Wolf's Milk	*Euphorbia esula*
Lesser celandine; fig buttercup	*Ranunculus ficaria*
Liverseed grass	*Urochloa panicoides*
Longstamen rice; red rice	*Oryza longistaminata*
Malabar melastome	*Melastoma malabathricum*
Melaleuca	*Melaleuca quinquenervia*
Mile-a-minute vine or weed; Asiatic Tearthumb	*Polygonum perfoliatum, Persicaria perfoliata*
Mile-a-minute; bittervine	*Mikania micrantha*
Mile-a-minute; heartleaf hempvine	*Mikania cordata*
Miramar weed	*Hygrophila polysperma*
Missiongrass	*Pennisetum polystachyon; P. polystachion*
Monochoria	*Monochoria hastata*
Morrow s honeysuckle	*Lonicera morrowii*
Mosquito fern	*Azolla pinnata*
Multiflora rose	*Rosa multiflora*
Murain-grass	*Ischaemum rugosum*
Norway maple	*Acer platanoides*
Onion weed	*Asphodelus fistulosus*
Oriental or Asiatic bittersweet	*Celastrus orbiculatus*
Oxygen weed	*Lagarosiphon major*
Pale swallow-wort	*Cynanchum rossicum*
Parrot-feather; water-feather; Brazilian water-milfoil	*Myriophyllum aquaticum*
Pickerel weed	*Monochoria vaginalis*
Pilipiliula	*Chrysopogon aciculatus*
Plume grass; Amur silvergrass	*Miscanthus sacchariflorus (*also covers *Miscanthus x giganteus*, a hybrid of *M. sacchariflorus and M. sinensis)*
Porcelain-berry; Amur peppervine	*Ampelopsis brevipedunculata*

Common Name	Scientific Name
Purple loosestrife	*Lythrum salicaria*
Red rice	*Oryza punctata*
Reed canary-grass, ribbon grass	*Phalaris arundinacea*
Serrated tussock	*Nassella trichotoma*
Sessile joyweed	*Alternanthera sessilis*
Spotted knapweed	*Centaurea biebersteinii; C. stoebe ssp. micranthos*
Sycamore maple	*Acer pseudoplatanus*
Tall mannagrass; reed mannagrass	*Glyceria maxima*
Tansy ragwort; stinking Willie	*Senecio jacobaea*
Tatarian honeysuckle	*Lonicera tatarica*
Three-cornered jack	*Emex australis*
Tornillo	*Prosopis reptans*
Tree of heaven	*Ailanthus altissima*
Tropical soda apple	*Solanum viarum*
Turkeyberry	*Solanum torvum*
Variable water-milfoil; two-leaved water-milfoil	*Myriophyllum heterophyllum*
Velvet fingergrass	*Digitaria velutina*
Velvet mesquite	*Prosopis velutina*
Water yellowcress; great yellowcress	*Rorippa amphibia*
Water-chestnut	*Trapa natans*
Wetland nightshade	*Solanum tampicense*
Wild blackberry complex	*Rubus fruticosus*
Wild blackberry	*Rubus moluccanus*
Wild chervil	*Anthriscus sylvestris*
Wild safflower; jeweled distaff thistle	*Carthamus oxyacanthus; C. oxycantha*
wild sugarcane	*Saccharum spontaneum*
Wineberry; Japanese wineberry; wine raspberry	*Rubus phoenicolasius*
Witchweed	*Striga spp.*
Wormleaf salsola	*Salsola vermiculata*
Yellow floating heart	*Nymphoides peltata*
Yellow Iris	*Iris pseudacorus*

Source: (MDAR, 2016)

In 2006, the MDAR began the two-step ban on the importation and sale of more than 156 plants identified as either noxious or invasive in Massachusetts. During the ban, effective January 1, 2009, MDAR established timelines on when certain species would need to be phased out.

8.1.6.4. Terrestrial Wildlife

This section discusses the terrestrial wildlife species in Massachusetts, divided among mammals, birds, reptiles and amphibians, and invertebrates. Terrestrial wildlife are 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, game birds, waterfowl,

and their habitats found in Massachusetts. A discussion of non-native or invasive wildlife species is also included.

Massachusetts has a rich biological legacy and is home to a wide range of terrestrial wildlife species. Of the native species in the state, there are 176 vertebrate and invertebrate species, and 104 species that are noted by MDFW as notable species, even though some these species are nocturnal, reclusive, or localized in distribution (MDFW, 2016a). Of the 104 species, 58 are native land mammals, 36 are marine mammals, 7 are introduced species, and 3 are feral domestic species (MDFW, 2016a). Among these species, 7 have been extirpated, 3 unsuccessfully introduced, and 5 seals and 1 sirenian are recognized as vagrants, leaving approximately 60 common mammals currently present in the state. The state also lists 23 mammals species determined to be SGCN (MDFW, 2015a).

Mammals

Of the 60 common mammal species present in Massachusetts, there are also several rare species, increasing the total number of species to approximately 74 species (MDFW, 2016a).

Mammal species commonly found throughout Massachusetts include the Virginia possum (*Dedelphis virginiana*); various flying squirrels and chipmunks, including the eastern gray squirrel and red squirrel (*Sciurus caroliensis* and *Tamiasciurus hudsonicus*); American beaver (*Castor canadensis*); and two jumping mouse species (*Napaeozapus insignis* and *Zapus hudsonius*). Several types of voles and deer mouse also occur, such as the meadow vole (*Microtus pennsylvanicus*) and southern bog lemming (*Synaptomys cooperi*). The North American Porcupine (*Erethizon dorsatum*) occurs, as well as several species of hares and rabbits, such as the Black-tailed jackrabbit (*Lepus californicus*) and New England cottontail (*Sylvilagus transitionalis*). Mammal species also include shrews, such as the northern short-tailed shrew (*Blarina brevicauda*), long-tailed shrew (*Sorex dispar*), and American water shrew (*Sorex palustris*), and moles and shrew moles such as the star-nosed mole (*Condylura cristata*).

Other mammals consist of cats, including the Canada lynx (*Lynx canadensis*), and bobcat (*Lynx rufus*); foxes and wolves, including the coyote (*Canis latrans*), gray wolf (*Canis lupus*), gray fox (*Urocyon cinereoargenteus*) and red fox (*Vulpes vulpes*); bears, including the American black bear (*Ursus americanus*); and weasels, minks, and martens, including the wolverine (*Gulo gulo*), American marten (*Martes Americana*), and long-tailed weasel (*Mustela frenata*). Striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), moose (*Alces americanus*), white-tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), and fallow deer (*Dama dama*) are also common mammal species that occur in Massachusetts (MDFW, 2016a).

The following six species of furbearers[94] may be legally hunted in the state during appropriate seasons: bobcat (*Lynx rufus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), and opossum (*Didelphimorhpia sp.*) (MDFW, 2016b). The state also allows the hunting of black bear, upland game birds, deer, rabbits and

[94] Furbearers are mammals that traditionally have been hunted and trapped for their fur.

squirrels; and the trapping of bobcat, coyote, fox, weasel, fisher, mink, river otter, beaver, and muskrat, opossum, raccoon, and skunk during specific seasons.

Approximately 10 percent of the mammal species in Massachusetts are protected as a federal or state listed endangered, threatened, or special concern species (MDFW, 2016c), however only one mammal species is federally listed under the ESA. Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern, identifies this protected species.

Massachusetts has identified five mammals as non-listed Species of Conservation Interest. These mammal include species that have been removed from the Massachusetts Endangered Species (MESA) List (MDFW, 2016a). Although these species have been targeted for conservation, they are not currently under legal protection. These species include: big brown bat (*Eptesicus fuscus*), northern flying squirrel (*Glaucomys sabrinus*), silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*Lasiurus borealis*), and hoary bat (*Lasiurus cinereus*) (MDNR, 2016).

Birds

The number of native bird species documented in Massachusetts varies according to the timing of the data collection effort, changes in bird taxonomy,[95] and the reporting organization's method for categorizing occurrence and determining native versus non-native status. This section begins with a summary of native bird species found in Massachusetts. Although the numbers differ slightly, the taxonomic richness of the state is evident. The variety of ecological communities (i.e., coastal areas, mountains, rivers and lakes, valleys, plains, etc.) in Massachusetts in turn supports a large variety of bird species.

According to the *Bird List for the Commonwealth of Massachusetts*, which is a continually updated and annotated list of birds in the state, there are 448 bird species meeting the listing criteria. Massachusetts considers a species authentic if at least one of three prerequisite listing criteria is satisfied. The three prerequisite criteria include: 1) a specimen is collected; 2) a recognizable photograph or video is taken, examined by at least three qualified observers and documented in literature, or 3) an unambiguous sight record is available of an identifiable species corroborated by three or more observers with extensive field experience in Massachusetts and documented in the literature (MDFW, 2016d).

Of these 448 bird species, 190 species of resident and migratory birds nest regularly in Massachusetts (MDFW, 2016a). These 448 bird species compare with 2,023 bird species known to occur in Massachusetts based on those listed in the 7th Edition of the *Checklist of North American Birds*, as amended (MDFW, 2016a). Among the 448 extant[96] bird species known to occur in Massachusetts, a total of 59 taxonomic families are represented; Warblers, such as the *Parulidae, are* the most strongly represented family with 43 species listed, of which 24 breed regularly (MDFW, 2016d). Other well-represented families that reflect the state's coastal location and a high percentage of passage-only species include: ducks, geese, and swans

[95] Taxonomy: "A formal representation of relationships between items in a hierarchical structure." (USEPA, 2015f)
[96] Extant: "A species that is currently in existence (the opposite of extinct)." (USEPA, 2015f)

(*Anatidae* family) with 42 species and 13 regular breeders; shorebirds (*Scolopacidae* family) with 41 species (including sandpipers) and 5 regular breeders; gulls (*Laridae* family) with 36 species and 8 regular breeders; and seed-eating passerine (*Emberizidae* family) with 31 species (including finches) and 13 regular breeders. Of the 216 species that have been known to nest in Massachusetts, approximately 58 percent are neotropical migrants (MDFW, 2016d). A number of the 448 bird species also occur on the MESA List of Endangered, Threatened, and Special Concern Species. Further, the state lists 87 birds determined to be SGCN (MDFW, 2015a).

In addition to the *Bird List for the Commonwealth of Massachusetts*, the *Breeding Bird Atlas* is a comprehensive, statewide survey that documents the distribution of breeding birds in Massachusetts. In collaboration with the Massachusetts Audubon Society, the state has supported the completion of two *Breeding Bird Atlas* projects. The first Bird Atlas was surveyed from 1974 to 1979, and the second from 2000 to 2005 (MassAudubon, 2016), with the most recent atlas surveyed from 2007 (MassAudubon, 2016). As a comparison to the *Bird List for the Commonwealth of Massachusetts,* which documents 448 bird species, Atlas 1 collected evidence on 199 species and Atlas 2 documented 222 species, including 191 species with high evidence of confirmed breeding (MassAudubon, 2016).[97]

Three threatened and endangered birds are located in Massachusetts. Section 8.1.6.6, lists and briefly describes these protected species.

Massachusetts 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) (Ducks Unlimited, 2015). Large numbers of waterfowl and non-waterfowl birds utilize this flyway and other migration corridors and pathways throughout the state during their annual migrations northward in the spring and southward in the fall. Despite the dense human population and development, the coastal areas near Boston and Cape Cod are an important ecological resource for migrating birds (MassAudubon, 2015a). There are 11 wildlife refuges in Massachusetts, including the Monomoy National Wildlife Refuge (NWR), Oxbow NWR, and the Nantucket NWR, each part of the Eastern Massachusetts NWR Complex are well-known migratory stopover areas for birds (USFWS, 2012a). The Berkshire Mountain and Connecticut River Valley region in western Massachusetts are also important stopover areas for migratory birds.

Bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) are protected under the Bald and Golden Eagle Protection Act. Bald eagles are generally found throughout the year near large rivers and lakes in the eastern half of the state (eBird, 2015a). Golden eagles are rarely seen and a transient species in Massachusetts (eBird, 2015b).

A total of 85 Important Bird Areas (IBAs) have been identified in Massachusetts as important locations for birds requiring land conservation (Figure 8.1.6-2) (MassAudubon, 2015a). The establishment of IBAs assist in achieving local conservation priorities to provide important

[97] Difference in species totals may be attributed to the number of scientists and volunteers, available research, and hours cataloging (MassAudubon, 2015b).

habitat for native bird populations during breeding[98], migratory stops, feeding, and over-wintering areas. A variety of habitats are designated as IBAs, including forests, scrub/shrub, grasslands, freshwater and saltwater wetlands, and bodies of water (MassAudubon, 2015a). Massachusetts's IBAs are widely distributed throughout the state with clusters around the southern coast of the state near Buzzards Bay and Cape Cod, the Greater Boston area and the northern coast of the state, and the Berkshires and Connecticut River Valley in the western portion of the state. Of the 85 IBAs listed in Massachusetts, 72 of them are listed at a IBA state priority level accounting for more than 1,116,000 acres (or 69 percent) of the total area identified as an IBA (MassAudubon, 2015a).

Habitats, such as freshwater marshes, grasslands, coastal beaches and islands, and coastal shrublands are examples of uncommon habitats that support rare bird species. Bird conservation in Massachusetts is accomplished through various programs that protect and enhance both populations and habitat of target bird species. In addition to protection through federal and state regulations, including the MESA, land conservation programs also protect habitat for birds and other wildlife. Through the Massachusetts Land Protection Program, MDFW collaborates with Massachusetts Department of Fish & Game (MassDFG) and manages tens of thousands of acres of upland, wetland, riparian, and coastal habitats that support rare and common species of birds (MDFW, 2016e). The MDFW also manages many Wildlife Management Areas (WMAs), including Monument Mountain, Lily Pond, East Mountain, Bolton Flats, Salisbury Marshes, and Burrage Pond that each provide land for rare species and natural community protection (MDFW, 2016f).

A total of 51 native reptile and amphibian species occur in Massachusetts, including 30 reptiles and 21 amphibians. Massachusetts also contains habitat for 10 species of salamanders and newts, 10 frogs and toads, 15 turtles, 1 lizard, and 14 snakes and vipers (Cardoza & Mirick, 2009) (UMassAmherst, 2014). These species occur in a wide variety of habitats statewide, but most consist of inland species. Some reptile and amphibian species, such as the eastern musk turtle (*Sternotherus odoratus*) and the wood frog (*Lithobates sylvaticus*) do not occur in Nantucket County (Cardoza & Mirick, 2009). Of these 51 species, the state lists 20 reptiles and 5 amphibians as SGCN (MDFW, 2015a).

[98] Breeding areas: "The area utilized by an organism during the reproductive phase of its lifecycle and during the time that young are reared." (USEPA, 2015f)

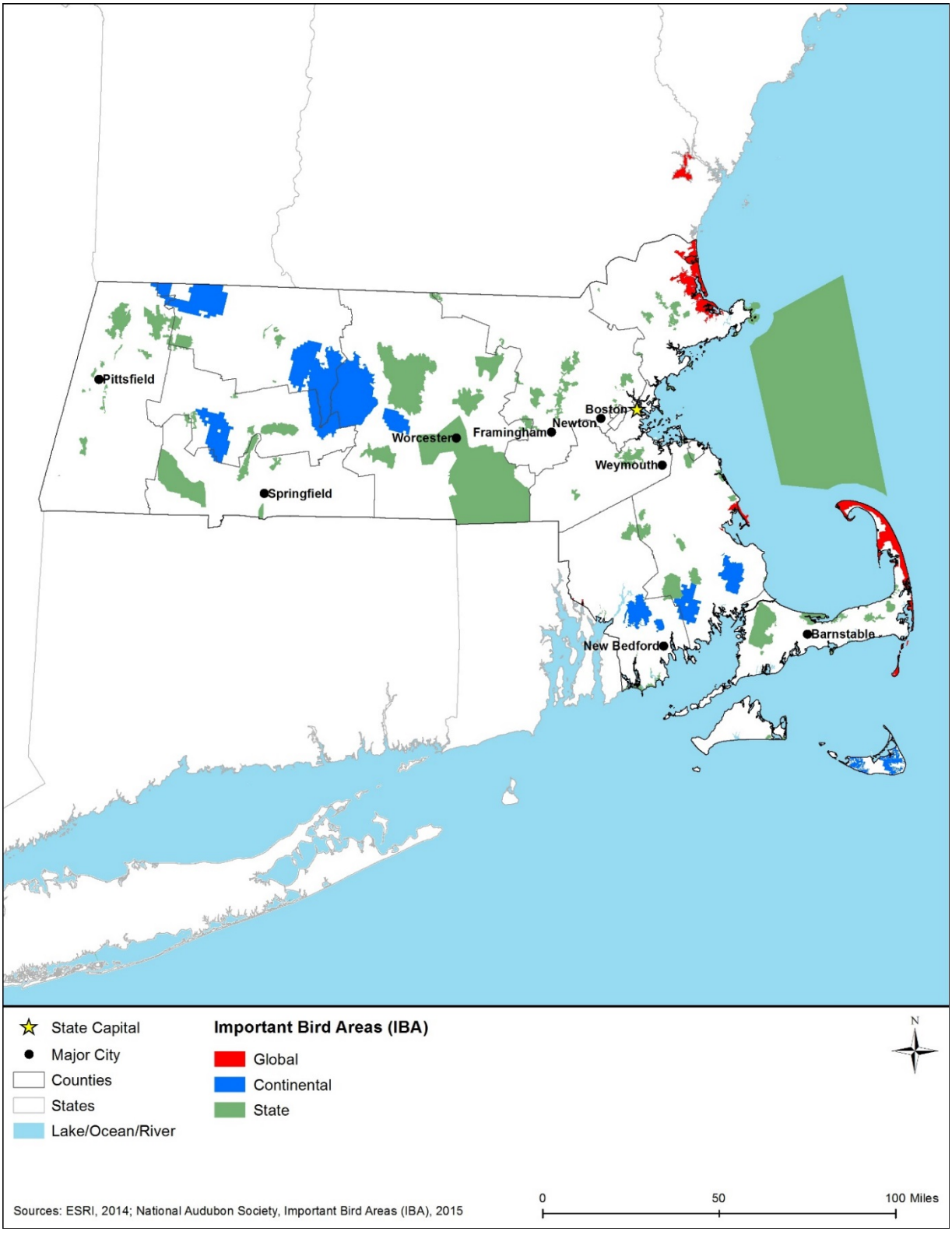


Figure 8.1.6-2: Important Bird Areas in Massachusetts Reptiles and Amphibians

In Massachusetts, it is illegal to hunt, fish, trap, or take certain reptile and amphibian species, including their eggs or young. The list of reptile and amphibian species that are not allowed to be taken under Massachusetts hunting regulations currently includes: spotted salamander (*Ambystoma maculatum*), four-toed salamander (*Hemidactylium scutatum*), spring salamander (*Gyrinophilus porphyriticus*), northern leopard frog (*Lithobates pipiens*), spotted turtle (*Clemmys guttata*), and eastern hognosed snake (*Heterodon platirhinos*) (MDFW, 2016g). The only turtle species with an open hunting season is the snapping turtle (*Chelydra serpentine*). American bullfrogs (*Lithobates catesbeinana*), green frogs (*Lithobates clamitans*), and wood frogs (*Lithobates sylvaticus*) may be hunted or taken (MDFW, 2016b).

Five threatened and endangered reptiles are located in Massachusetts; there are no federally listed amphibians in the state. Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern, lists and briefly describes these protected species.

Invertebrates

Massachusetts is home to many invertebrate species, including moths and butterflies, dragonflies and damselflies, beetles, crustaceans (shrimps and amphipods), freshwater mussels, snails, worms, and a sponge (MDFW, 2015b). These invertebrates provide an abundant food source for mammals, birds, reptiles, amphibians, and other invertebrates.

Most invertebrate species in Massachusetts are rare, and most of them require very specific habitat. Many of the rare moths and butterflies inhabit pitch pine-scrub oak barrens that have an open vegetation structure due to past fire or other disturbances. Similarly, aquatic species, including dragonflies and damselflies, crustaceans, mussels and snails live in clean and unpolluted waters (MDFW, 2015b). Massachusetts lists 111 invertebrate species determined to be SGCN, including 8 miscellaneous invertebrates, 10 freshwater mussels, 8 crustaceans, 27 dragonflies and damselflies, 9 beetles, 44 butterflies and moths, and 5 bees (MDFW, 2015a).

Four threatened and endangered invertebrates are located in Massachusetts. Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern, identifies these protected species.

Invasive Wildlife Species

The Massachusetts NHESP and other conservation organizations work to control the spread of invasive wildlife species in critical habitats and natural communities. Outbreaks of invasive animal species are handled on a case-by-case and species-by-species basis in Massachusetts. Most of Massachusetts invasive species detection, monitoring, and identification programs are focused on aquatic invasive species, which are described in more detail in Section 8.1.6.5, Fisheries and Aquatic Habitats.

8.1.6.5. Fisheries and Aquatic Habitats

This section discusses the aquatic wildlife species in Massachusetts, including fish, invertebrates, marine mammals, and sea turtles. A summary of non-native and invasive aquatic species is also presented in this section. Fish are divided into freshwater and saltwater species, although many

of Massachusetts's fish are diadromous (i.e., anadromous[99] and catadromous[100]), reflecting the state's location along the Atlantic coast and the variety of aquatic habitats that it provides. A distinctive feature of the Massachusetts landscape with regard to aquatic wildlife is the coastal habitats along the northern and southern coastal areas, and near Boston Harbor, Cape Cod, and Buzzards Bay, as this area includes open ocean, estuaries, bays, inlets, and other coastal features that provide habitat for a multitude of fisheries and aquatic wildlife.

Freshwater Fish

Massachusetts is home to more than 82 species of freshwater fish, including such species as, largemouth bass (*Micropterus salmoides*), brown trout (*Salmo trutta*), Atlantic salmon (*Salmo salar*), smallmouth bass (*Micropterus dolomieu*), brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*), brown bullhead (*Ameiurus nebulosus*), bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), and black crappie (*Pomoxis nigromaculatus*). Approximately 24 of these species reside in coastal habitats and 58 species reside in inland habitat. Coastal species include anadromous species that generally inhabit coastal streams, ponds and descend to the ocean to spawn. Coastal species also include estuarine species that have been reported or occur in past coastal river surveys. Of the inland species, Massachusetts recognizes 39 as native fish species (MDFW, 1984). Inland species also include statewide, regional, and local species. Statewide species occur throughout the state and are abundantly represented. State species are noticeably absent from other areas, and local species are restricted to limited areas, typically as a result of stocking programs. Massachusetts also lists 28 fish species as SGCN (MDFW, 2015a).

In Massachusetts, the lamprey family includes the American brook lamprey (*Lampetra appendix*) and sea lamprey (*Petromyzon marinus*). There are two types of sturgeons in the state: Shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*Acipenser oxyrhynchus*). The state also recognizes one eel and three herring species: American eel (*Anguilla rostrata*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), and American shad (*Alosa sapidissima*). Seven types of trout species occur within the state including: Coho salmon (*Oncorhynchus kisutch*), Kokanee salmon (*Oncorhynchus nerka*), rainbow trout (*Salmo gairdneri*), Atlantic salmon (*Salmo salar*), Brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), and lake trout (*Salvelinus namaycush*). Numerous smelts, pikes, carps and minnows, suckers, bullhead catfishes, trout-perches, killifishes, silversides, sticklebacks, pipefishes and seahorses, temperate basses, sunfishes, perch, gobies, and sculpins also occur within the waters of Massachusetts (MDFW, 1984).

Saltwater Fish

Massachusetts's nearshore marine waters are home to a large number of saltwater fish species inhabiting the wide variety of marine habitats such as the Ipswich Bay, Massachusetts Bay and

[99] 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, 2015f)
[100] Catadromous: "An organism which lives in fresh water and goes to the sea to spawn, such as some eels." (USEPA, 2015f)

Boston Harbor, Cape Cod Bay, Nantucket Sound, Buzzards Bay, Vineyard Sound, numerous smaller bays and estuaries, and miles of Atlantic coastline.

Many saltwater fish species are known for their recreational and commercial fishing value. Commonly caught species in the marine waters off the coast of Massachusetts include Billfish or Blue Marlin, typically caught in southern New England; and Black Sea Bass, a migratory fish inhabiting the near shore waters near the south side of Cape Code Bay, and Buzzard Bay to Rhode Island border. Other commonly caught species include bonito, bluefish, cod, cusk, albacore, haddock, halibut, mackerel, Pollock, scup, striped bass, flounder, tuna, tautog, weakfish, and wolfish, and smelt. Blue and mako sharks are also commonly caught in the offshore waters and sought after by recreational anglers (Commonwealth of Massachusetts Marine Fisheries, 2016). Table 8.1.6-4 presents a list of popular saltwater sportfish in Massachusetts.

Table 8.1.6-4: Popular Saltwater Sportfish Species in Massachusetts

Common Name	General Habitat
Billfish/Blue Marlin, White Marlin, Swordfish	Southern New England, offshore canyons, steep drop-offs on the ocean floor where current boundaries, thermal water fronts, and upwellings tend to concentrate schools of bait
Black Sea Bass	South side of Cape Cod, Buzzards Bay to Rhode Island border; some found in Cape Cod Bay, inhabit area near bottom structure, such as reefs, rocks, and wrecks
Bonito	Southern Cape Cod and the Islands, rarely north of Cape Cod
Bluefish	Whole coastline, inshore bars, tide rips, bays, and estuaries
Cod	Whole state coastline, deepwater, inshore while water is cold
Cusk	Rocky ledges, hard bottom, moderately deep waters
False Albacore	Mostly warmer waters on the south side of Cape Cod and the Islands
Haddock	Whole coastline, cool waters, prefer depths of 140-450 ft., also prefer shell/sand and smooth rock or gravel bottoms
Halibut	Whole coastline, cool and deep waters, prefer bottom sand, gravel, and clay, and not soft mud or rock
Mackerel	Whole coastline, deep water to shallow bays, beaches, jetties, canals, and bridges
Pollock	Whole coastline with more north of Plymouth; inshore and offshore depending on the water temperatures
Scup	South side of Cape Cod and along the coast of Rhode Island
Blue and Mako Sharks	South of the Islands, East of Cape Cod, off north shore including Cape Cod Bay
Smelt	Whole coastline, estuaries, mouths of coastal rivers and within coastal rivers
Striped Bass	Whole coastline, surf, inshore bars, reefs, tide-rips, bays, and estuaries
Summer Flounder	South side of Cape Cod, Islands, Cape Cod Bay, Buzzards Bay
Tunas	Offshore east of North Shore, Cape Cod Bay, East of Cape Cod, South of Islands in offshore canyons
Tautog	Whole coastline, rocky bottoms, inshore bays, harbors, jetties, breakwaters
Weakfish	Southern Massachusetts sandbars, deep water drop offs, channels, bays, and estuaries
Winter Flounder	Whole coast, tidal streams, shallow bays, and estuaries

ft. = feet
Source: (Commonwealth of Massachusetts Marine Fisheries, 2016)

Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act identifies and protects those fish habitats that are necessary for spawning, breeding, feeding, or growth to maturity. These habitats are termed "Essential Fish Habitat" or EFH. NOAA provides an online mapping application[101] and website[102] to provide the public a means to obtain illustrative representations of EFH. This tool is used to identify the existing conditions for a project location to identify sensitive resources. Table 8.1.6-5 presents a summary of EFH offshore of Massachusetts.

Table 8.1.6-5: Essential Fish Habitat Offshore of Massachusetts

Common Name	Eggs	Larvae/YOY[103]	Juveniles	Adults
Atlantic herring	Bottom habitats with a substrate of gravel, sand, and cobble	Pelagic waters in the Gulf of Maine, Georges Bank, and southern New England	Pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, and southern New England	Pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, and southern New England
Atlantic salmon	Bottom habitats with gravel or cobble riffle	Bottom habitats with gravel or cobble riffle	Bottom habitats of shallow gravel/cobble riffles interspersed with deeper riffles and pools in rivers	Resting and holding pools in rivers and estuaries
Atlantic sea scallops	Bottom habitats in the Gulf of Maine, Georges Bank, southern New England	Pelagic waters and bottom habitats with a substrate of gravelly sand, shell fragments, and pebbles, or on algae	Bottom habitats with a substrate of cobble, shells, and silt in the Gulf of Maine, Georges Bank, southern New England	Bottom habitats with a substrate of cobble, shells, coarse/gravelly sand, and sand in the Gulf of Maine, Georges Bank, and southern New England
Monkfish (north and south)	Surface waters of the Gulf of Maine, Georges Bank, southern New England	Pelagic waters of the Gulf of Maine, Georges Bank, and southern New England	Bottom habitats with substrates of a sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud along the outer continental shelf	Bottom habitats with substrates of sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud along the outer continental shelf in the middle Atlantic
American plaice	Surface waters of the Gulf of Maine and Georges Bank	Surface waters of the Gulf of Maine, Georges Bank, and southern New England	Bottom habitats with fine-grained sediments or a substrate of sand or gravel in the Gulf of Maine	Bottom habitats with fine-grained sediments or a substrate of sand or gravel in the Gulf of Maine

[101] http://www.habitat.noaa.gov/protection/efh/efhmapper/index.html.

[102] http://www.greateratlantic.fisheries.noaa.gov/hcd/list.htm.

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

Common Name	Eggs	Larvae/YOY[103]	Juveniles	Adults
Atlantic halibut	Pelagic waters to the sea floor of the Gulf of Maine and Georges Bank	Surface waters of the Gulf of Maine and Georges Bank	Bottom habitats with a substrate of sand, gravel, or clay in the Gulf of Maine and Georges Bank	Bottom habitats with a substrate of sand, gravel, or clay in the Gulf of Maine and Georges Bank
Atlantic wolffish	Bottom habitats of the continental shelf and slope within the Gulf of Maine and on Georges Bank	Surface to the seafloor across the predominant depth and distribution range identified for the species.	Bottom habitats of the continental shelf and slope within the Gulf of Maine south to Cape Code, and on Georges Bank	Bottom habitats of the continental shelf and slope within the Gulf of Maine south of Cape Cod, and on Georges Bank
Atlantic cod (Gulf of Maine and Georges Bank)	Surface waters around the perimeter of the Gulf of Maine, Georges Bank, and the eastern portion of the continental shelf off southern New England	Pelagic waters of the Gulf of Maine, Georges Bank, and the eastern portion of the continental shelf off southern New England	Bottom habitats with a substrate of cobble or gravel in the Gulf of Maine, Georges Bank, and the eastern portion of the continental shelf off southern New England	Bottom habitats with a substrate of smooth sand, rocks, and pebbles, or gravel in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south of Delaware Bay
Haddock (Georges Bank and Gulf of Maine)	Surface waters over Georges Bank southwest to Nantucket Shoals and the coastal areas of the Gulf of Maine	Surface waters over Georges Bank southwest to the middle Atlantic south to Delaware Bay	Bottom habitats with substrate of pebble gravel on the perimeter of Georges Bank, the Gulf of Maine, and the middle Atlantic south to Delaware Bay	Bottom habitats with a substrate of broken ground, pebbles, smooth hard sand and smooth areas between rocky patches on Georges Bank and the eastern side of Nantucket Shoals
Ocean pout	Bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay	Bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay	Bottom habitats, often smooth bottom near rocks or algae in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay	Bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay
Offshore hake	Pelagic waters along the outer continental shelf of Georges Bank and southern New England south to Cape Hatteras, North Carolina	Pelagic waters along the outer continental shelf of Georges Bank and southern New England south to Chesapeake Bay	Bottom habitats along the outer continental shelf of Georges Bank and south to Cape Hatteras, North Carolina	Bottom habitats along the outer continental shelf of Georges Bank and southern New England south to Cape Hatteras, North Carolina

Common Name	Eggs	Larvae/YOY[103]	Juveniles	Adults
Pollock	Pelagic waters of the Gulf of Maine and Georges Bank	Pelagic waters of the Gulf of Maine and Georges Bank	Bottom habitats with aquatic vegetation or a substrate of sand, mud, or rocks, in the Gulf of Maine and Georges Bank	Bottom habitats in the Gulf of Maine and Georges Bank and hard bottom habitats off southern New England and the middle Atlantic south to New Jersey
Redfish	Fertilized internally and develop into larvae within the oviduct, therefore there is no essential fish habitat for this life history stage	Pelagic waters in the Gulf of Maine and southern Georges Bank	Bottom habitats with a substrate of silt, mud, or hard bottom in the Gulf of Maine and southern edge of Georges Bank	Bottom habitats with a substrate of silt, mud, or hard bottom in the Gulf of Maine and on the southern edge of Georges Bank
Red hake	Surface waters on the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle of the Atlantic south to Cape Hatteras	Surface waters of Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle of Atlantic south to Cape Hatteras	Bottom habitats with a substrate of shell fragments, including areas with an abundance of live scallops, in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras	Bottom habitats in depressions with a substrate of sand and mud in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and in the middle Atlantic south to Cape Hatteras
Silver hake	Surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras	Surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras	Bottom habitats of all substrate types in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras	Bottom habitats of all substrate types in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras

Common Name	Eggs	Larvae/YOY[103]	Juveniles	Adults
White hake	Surface waters of the Gulf of Maine, Georges Bank, and southern New England	Pelagic waters of the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle Atlantic	Pelagic waters of the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle of the Atlantic; In the demersal stage, white hake juveniles inhabit bottom habitats with seagrass beds or a substrate of mud or fine-grained sand in the Gulf of Maine	Bottom habitats with a substrate of mud or fine-grained sand in the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the middle Atlantic
Windowpane flounder	Surface waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle of Atlantic south the Cape Hatteras	Pelagic waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras	Bottom habitats with a substrate of mud or fine-grained sand around the perimeter of Gulf of Maine, on Georges Bank, southern New England	Bottom habitats with a substrate of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south of the Virginia-North Carolina border
Winter flounder	Bottom habitats with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay	Pelagic and bottom waters of Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay	Bottom habitats with a substrate of mud or fine-grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay	Bottom habitats including estuaries with a substrate of mud, sand, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay
Witch flounder	Surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras	Surface waters in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras	Bottom habitats with fine-grained substrate in the Gulf of Maine and along the outer continental shelf from Georges Bank south to Cape Hatteras	Bottom habitats with a fine-grained substrate in the Gulf of Maine and along the outer continental shelf from Georges Bank south to Chesapeake Bay

Common Name	Eggs	Larvae/YOY[103]	Juveniles	Adults
Yellowtail flounder	Surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, and the southern New England continental shelf south to Delaware Bay	Surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, the southern New England shelf and throughout the middle Atlantic south to the Chesapeake Bay	Bottom habitats with a substrate of sand or mud on Georges Bank, the Gulf of Maine, and the southern New England shelf south to Delaware Bay	Bottom habitats with a substrate of sand or mud on Georges Bank, the Gulf of Maine, and the southern New England shelf south to Delaware Bay
Barndoor skate	NA	No larval life stage exists for this species; upon hatching they are fully developed juveniles	Bottom habitats with mud, gravel, and sand substrates in the eastern Gulf of Maine, eastern Georges Bank, southern New England, and the Mid-Atlantic Bight down to the Hudson Canyon	Bottom habitats with mud, gravel, and sand substrates in the eastern Gulf of Maine, eastern Georges Bank, southern New England, and Mid-Atlantic Bight down to the Hudson Canyon
Clearnose skate	NA	No larval life stage exists for this species; upon hatching they are fully developed juveniles	Bottom habitats with a substrate of soft bottom along the continental shelf and rocky or gravelly bottom, ranging from the Gulf of Maine south along the continental shelf to Cape Hatteras, North Carolina	Bottom habitats with a substrate of soft bottom along the continental shelf and rocky or gravelly bottom, ranging from the Gulf of Maine south along the continental shelf to Cape Hatteras, North Carolina
Little skate	Bottom habitats with a sandy substrate from Georges Bank through southern New England to the middle Atlantic Bight	No larval life stage exists for this species; upon hatching they are fully developed juveniles	Bottom habitats with a sandy or gravelly substrate or mud, ranging from Georges Bank through the Mid-Atlantic Bight to Cape Hatteras, North Carolina	Bottom habitats with a sandy or gravelly substrate or mud, ranging from Georges Bank through the Mid-Atlantic Bight to Cape Hatteras, North Carolina

Common Name	Eggs	Larvae/YOY[103]	Juveniles	Adults
Rosette skate	NA	No larval life stage exists for this species; upon hatching they are fully developed juveniles	Bottom habitats with a soft substrate, including sand/mud bottoms, mud with echinoid and ophuiroid fragments, and shell and pteropod ooze, ranging from Nantucket Shoals and southern edge of Georges Bank to Cape Hatteras, North Carolina	Bottom habitats with a soft substrate, including sand/mud bottoms, mud with echinoid and uphuiroid fragments, and shell and pteropod ooze, ranging from Shoals and southern edge of Georges Bank to Cape Hatteras, North Carolina
Smooth skate	NA	No larval life stage exists for this species; upon hatching they are fully developed juveniles	Bottom habitats with a substrate of soft mud (silt and clay) bottoms and also on sand, broken shells, gravel, and pebbles on offshore banks of the Gulf of Maine	Bottom habitats with a substrate of soft mud (silt and clay) bottoms and also no sand, broken shells, gravel and pebbles on offshore banks of the Gulf of Maine
Thorny skate	NA	No larval life stage exists for this species; upon hatching they are fully developed juveniles	Bottom habitats with a substrate of sand, gravel, broken shell, pebbles, and soft mud in the Gulf of Maine and Georges Bank	Bottom habitats with a substrate of sand, gravel, broken shells, pebbles, and soft mud in the Gulf of Maine and Georges Bank
Winter skate	NA	No larval life stage exists for this species; upon hatching they are fully developed juveniles	Bottom habitats with a substrate of sand and gravel or mud in Cape Cod Bay, on Georges Bank, the southern New England shelf, and through the Mid-Atlantic Bight to North Carolina	Bottom habitats with a substrate of sand and gravel or mud in Cape Cod Bay, on Georges Bank, the southern New England shelf, and through the Mid-Atlantic Bight to North Carolina
Deep-Sea red crab	Attached to the underside of the female crab until they hatch into larvae and are released into the water column	Water column near the surface of the seafloor across the entire southern flank of Georges Bank and south to Cape Hatteras, North Carolina	Bottom habitats of the continental slope with a substrate of silts, clays, and all silt-clay-sand composites along the southern flank of Georges Bank and south to Cape Hatteras, NC	Bottom habitats of the continental slope with a substrate of silts, clays, and all silt-clay-sand composites along the southern flank of Georges Bank and south to Cape Hatteras, NC

Source: (NOAA, 2015c) NA = Not Available

Shellfish and Other Invertebrates

Massachusetts is home to both freshwater and marine shellfish. Marine invertebrates, as filter feeders, play an important role in marine ecology as these animals filter great volumes of water and consume much of the zoo- and phytoplankton in it. As a result, they shape the chemical and biotic composition of the marine system (NPS, 2015f). Massachusetts has an important shellfishing industry, and many miles of protected seashore of salt marshes and estuaries, such as the Cape Code National Seashore, which serve as critical habitat for oysters, scallops, and clams, among many other vertebrate species (NPS, 2015f).

Familiar freshwater bivalve[104] species include a variety of oyster, sea scallop, razor clams, soft-shell clams, and mussel species that often aggregate in dense grouping, forming a habitat known as shellfish beds (Massachusetts Bay Program, 2011). Shellfish species that occur along the coast of Massachusetts, within Boston Harbor, and near Cape Cod include sea scallops (*Placopecten magellanicus*) blue mussels (*Mytilus edulis*), shrimp (*Heterocarpus ensifer*), northern quahogs (*Mercenaria mercenarioa*) also known as hard clams, and American oysters (*Crassostrea virginica*).

Massachusetts regulates the management of shellfish farming due to the threats of contamination associated with farming areas within close proximity to urban areas, such as Boston Harbor, where shellfish growing areas have become predominantly classified as prohibited, with some areas conditionally restricted to shellfish growing (Massachusetts Bay Program, 2011). Elevated levels of mercury, heavy metals, and pesticides in fish tissue can resulted in fish consumption advisories in the state. Hundreds of designated shellfish growing areas are spread across the Massachusetts's coastline from Buzzards Bay, Cape Cod Bay, the Elizabethan Islands, Greater Boston Harbor, and Massachusetts Bay to Mount Hope Bay, North Shore, Nantucket Sound, Outer Cape Cod, South Cape Cod, and Martha's Vineyard (MassDFG, 2016).

Lobsters and crabs are familiar crustaceans found in Massachusetts. American lobster (*Homarus americanus*) habitat extends on the ocean floor in the northwest Atlantic Ocean, both nearshore and in distant waters. Lobsters are a common resident of Massachusetts's rocky coastline, where they can capture prey and hide from predators in crevices. There is a substantial lobster fishery in the Gulf of Maine, Georges Bank, and southern New England (ASMFC, 2016). As one of the most valuable commercial fisheries along the Atlantic coast, the majority of the commercial fishing operations catch lobster in state waters (0 to 3 miles from shore), with Maine and Massachusetts accounting for 85 percent and 10 percent of the catch, respectively. Horseshoe crabs (*Limulus polyphemus*) are another common crustacean caught on the Atlantic coast, including Massachusetts. Commercial fishing operations also frequently catch Jonah crab (*Cancer borealis*) off the coast of Massachusetts (ASMFC, 2016).

Marine Mammals

Massachusetts also recognizes the protection of numerous marine mammal species. Some species include West Indian manatee (*Trichechus manatus*); walrus (*Odobenus rosmarus*)*;* seals,

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

such as the hooded seal (*Cystophora cristata*) and harbor seal (*Phoca vitulina*); and North American river otter (*Lontra Canadensis*). Several types of bowhead, rorqual, and pilot whales, dolphins, belugas, and porpoises also occur off the coast of Massachusetts. These whale and dolphin species include: northern right whale (*Eubalaena glacialis*); Common Minke Whale (*Balaenoptera acutorostrata*); humpback whale (*Megaptera novaeangliae*); dolphins, such as the short-beaked common dolphin (*Delphinus delphis*) and bottle-nose dolphin (*Tursiops truncates*); long-finned pilot whale (*Globicephala melas*); beluga (*Delphinapterus leucas*); and harbor porpoise (*Phocoena phocoena*). This section briefly introduces the marine mammal species found in Massachusetts waters.

Marine mammals are more commonly abundant in offshore waters, off the coast of Barnstable, Nantucket, and near Essex. Large marine mammals, such as Sperm whale (*Physeter microcephalus*) and Beaked whale (*Hyperoodontidae*) are also recorded. Species occurrences of sperm and beaked whales have included Pygmy Sperm whale (*Kogia breviceps*), which has been seen stranded in Barnstable, Dukes, Essex, Norfolk, and Plymouth counties and recorded in Bristol county waters. Sperm whale (*Physeter catodon*), a formerly abundant species in the offshore waters, has been recorded in Barnstable, Dukes, Essex, Nantucket, and Plymouth counties. Similarly, records of beaked whales occur, with the most recent recording noted in 1997, including the Gervais' beaked whale (*Mesoplodon mirus*) in Barnstable County (MDMF, 2016).

Many whale species occur offshore of Massachusetts as they migrate northward towards feeding grounds and southward towards warmer waters for breeding. Their presence offshore is often unnoticed because of their transient nature and deep ocean preference.

Sea Turtles

Six species of sea turtles occur in U.S. waters, all of which are protected under the ESA. Three of these sea turtles occur in Massachusetts's waters, including the green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricate*), and leatherback sea turtle (*Dermochelys coriacea*). Sea turtles are typically observed off the coast of Cape Cod. For more information on these protected sea turtles, refer to Section 8.1.6.6.

Invasive Aquatic Species

Massachusetts has adopted regulations that prohibit or regulate select invasive plant and animal species, but the state primarily focuses on managing aquatic invasive plant species in freshwater lakes and ponds, although some efforts have focused on programs to protect native marine shellfish resources. The Massachusetts Aquatic Invasive Species (AIS) Working Group identifies nine established aquatic invasive plant species in the state. These species include water chestnut (*Trapa natans*), Hydrilla (*Hydrilla verticillata*), curly leaf pondweed (*Potamogeton crispus*), Fanwort (*Cabomba caroliniana*), and lesser naiad (*Najas minor*). Also included are waterweed (*Egeria densa*), yellow floating-heart (*Nymphoides peltata*), Eurasian water milfoil (*Myriophyllum spicatum*), and variable milfoil (*Myriophyllum heterophyllum*).The detection of new invasions are also priorities for the state and include the management of common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*). Zebra mussel

(*Dreissena polymorpha*) and Asian clam (*Corbicula fluminea*) have not been documented in Massachusetts (as of 2002); however, they both are considered viable threats to the state's freshwater systems. Other known invasive aquatic marcophytes include parrot feather (*Myriophyllum aquaticum*), European frog-bit (*Hydrocharis morus-ranae*), and giant salvinia (*Salvinia molesta*) (MCZM, 2002).

The MDFW has also identified several fish species posing significant threats to the state. The following fish cannot be kept without a permit from the MDFW (321 CMR 9.01(3)): Grass carp (*Ctenopharyngodon idella*), various piranha species (*Phgocentrus spp*.), rudd (*Scardinius erythrophtalmus*), and walking catfish (*Clarias batrachus*). Numerous non-native ocean and coastal species are also found in the marine and estuarine environments of Massachusetts. Though most of these non-native species are well established, Massachusetts has determined that reductions in the populations may result in shift towards biological communities in the state. The established, but non-native marine vertebrate include: European green crab (*Carcinus maenus*), Asian shore crab (*Hemigrapsus sanguineus*), and lace bryozoan (*Membranipora membranacea*) (MCZM, 2002).

8.1.6.6. Threatened and Endangered Species and Species of Conservation Concern

The USFWS is responsible for administering the ESA (16 U.S.C. §1531 *et seq*.) in Massachusetts. The USFWS has identified 8 federally endangered[105] and eight threatened species[106] known to occur in Massachusetts[107] (USFWS, 2015c). Of these, one has designated critical habitat[108] (USFWS, 2016a). These listed species include one mammal, five reptiles, three birds, four invertebrates, and three plants (USFWS, 2015c); these species are discussed in detail under the following sections. Figure 8.1.6-3 depicts the critical habitat in Massachusetts for the Plymouth redbelly turtle.

[105] 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))

[106] 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))

[107] For purposes of this discussion, only listed species identified by USFWS will be discussed specifically as a threatened or endangered species in New Jersey.

[108] 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))

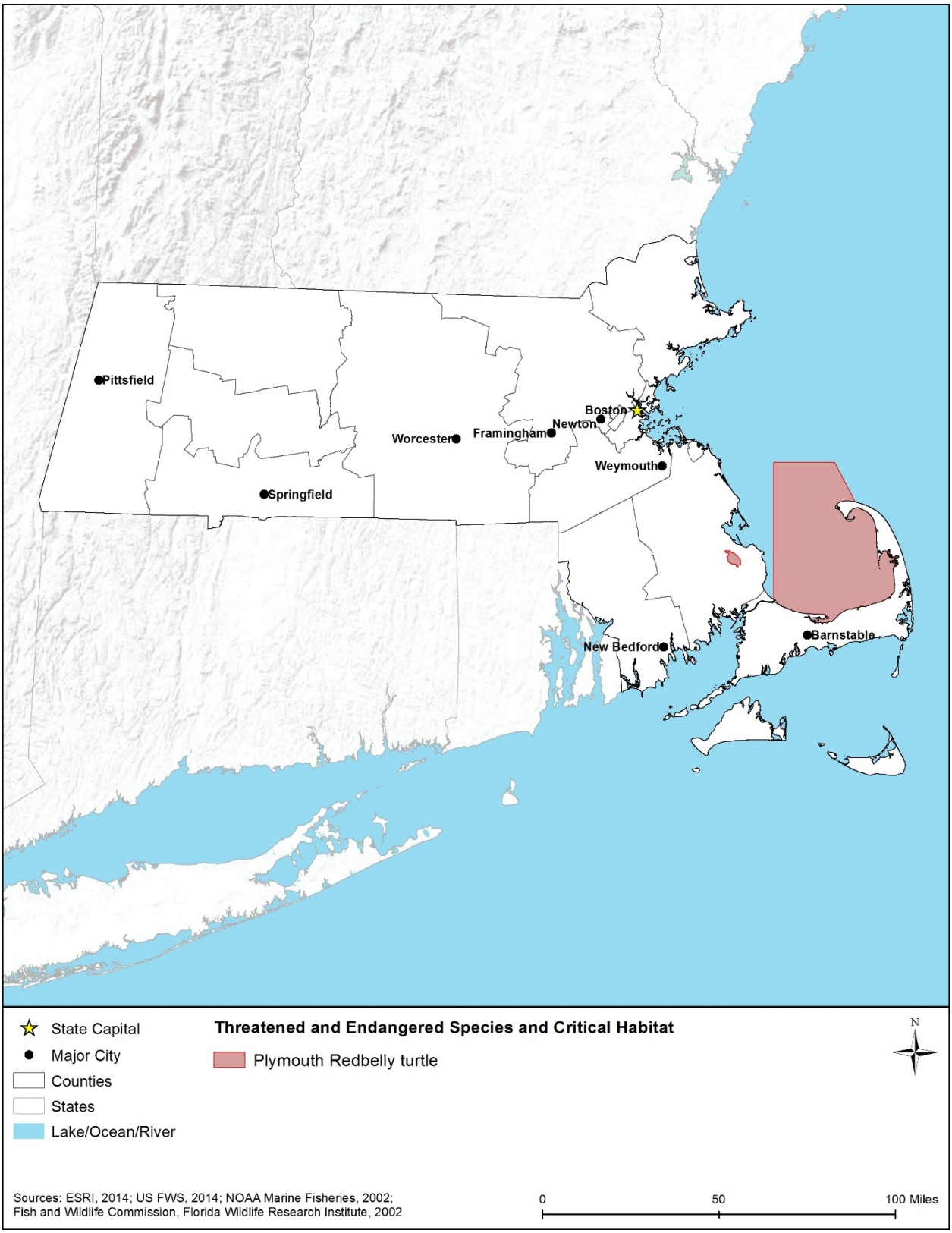


Figure 8.1.6-3: ESA Designated Critical Habitat for Massachusetts

Mammals

One endangered mammal is federally listed for Massachusetts as summarized in Table 8.1.5-6. The northern long-eared bat (*Myotis septentrionalis*) occurs throughout. Information on the habitat, distribution, and threats to the survival and recovery of this species in Massachusetts is provided below.

Table 8.1.6-6: Federally Listed Mammal Species of Massachusetts

Common Name	Scientific Name	Federal Status [a]	Critical Habitat	Habitat Description
Northern long-eared bat	*Myotis septentrionalis*	T	No	Trees and snags, caves and abandoned mines throughout the state

[a] T = threatened

Source: (USFWS, 2015c)

Terrestrial Mammals

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*. 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, April 2, 2015). In the U.S., its range includes most of the eastern and north central states (USFWS, 2015d). In Massachusetts, they are widespread in the state and found in all 14 counties (MDFW, 2012) (USFWS, 2015t).

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, 2015d).

White Nose Syndrome is the leading cause for the decline of this species. The numbers of northern long-eared bats in hibernacula has decreased by 99 percent in the northeast 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, 2015d).

Reptiles

Three endangered and two threatened reptiles are federally listed for Massachusetts as summarized in Table 8.1.6-7. Sea turtles are found off the coast as migrant visitors; the Plymouth redbelly turtle (*Pseudemys rubriventris bangsi*) and Muhlenberg northern bog turtle (*Clemmys muhlenbergii*) are found in specific ponds or wetlands in the eastern and western parts of the state respectively. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in Massachusetts is provided below.

Table 8.1.6-7: Federally Listed Reptile Species of Massachusetts

Common Name	Scientific Name	Federal Status [a]	Critical Habitat	Habitat Description
Terrestrial Reptiles				
Bog Turtle	*Clemmys muhlenbergii*	T	No	Wetlands and bogs of western Massachusetts
Plymouth Redbelly Turtle	*Pseudemys rubriventris bangsi*	E	Yes; an area within Plymouth, Massachusetts	Specific ponds of eastern Massachusetts
Marine Reptiles				
Green Sea Turtle	*Chelonia mydas*	T	No	Coastal waters off Cape Cod
Hawksbill Sea Turtle	*Eretmochelys imbricata*	E	No	Coastal waters off Cape Cod
Leatherback Sea Turtle	*Dermochelys coriacea*	E	No	Coastal waters off Cape Cod

[a] E = Endangered, T = Threatened

Source: (USFWS, 2015c)

Terrestrial Reptiles

Bog Turtle. The bog turtle is a small turtle, averaging 3.1 to 4.5 inches in length (USFWS, 2015s) characterized by a light brown to ebony shell and bright yellow, orange, or red blotches on each side of the head (USFWS, 2001). The USFWS proposed a rule in 1997 to list the northern population of the bog turtle as threatened as well as the southern population due to similarity of appearance, under provisions of the ESA (*62 FR 59605, November 4, 1997*). Regionally, the northern population of the bog turtle is known to occur in localized distributions from western Massachusetts and Connecticut southward to Maryland (USFWS, 2001). In Massachusetts the bog turtle is known to occur in Berkshire County in the western part of the state (USFWS, 2015s).

The bog turtles prefer habitats that are open wetlands, sedge meadows, calcium rich wetlands, and boggy areas with cool, shallow, slow-moving water, deep and soft muck soils, and with clumpy vegetation (USFWS, 2001) (USFWS, 2011b). For hibernation the bog turtle generally retreats back to densely vegetated areas in October and tends to emerge from hibernation in late March and April. The bog turtle is omnivorous, feeding primarily on insects but also eating slugs, worms, frogs, plants, and beetles. Current threats to this species are habitat loss and fragmentation from development, vegetation succession, and invasion of nonnative plants, such as purple loosestrife (*Lythrum salicaria*) which out-compete native wetland plants. The illegal collection of bog turtles has also been a major threat throughout the species' range (USFWS, 2001).

Plymouth Redbelly Turtle. The Plymouth redbelly turtle is a large fresh water pond turtle of between 10 to 15 inches in length. Its shell is dark brown to black with orange or coral markings on its underside. The species was first listed as endangered in 1980 and was assigned critical habitat in the same listing (*45 FR 21828-21833, April 2, 1980*) (USFWS, 2007). In 1997, it was commonly believed there were fewer than 200 turtles in 12 ponds of eastern Massachusetts.

Figure 8.1.6-3 shows the extent of the turtle's critical habitat as it was defined within Plymouth, Massachusetts; however, the species is known to have greater range throughout Plymouth, Barnstable, and Bristol counties. The species feeds on aquatic vegetation and crayfish and requires good water quality, sandy nesting soil, and deep ponds for overwinter hibernation (USFWS, 1994a).

Historically, the collection of Plymouth redbelly turtles has also been a major threat throughout the species' range. Current threats to this species include habitat loss and fragmentation from development, reduction in water levels of ponds, the species small population which contributes to their lack of genetic diversity,[109] vegetation succession and loss of basking habitat, and the invasion of nonnative plants which out-complete native wetland plants (USFWS, 1994a).

Marine Reptiles

Green Sea Turtle. The green sea turtle (*Chelonia mydas*) 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 4 feet in length. The breeding populations in Florida were listed as endangered in 1978 (*43 FR 32800, July 28, 1978*), whereas all other populations were listed as threatened (NOAA, 2015d). Regionally, green sea turtles are found from Maine south to Florida, and throughout the Gulf of Mexico and the Caribbean Sea (USFWS, 2015e) (USFWS, 2016c). The North Atlantic green sea turtle distinct population segment has recently been approved for continued listing as threatened via a Final Rule, continuing its current listing status near Massachusetts (81 FR 20057 20090, *April 6, 2016*).

Green Sea Turtle Photo credit: USFWS

They are found in the shallow waters (except during migration) of shoals, bays, lagoons, reefs, and inlets, often where submerged aquatic vegetation exists (NOAA, 2015d). 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 (USFWS, 2016c) (NOAA, 2015d). Hatching usually occurs at night, and many green sea turtle hatchlings seek refuge and food in masses of floating sea plants (USFWS, 2016c).

The collection of green sea turtles for food was the primary cause for the decline of this species; however, 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, 2015d) (USFWS, 2016c).

Hawksbill Sea Turtle. The hawksbill sea turtle (*Eretmochelys imbricata*) is one of the smaller sea turtles. It was listed as endangered in 1970 (NOAA, 1970). It has overlapping plates on its shell 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

[109] Small populations often experience genetic "bottlenecking" where less genetic variation is observed in the population and can contribute to lowered survivability of the species.

weigh up to 300 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 (USFWS, 2015f) (USFWS, 2015g). Although in the Atlantic they range from the East Coast of the U.S. to northern Brazil, they are occasionally found offshore of New England, and are specifically known or believe to occur off of Barnstable, Bristol, Dukes, Essex, Nantucket, Norfolk, and Suffolk Counties (NOAA, 2016).

This species prefers warm, shallow, coastal waters of reefs, lagoons, inlets, and bays with submerged aquatic vegetation. It is an omnivore, feeding mostly on sponges and is most often associated with the coral reef community. Nesting occurs on remote beaches in the Gulf of Mexico and the Caribbean Sea in two to three year cycles (USFWS, 2015g).

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 collection for meat, eggs, and parts, which was the historic threat to this species causing their decline (USFWS, 2013a).

Leatherback Sea Turtle. The leatherback sea turtle (*Dermochelys coriacea*) is "the largest and most migratory and wide ranging of all sea turtles," found in all of the world's oceans. Adult leatherback sea turtles can weigh up to 2,000 pounds and grow up to 6.5 feet in length (USFWS, 2015h). It was listed as endangered in 1970 (*35 FR 8491, June 2, 1970)* and was grandfathered into the ESA of 1973 (NOAA, 2015e). The leatherback sea turtle ranges as far north as the Gulf of Maine and Newfoundland and may be found along the coasts of Massachusetts during summer as an oceanic, visiting species; they are specifically known or believed to occur off of Barnstable, Bristol, Dukes, Essex, Nantucket, Norfolk, and Suffolk Counties (USFWS, 2015i).

Their diet consists of jellyfish and squid and while they may forage in coastal waters but they prefer open sea environments (NOAA, 2015e) (USFWS, 2015i). Female leatherback sea turtles nest at 2 to 3 year intervals on beaches composed of coarse sand that are adjacent to deep water and subject to erosion (USFWS, 2015i). Major threats to the species include harvesting of their eggs, hunting, their incidental capture in fishing gear, beach lighting, beach cleaning, and consumption of plastics that were mistaken for jellyfish (NOAA, 2015e).

Leatherback Sea Turtle Photo credit: USFWS

Birds

One endangered and two threatened bird are federally listed for Massachusetts as summarized in Table 8.1.6-8. The piping plover (*Charadrius melodus*) and red knot (*Calidris canutus rufa*) are found along the 200 miles of coast in the state, wheras the roseate tern (*Sterna dougallii dougallii*) is primarily found on the beaches of Ram Island in southern Massachusetts. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in Massachusetts is provided below.

Table 8.1.6-8: Federally Listed Bird Species of Massachusetts

Common Name	Scientific Name	Federal Status [a]	Critical Habitat	Habitat Description
Piping Plover	*Charadrius melodus*	T	No	Coastal dunes of eastern and southern counties Massachusetts Islands
Red Knot	*Calidris canutus rufa*	T	No	Occurs as a migrant for foraging between wintering and breeding grounds
Roseate Tern	*Sterna dougallii*	E	No	Coasts of Ram Island in Buzzards Bay

[a] E = Endangered, T = Threatened

Source: (USFWS, 2015c)

Piping Plover Photo credit: USFWS

Piping Plover. The piping plover is a small, pale-colored shorebird with a short beak and black band across the forehead, listed as endangered in 1985 (USFWS, 2009b) for the Great Lakes watershed of both the U.S. and Canada. This species was listed as threatened in the remainder of its range in the U.S., which includes the Northern Great Plains, the Atlantic and Gulf Coasts, Puerto Rico, and the Virgin Islands (*50 FR 50726, December 11, 1985)* (USFWS, 2016e). Piping plovers breed in three geographic regions of North America, composed of two separate subspecies. Those breeding within the northeastern U.S. and Canada are of the subspecies *C. m. melodus*, whose range extends from the Atlantic to the Great Lakes (USFWS, 2016e). In Massachusetts, piping plovers use coastal beaches for breeding between the summer months of March and August (USFWS, 2012b).

Red Knot Photo credit: FWS

This species feeds in the intertidal zone of ocean beaches, ocean washover areas, mudflats, sandflats, wrack lines, and the shorelines of coastal ponds, lagoons, and salt marshes. They feed on worms, fly larvae, beetles, crustaceans, and other marine macroinvertebrates (USFWS, 2015j). Current threats to this species include habitat loss and habitat degradation, human disturbance, pets, predation,[110] flooding from coastal storms, and environmental contaminants (USFWS, 2012b) (USFWS, 2016f).

[110] Predation: "The act or practice of capturing another creature (prey) as a means for securing food." (USEPA, 2015f)

Red Knot. Federally listed as a threatened species in 2014 *(79 FR 73705, December 11, 2014)*, the red knot is a large sandpiper that flies in large flocks along Delaware Bay and the Atlantic coast each spring. Red knots spend their winters in the southern tip of South America, northern Brazil, the Caribbean, and the southeastern and Gulf Coasts of the U.S. and breed in the tundra of the central Canadian Arctic. Some have been documented to migrate more than 9,300 miles from south to north every spring and return south in autumn. Red knots are observed in coastal areas of the state. The species is primarily observed here during migration periods when they are moving either to or from breeding areas in the Canadian Arctic (USFWS, 2015k) (USFWS, 2015l).

The preferred habitat for the red knot is intertidal marines, estuaries, and bays. The red knot stops along the Atlantic coast during the spawning season for the horseshoe crab (*Limulus polyphemus*), feeding on horseshoe crab eggs, and mussel and clam beds, which are important food sources to the species (USFWS, 2005). Threats to the Red knot include sea level rise; coastal development; shoreline stabilization; dredging; reduced food availability at their migration stopovers; and disturbance by humans, dogs, vehicles, and climate change (USFWS, 2014b) (USFWS, 2015k).

Roseate Tern. The roseate tern is approximately 15 inches in length with light-gray wings and a black cap. During breeding season, the roseate tern's white chest gains a rosy tinge on the chest, and its bill and legs turn from black to orange-red (USFWS, 2011c). The tern was listed as endangered in 1987 in the Northeast region and threatened in the southeast region (*52 FR 42064, November 2, 1987)* (USFWS, 2015m). The species is a marine bird that breeds along the coasts on salt marsh islands and beaches with sparse vegetation (USFWS, 2011c). In general, the species is present along the coasts of the Atlantic, Pacific, and Indian Oceans. In northeastern America, the roseate tern breeds from the Canadian maritime provinces south to New York (USFWS, 1998) (USFWS, 2011c).

In Massachusetts, the Ram Islands of Buzzards Bay host 1 of the 4 most populous nesting sites in the North Atlantic where more than 90 percent of North America's red knot populations exist (USFWS, 1998). This species was almost hunted to extinction for the millinery trade (e.g., for feathers used in women's hats). Present threats include vegetation changes in breeding areas, competition with gulls for suitable nest sites, and predation (USFWS, 1998).

Invertebrates

Two endangered and two threatened invertebrates are federally listed for Massachusetts as summarized in Table 8.1.6-9. The American burying beetle (*Nicrophorus americanus*) and the northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*) are found on islands or beaches in eastern Massachusetts. The dwarf wedgemussel (*Alasmidonta heterodon*) is endemic to rivers and streams in central parts of the state, and the Puritan Tiger Beetle (*Cicindela puritana*) can be among cliffs along the Connecticut River in western Massachusetts (USFWS, 2013b). Information on the habitat, distribution, and threats to the survival and recovery of each of these species in Massachusetts is provided below.

Table 8.1.6-9: Federally Listed Invertebrate Species of Massachusetts

Common Name	Scientific Name	Federal Status [a]	Critical Habitat	Habitat Description
American Burying Beetle	*Nicrophorus americanus*	E	No	Woodlands or grasslands on the islands of Nantucket County
Dwarf Wedgemussel	*Alasmidonta heterodon*	E	No	Streams of the Connecticut River basin in central Massachusetts
Northeastern Beach Tiger Beetle	*Cicindela dorsalis*	T	No	Beaches of Martha's Vineyard and Monomoy National Wildlife Refuge.
Puritan Tiger Beetle	*Cicindela puritana*	T	No	Cliffs of the Connecticut River in Berkshire County

[a] E = Endangered, T = Threatened

Source: (USFWS, 2015c)

American Burying Beetle. The American burying beetle was listed as endangered in 1989 (*54 FR 29652-29655, July 13, 1989*). It is the largest carrion beetle in North America with a length of between one to two inches with a shiny black shell, smooth shiny black legs, with pronounced orange markings on its body and orange club shaped antennae. The beetle buries carcasses to feed its larvae and upon which it feeds while caring for its young (USFWS, 2014c) (USFWS, 1991).

The American burying beetle can be found in flat topography with forest litter and decomposing plant matter in the top layers of well-drained soil. Historically the species ranged in more than 150 counties in 35 states of the eastern and central U.S. (USFWS, 1991) but today is found in five distinct populations across 10 states. In 2012, Missouri established a non-essential experimental population with efforts to reintroduce the American burying beetle. In Massachusetts, the American burying beetle is only found on Islands of Nantucket County (MassDFG, 2012). Threats to the species include habitat loss, fragmentation, and overall loss of reduction of small vertebrates to host the species (USFWS, 1991).

Dwarf Wedgemussel. The dwarf wedgemussel is a small (less than 1.5 inches in length), brown or yellowish-brown freshwater mussel. Listed as endangered in 1990 (*55 FR 9447-9451, March 14, 1990)* (USFWS, 1993a) throughout its range, except along the lower Neversink River in Orange County, New York and the Tar River in North Carolina where they number in the thousands. In Massachusetts several streams in the Connecticut River basin have been identified as habitat for the dwarf wedgemussel, specifically within Franklin, Hamden, and Hampshire counties (USFWS, 1993b) (USFWS, 2015n).

Dwarf wedgemussels are filter feeders feeding off suspended particles and algae, spending most of their time buried in stream bottoms. They require the tessellated darter (*Etheostoma olmstedi*), the Johnny darter (*Etheostoma nigrum),* or the mottled sculpin (*Cottus bairdi*) in order to host larvae in their gills while the mussel develops. Threats to this species include pollution from agriculture and development projects, channelization, and habitat loss resulting from dams and impoundments (USFWS, 1993b) (USFWS, 2015n).

Northeastern Beach Tiger Beetle. The northeastern beach tiger beetle grows up to more than 0.5 inches in length 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 and dark markings. 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. It is known or believed to occur in Barnstable, Bristol, and Dukes Counties (USFWS, 2015o).

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 medium 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 three stages of larvae transformations over two to three years, which takes place in self-made burrows of 15 to 50 cm deep along the beaches. Once they reach maturity the northeastern beach tiger beetle disperses to distances of approximately four miles (USFWS, 2015o).

Primary threats to this species are from human driven 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, which could be impacted by climate change (USFWS, 2015o).

Puritan Tiger Beetle. The Puritan tiger beetle (*Cicindela puritana*), measuring just under 0.5 inches, was federally listed as threatened throughout its range in 1990 (*55 FR 32088-32094, August 7, 1990)* (USFWS, 2015p). The species is identified by its brownish bronze body with a metallic blue underside, covered with narrow white lines on each wing cover. Found in only two distinct regions, the Puritan tiger beetles has habitat along the Chesapeake Bay in Maryland and along the Connecticut River in New England. However, the nature of the separation of these populations has lasted several thousands of years resulting in genetic and ecological differences between populations. Within Massachusetts, this species is known or believed to occur in Hampshire County and has very specific habitat requirements, laying their larvae only within non-vegetated sandy deposits of eroding bluffs, including the bluff face and base. Similar to the northeastern beach tiger beetle, maturity of these species requires at least two years of larvae transformations, taking place within their bluff burrows (USFWS, 2013c).

Due to the very specific habitat requirements and limited range, this species is particularly vulnerable. Major threats include habitat loss and degradation, primarily from shoreline development and bluff stabilization which generally involve increased vegetation along cliffs (USFWS, 2013c).

Plants

Two endangered and one threatened plant are federally listed for Massachusetts as summarized in Table 8.1.6-10. The northeastern bulrush (*Scirpus ancistrochaetus*) can be found in western Massachusetts along the Connecticut River, the sandplain gerardia (*Agalinis acuta*) grows in

eastern Massachusetts on the shores of Cape Cod, and the small whorled pogonia (*Isotria medeoloides*) is found in north eastern and central parts of the state. Information on the habitat, distribution, and threats to the survival and recovery of each of these species in Massachusetts is provided below.

Table 8.1.6-10: Federally Listed Plant Species of Massachusetts

Common Name	Scientific Name	Federal Status [a]	Critical Habitat	Habitat Description
Northeastern Bulrush	*Scirpus ancistrochaetus*	E	No	Wetlands of Franklin County along the Connecticut River
Sandplain Gerardia	*Agalinis acuta*	E	No	Coastal grasslands of Cape Cod
Small Whorled Pogonia	*Isotria medeoloides*	T	No	Shady wooded areas of central and northeastern parts of the state

[a] E = Endangered, T = Threatened

Source: (USFWS, 2015c)

Northeastern Bulrush. The northeastern bulrush (*Scirpus ancistrochaetus*) was federally listed as endangered in 1991 (56 FR 21091). It is a wetland plant in the sedge family (*Cyperaceae*) that is very similar to other bulrushes, but its flowers and seeds are structurally different; it is approximately three to four feet tall, with narrow leaves and a drooping head with chocolate-brown florets (USFWS, 2010). The species is a wetland species found in small wetlands and wet depressions with seasonally fluctuating water levels. In Massachusetts, the northeastern bulrush persists with a population of four plants at one location in Franklin County in the Connecticut River Valley and has been documented there since 1928 (USFWS, 1993c). Threats to the northeastern bulrush include alterations to the surrounding hydrology,[111] either by drier or wetter conditions;[112] habitat loss; and herbivory (USFWS, 2006).

Sandplain Gerardia. Sandplain gerardia was federally listed as endangered in 1988 (*53 FR 34701-34705, September 7, 1988).* It is a light yellowish green annual with pink blossoms. It is known or believed to occur in Barnstable, Bristol, Dukes, Middlesex, Nantucket, and Worcester Counties (USFWS, 2015u). Preferred habitats are sandy soils of grasslands and roadsides, in pine/oak scrubs, and on scattered patches of bare soils. They cannot survive on their own and require a relationship with the little bluestem (*Schizachyrium scoparium*). Threats to this species include habitat loss from succession, fire suppression, land development, and invasive competitors. Periodic disturbances that create open grassland habitat are necessary for sandplain gerardias success (MassDFG, 2015a).

[111] Hydrology: "The way water moves and is distributed via precipitation, runoff, storage and evaporation."

[112] The northeastern bulrush "appears to have adapted to regularly changing water levels, which may have given it an advantage over less tolerant plant species. But habitat alterations that make a site consistently drier or wetter could make life impossible for the northeastern bulrush." (USFWS, 2006).

Small Whorled Pogonia. The small whorled pogonia *(Isotria medeoloides)* is a member of the orchid family, which grows between 10 to 14 inches in height with greenish yellow flowers. The small whorled pogonia was federally listed as endangered in 1982 (47 FR 39827) and in 1994 was reclassified as threatened (59 FR 50852, Oct. 06, 1994) (USFWS, 2016d) (USFWS, 2016h). Regionally, this species is known to occur sparsely distributed from Maine south to Georgia and west to Illinois (USFWS, 2008). Locally, the small whorled pogonia is known or believed to occur in the central and eastern counties of Essex, Hampden, Hampshire, Middlesex, and Worcester (USFWS, 1992) (USFWS, 2016b).

The small whorled pogonia occurs in hardwood stands that have an open understory, preferring acidic soils along small streams that have a thick layer of litter (USFWS, 2008). One distinct feature of this species is that it can remain dormant underground for 10 to 20 years before reappearing (USFWS, 1992). Current threats to small whorled pogonia include habitat loss due to urban expansion and forestry practices (USFWS, 2008).

8.1.7. Land Use, Recreation, and Airspace

8.1.7.1. Definition of the Resource

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

Land Use and Recreation

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

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. Recreational resources are typically managed by federal, 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, highlighting areas of recreational significance within four identified regions.

Airspace

Airspace is generally defined as the space lying above the earth, above a certain area of land or water, or above a nation and the territories that it controls, including territorial waters (Merriam Webster Dictionary, 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 charged with the safe and efficient use of the nation's airspace and has established criteria and limits to its use.

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

8.1.7.2. Specific Regulatory Considerations

Appendix C summarizes numerous federal laws and regulations that, to one degree or another, affect land use in Massachusetts. However, most site-specific land use controls and requirements are governed by local county, city, and village laws and regulations. Furthermore, many land use controls and requirements are implemented and enforced under the umbrella of land use planning, often with the help and support of state authorities. Massachusetts state laws delegate most zoning, regional planning, and smart-growth zoning[113] to cities and towns (Massachusetts Court System, 2016).

Because the nation's airspace is governed by federal laws, there are no specific Massachusetts state laws that would alter the existing conditions relating to airspace for this PEIS.

[113] Encourages "smart growth" to preserve open space while increasing affordable housing.

8.1.7.3. Land Use and Ownership

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

Land Use

Table 8.1.7-1 identifies the major land uses in Massachusetts. The largest portion of land use with 51 percent of Massachusetts' total land is comprised of forest and woodlands (Table 8.1.7-1 and Figure 8.1.7-1). Open water and wetlands is the second largest area of land use with 23 percent of the total land area. Developed land accounts for approximately 17 percent of the total land area (USGS, 2012d). The remaining percentage of land includes agricultural land, public land, surface water, and other land covers, shown in Figure 8.1.7-1, that are not associated with specific land uses (USGS, 2012d).

Table 8.1.7-1: Major Land Uses in Massachusetts

Land Use	Square Miles	Percent of Land
Forest and Woodland	5,208	51%
Agricultural Land	598	6%
Developed Land	1,715	17%

Source*:* (USGS, 2012d)

Forest and Woodland

Forest and woodland areas can be found throughout Massachusetts and interspersed with, and adjacent to, agricultural land, developed land, and water. The largest concentrations of forest are in western Massachusetts in the Central Uplands, Berkshire Uplands, and Taconic Mountains. Approximately 70 percent of the forest and woodland areas throughout Massachusetts are privately owned (de la Cretaz, Fletcher, Gregory, VanDoren, & Barten, 2010). Section 8.1.6, Biological Resources, presents additional information about terrestrial vegetation.

State Forests

The Massachusetts Department of Conservation and Recreation manages 480 square miles of state forests by applying ecosystem management principles to achieve long-term stewardship of forest resources. Chapter 132 of the Massachusetts General Law states that: "the public welfare requires the rehabilitation, maintenance, and protection of forest lands for the purpose of conserving water, preventing floods and soil erosion, improving the conditions for wildlife and recreation, protecting and improving air and water quality, and providing a continuing and increasing supply of forest products for public consumption, farm use and for the wood-using industries of the commonwealth." The management of state forests are described in Forest Resource Management Plans prepared by the Department of Conservation and Recreation (MassDCR, 2015e).

Private Forest and Woodland

Approximately 212,000 landowners privately own 5,000 square miles of forestland in Massachusetts (about 70 percent). These forests provide timber products, wildlife habitat, ecological benefits, recreation opportunities, and educational opportunities (de la Cretaz, Fletcher, Gregory, VanDoren, & Barten, 2010). Federal, state, and local government programs provide forest management assistance to private landowners. For additional information regarding forest and woodland areas, see Section 8.1.6, Biological Resources, and Section 8.1.8, Visual Resources.

Agricultural Land

Agricultural land exists in every region of the state (Figure 8.1.7-1). Approximately 6 percent of the total land area in Massachusetts is classified as agricultural land (Figure 8.1.7-1). In 2012, there were 7,755 farms in Massachusetts and approximately 80 percent were owned and operated by small, family businesses, with the average farm size of 68 acres. Some of the state's largest agricultural uses include cranberries, dairy, hay, apples, and sweet corn (USDA, 2012). For more information about Massachusetts agriculture by county, access the USDA Census of Agriculture website at www.agcensus.usda.gov/Publications/2012/Full_Report/Census_by_State/Massachusetts/.

Developed Land

Developed land in Massachusetts tends to be concentrated within major metropolitan areas and surrounding cities, towns, and suburbs (Figure 8.1.7-1). Approximately 17 percent of Massachusetts is developed. These developed areas are highly utilized for residential, commercial, industrial, recreational, and government purposes. Table 8.1.7-2 lists the top five developed metropolitan areas within the state and their associated population estimates, and Figure 8.1.7-1 shows where these areas are located within the developed land use category.

Table 8.1.7-2: Top Five Developed Metropolitan Areas

Metropolitan Area	Population Estimate
Boston-Cambridge-Newton, MA-NH Area	4,087,709
Providence-Warwick, RI-MA Area	260,276
Worcester, MA-CT Area	453,586
Springfield, MA Area	531,589
Barnstable Town, MA Area	246,695
Total Population	5,579,855
Total State Population	6,547,629

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

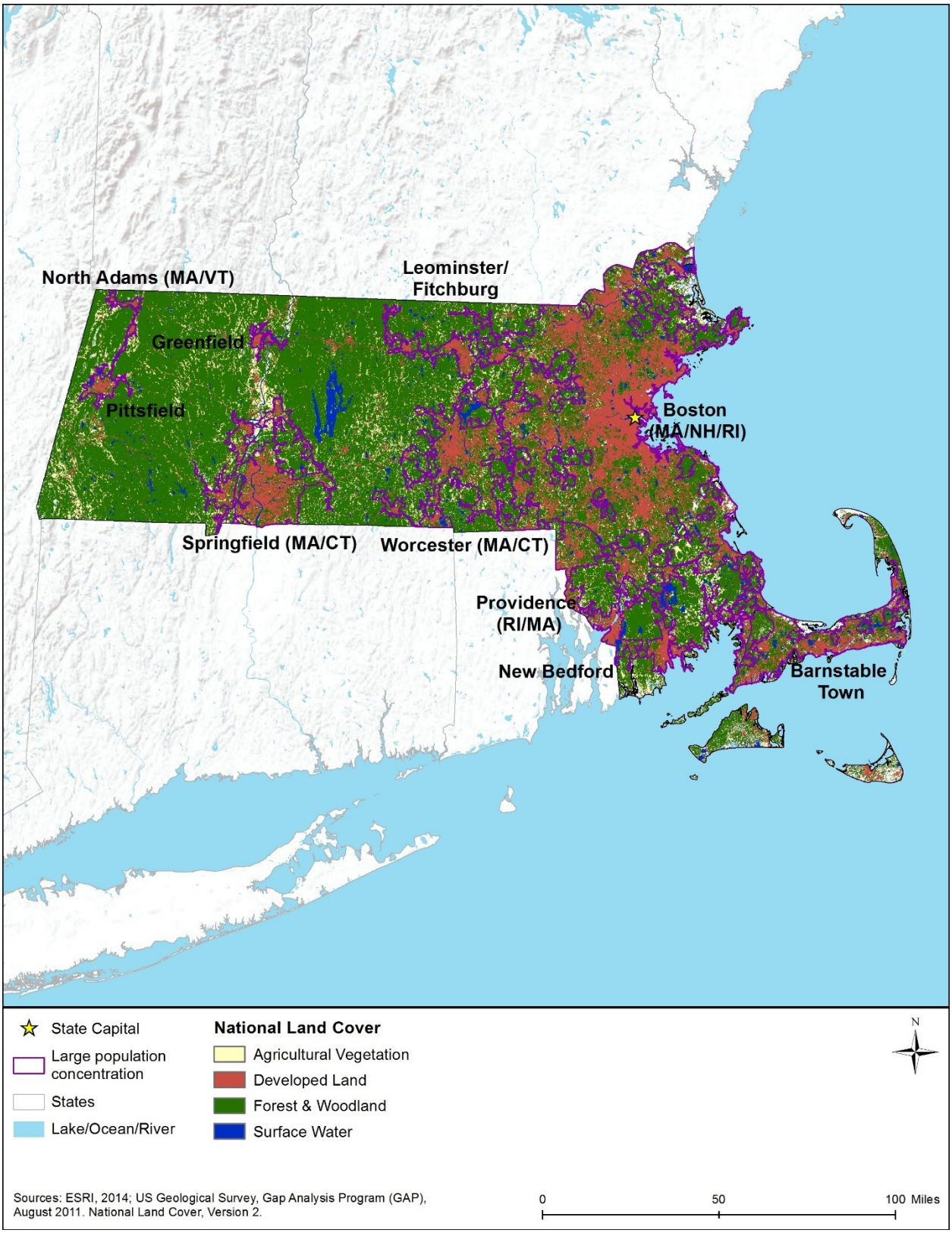


Figure 8.1.7-1: Land Use Distribution

Land Ownership

Land ownership within Massachusetts has been classified into four main categories: private, federal, state, and tribal (Figure 8.1.7-2).

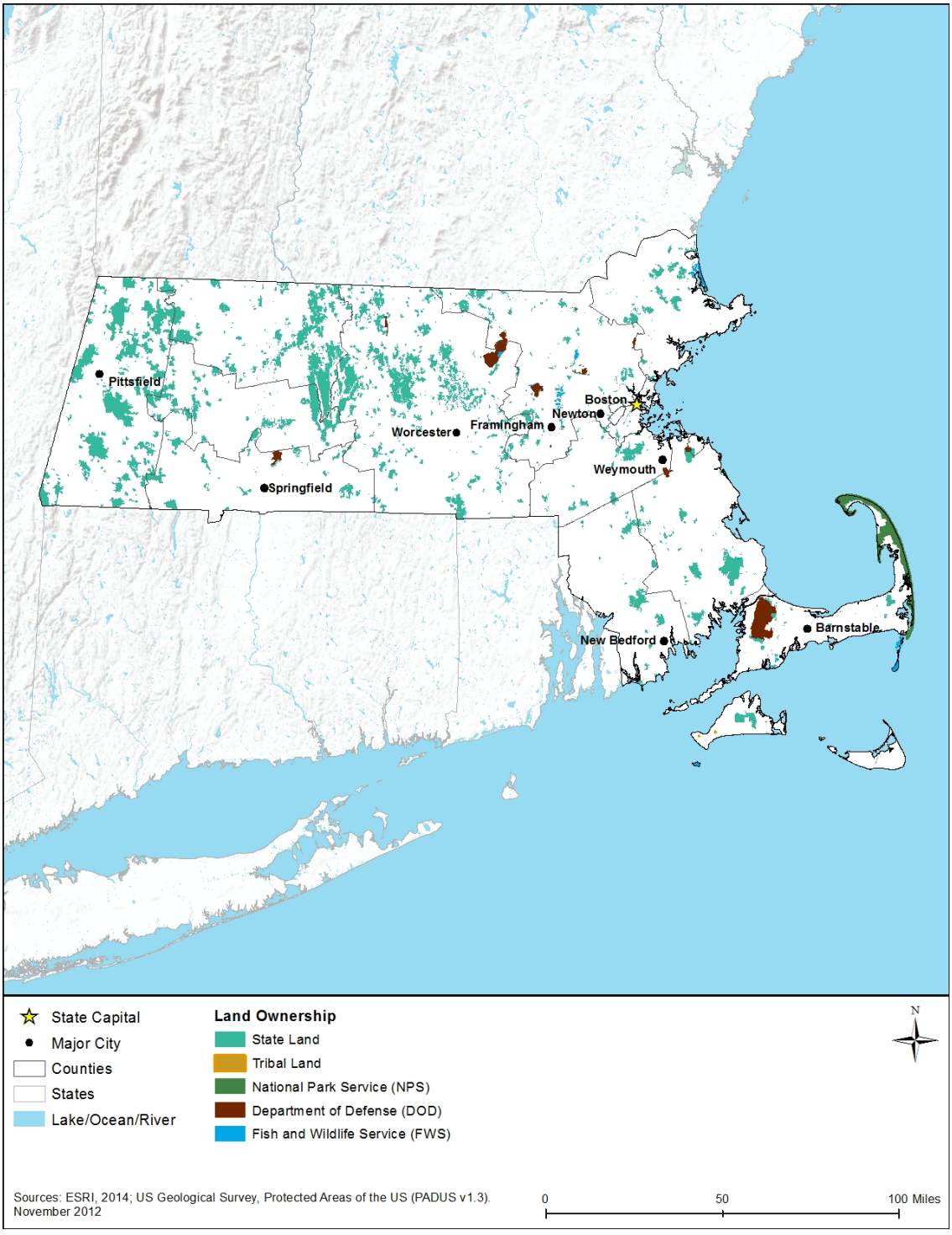


Figure 8.1.7-2: Land Ownership Distribution

Private Land

The majority of land in Massachusetts is privately owned, with most of this land falling under the land use categories of agricultural, forest and woodland, and developed (Figure 8.1.7-2). Highly developed, urban, metropolitan areas transition into suburban, agriculture, shrub, and woodland areas, which then transition into more wild and remote areas. Private land exists in all regions of the state.[114]

Federal Land

The federal government manages 154.1 square miles (less than 2 percent) of land in Massachusetts with a variety of land types and uses, including military bases, national wildlife refuges, national parks, and a national seashore (Figure 8.1.7-2) (USGS, 2014d). Three federal agencies manage federal lands throughout the state (Table 8.1.7-3). Additional information on lands managed by federal agencies is provided in Section 8.1.5, Wetlands, and Section 8.1.8, Visual Resources.

Table 8.1.7-3: Federal Land in Massachusetts

Agency	Square Miles	Type
Department of Defense[1]	61.9	Military Bases, Military Housing, and Training Centers
U.S. Fish and Wildlife Service	26.3	National Wildlife Refuges
National Park Service[2]	65.5	National Historical Parks and Sites, National Recreation Area, and National Seashore

Source: (USGS, 2014d), (NPS, 2015g), (USFWS, 2014d)

[1] Table identifies land wholly managed by the Agency; additional properties may be managed by or affiliated with the Agency.

[2] Additional trails and corridors pass through Massachusetts that are part of the National Park System.

- The Department of Defense own and manages approximately 61.9 square miles used for military bases, military housing, and training centers (DoD, 2014);
- The USFWS owns and manages approximately 26.3 square miles consisting of 11 NWRs in Massachusetts, eight of which are part of the Eastern Massachusetts National Wildlife Refuge Complex (USFWS, 2011a) (USFWS, 2014e) (USFWS, 2015q) (USFWS, 2013d); and
- The National Park Service (NPS) manages 65.5 square miles including 16 national parks, 11 national natural landmarks, 187 national historic landmarks, and 1 national seashore (NPS, 2015g) (NPS, 2014a).

State Land

The Massachusetts state government owns and manages approximately 1,016 square miles of land. This land is comprised of Wildlife Management Areas, Wildlife Conservation Easements, Access Areas, Wildlife Sanctuaries, State Forests, State Parks, and Recreation Areas (Table 8.1.7-4) (Figure 8.1.7-2) (Commonwealth of Massachusetts, 2015d).

[114] Total acreage of private land could not be obtained for the state.

Table 8.1.7-4: State Land in Massachusetts

Agency	Square Miles	Representative Type
Department of Fish and Game	313	Wildlife Management Areas, Wildlife Conservation Easements, Access Areas, and Wildlife Sanctuaries
Department of Conservation and Recreation	703	State Forests, Parks, Recreation Areas
Total	1,016	NA

Source: (Commonwealth of Massachusetts, 2015d)

Tribal Land

The Bureau of Indian Affairs, along with individual tribes, manage 1.6 square miles, or less than 0.1 percent of the total land within Massachusetts (Figure 8.1.7-2). These lands are composed of the Wampanoag Indian Reservations (0.8 square miles) and land owned by the Mashpee Wampanoag Tribe (0.8 square miles) (USEPA, 2012b). These lands are managed for multiple use including wildlife and natural resources protection. For additional information regarding tribal land, see Section 8.1.11, Cultural Resources.

8.1.7.4. Recreation

Massachusetts is relatively small in size, with the Appalachian Mountains to the west and the Atlantic Ocean and the Cape Cod Bay with the Cape Cod peninsula to the east. Population density is highest in the eastern and southern regions of the state. The state is often visited for locations associated with historically or culturally significant events or persons. The interior of the state is known for outdoor recreation, while locations along the shore are known for sailing and other water-based recreation. This section discusses recreational opportunities available at various locations throughout Massachusetts (Figure 8.1.7-3). For information on visual resources, see Section 8.1.8, Visual Resources, and for information on the historical significance of locations, see Section 8.1.11, Cultural Resources.

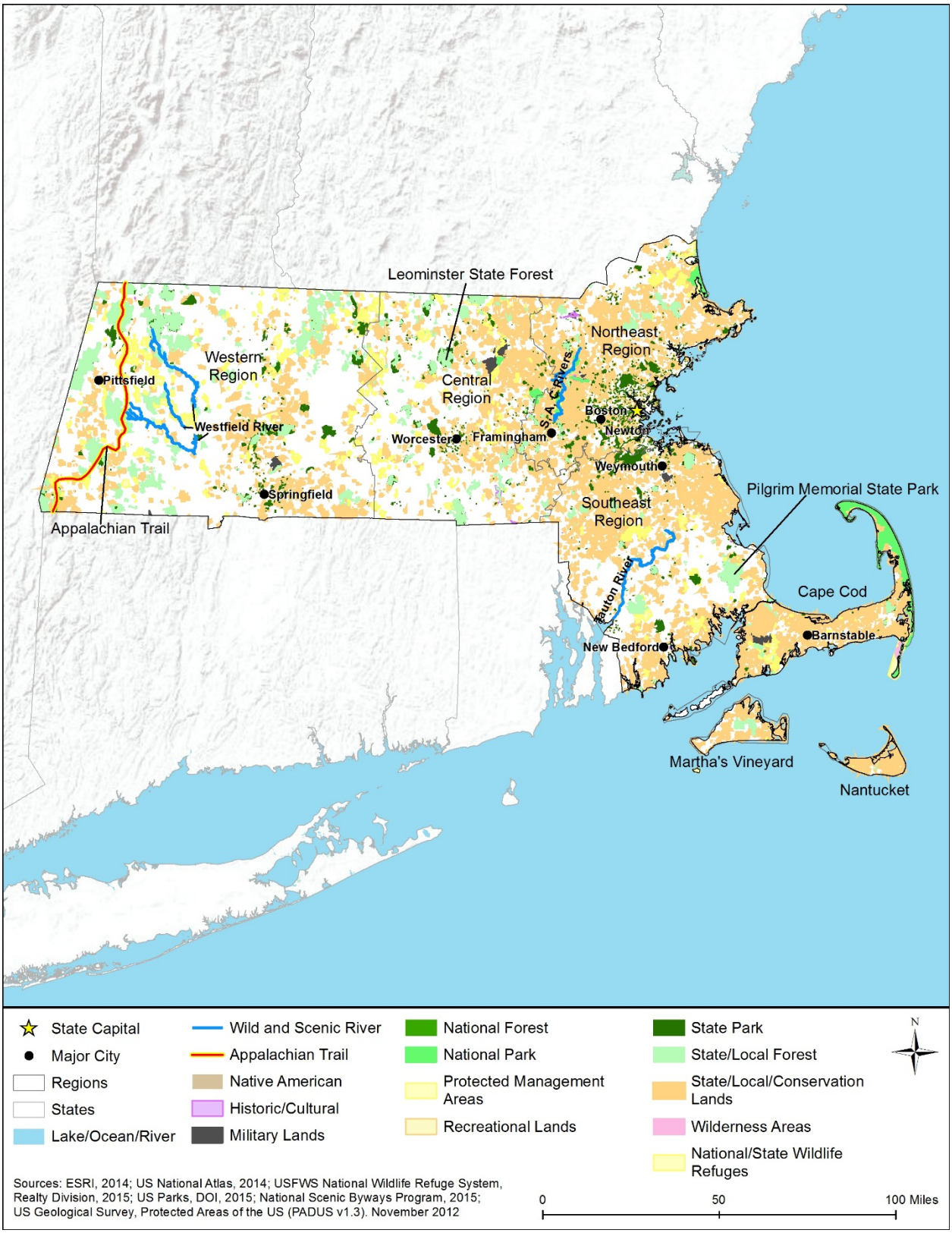


Figure 8.1.7-3: Massachusetts Recreation Resources

Western Region

The Western Region, although largest in area of the regions, is smallest in population. From east to west, the region is composed of the Taconic Mountain Range, part of the Appalachian Mountains, the Berkshire Hills, the Connecticut River, and the Quabbin Reservoir. This region is known for skiing, hiking, and other recreational activities taking advantage of the region's topography, as well as water-based activities (MassDEP, 2015s).

The Appalachian Trail in Massachusetts winds through the Berkshire Hills, with difficulty ratings ranging from flat and smooth to easy, short duration rock scrambling (Appalachian Trail Conservancy, 2015). Six state-run areas contain portions of the trail: Clarksburg State Forest, Mt. Greylock State Reservation, October Mountain State Forest, East Mountain State Forest, and Mt. Everett State Reservation. Within these areas, facilities for long-distance and day hikers include outhouses, camping facilities, and parking (MassDEP, 2015t). Other maintained trails within the region are the Ashuwillticook Rail Trail, the Canalside Rail Trail, the Mahican – Mohawk Trail, and the Massachusetts Central Rail Transit (MRCT) – Norwottuck Rail Trail; some are paved multi-use trails open for bicycling in the summer and cross-country skiing in the winter (MassDCR, 2015f).

Massachusetts is home to several skiing and snowboard resorts, the majority of which are in the Western Region. Resorts in the region have both the longest beginner trails and the steepest expert terrain within the state and night skiing (Massachusetts Office of Travel and Tourism, 2015).

Central Region

The Central Region consists of seven separate river basins, along with the Wachusett Reservoir and watershed providing water-based recreational activities. The region was known for textile mills and farms; residential and commercial development is restructuring the region (MassDEP, 2015u).

The Wachusett Reservoir provides a variety of recreation: shoreline fishing; hiking, bicycling, and snowshoe trails; picnicking; and seasonal permitted hunting (MassDCR, 2015a). The Wachusett Mountain State Reservation, part of the Leominster State Forest, has bicycling, hiking, cross-country skiing, and seasonal hunting (MassDCR, 2015g). Other areas of the Leominster State Forest have available activities including non-motorized boating, canoeing, swimming, fishing, hiking, mountain bicycling, rock climbing, cross-country skiing, and seasonal hunting (MassDCR, 2015h).

Northeast Region

The Northeast Region contains the city of Boston and its northern and western suburbs, and is the most populated region in Massachusetts. It is characterized by a coastline that includes Boston's inner harbor and Cape Ann. On the interior, the region contains nine river basins providing freshwater recreational activities (MassDEP, 2015v).

Lowell National Historical Park is an urban park marking a historic canal system. Multi-use paved pathways along the canal and river highlight both scenic and historic places within the

park (NPS, 2015h). Boston's Freedom Trail is a 2.5-mile route with 16 historically significant locations, frequently visited for guided tours (The Freedom Trail Foundation, 2015).

Southeast Region

The Southeast Region contains the southern suburbs of Boston, Cape Cod, Martha's Vineyard, Nantucket, and the Elizabeth island chain. The Massachusetts coastline, Assawompset Pond, and the North and Taunton Rivers provide ocean and freshwater-based recreational activities (MassDEP, 2015w).

Pilgrim Memorial State Park has nearly one million visitors annually, containing historic icons including the Plymouth Rock and a replica of the Mayflower (MassDCR, 2015i). Cape Cod and the islands in the Southeast Region are known for beaches, bicycle trails, fishing, boating, and golfing (Martha's Vineyard Chamber of Commerce, 2013).

8.1.7.5. 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 8.1.7-4 depicts the different classifications and dimensions for controlled airspace. Air Traffic Control (ATC)[115] service is based on the airspace classification (FAA, 2008).

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

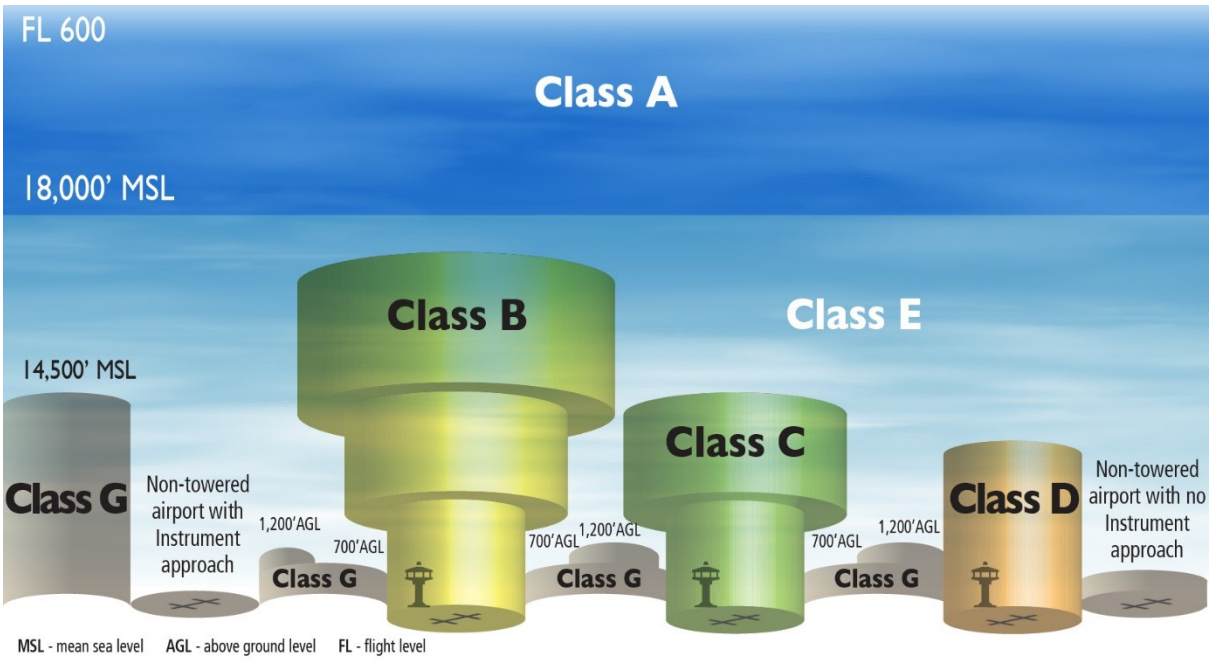


Figure 8.1.7-4: National Air Space Classification Profile

Source: Derived from (Federal Aviation Administration 2008)

Controlled Airspace

- **Class A:** Airspace from 18,000 feet to 60,000 feet above Mean Sea Level (MSL)[116]. 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).[117]
- **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.

[116] 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." (USGS, 2000)
[117] IFR – Rules for the conduct of flights under instrument meteorological conditions. (FAA, 2015c).

- **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).

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 8.1.7-5).

Table 8.1.7-5: 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."
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."

SUA Type	Definition
National Security Areas (NSA)	"Airspace of defined vertical and lateral dimensions established at locations where there is a requirement for increased security and safety of ground facilities. Pilots are requested to voluntarily avoid flying through the depicted NSA. When it is necessary to provide a greater level of security and safety, flight in NSAs may be temporarily prohibited by regulation under the provisions of 14 CFR Section 99.7. Regulatory prohibitions are issued by System Operations, System Operations Airspace and Aeronautical Information Manual (AIM) Office, Airspace and Rules, and disseminated via Notices to Airmen (NOTAM). Inquiries about NSAs should be directed to Airspace and Rules."

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

Other Airspace Areas

Other airspace areas, explained in Table 8.1.7-6, 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 8.1.7-6: Other Airspace Designations

Type	Definition
Airport Advisory	There are 3 types: • Local Airport Advisory – Operated within 10 statute (5,280 feet/mile) miles of an airport where there is a Flight Service Station (FSS) located on an airport, but no operational control tower. The FSS advises the arriving and departing aircraft on particular conditions. • Remote Airport Advisory – Operated within 10 statute miles for specific high activity airports with no operational control tower. • Remote Airport Information Service – Used for short-term special events.
MTRs	MTRs are for use by the military for training, specifically low level combat tactics where low altitudes and high speed are needed.
TFRs	TFRs are established to: • Protect people and property from a hazard; • Provide safety for disaster relief aircraft during operations; • Avoid unsafe aircraft congestion associated with an incident or public interest event; • Protect the U.S. President, Vice President, and other public figures; • Provide safety for space operations; and • Protect in the State of Hawaii declared national disasters for humanitarian reasons. Only those TFRs annotated with an ending date and time of "permanent" are included in this Draft PEIS, since it indicates a longer, standing condition of the airspace. Other TFRs are typically a shorter duration of for a one-time specific event.
Parachute Jump Aircraft Operations	Parachute jump area procedures are in 14 CFR Part 105, while the U.S. parachute jump areas are contained in the regional Airport/Facility Directory.
Published VFRs and IRs	These are established routes for moving around and through complex airspace, like Class B airspace. VFRs are procedures used to conduct flights under visual conditions. IFRs are procedures used to conduct flights with instruments and meteorological conditions.
Terminal Radar Service Areas	Airspace areas that are not one of the established U.S. airspace classes. These areas provide additional radar services to pilots.

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

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

Balloons

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

Obstructions to Airspace Considerations

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

- "Any construction or alteration exceeding 200 ft. aboveground level
- Any construction or alteration:

  - within 20,000 ft. of a public use or military airport which exceeds a 100:1 surface from any point on the runway of each airport with its longest runway more than 3,200 ft.
  - within 10,000 ft. of a public use or military airport which exceeds a 50:1 surface from any point on the runway of each airport with its longest runway no more than 3,200 ft.
  - within 5,000 ft. of a public use heliport which exceeds a 25:1 surface
- Any highway, railroad, or other traverse way whose prescribed adjusted height would exceed the above noted standards
- When requested by the FAA
- 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 FCC licensing requirements are also required to have an OE/AAA performed by the FAA Airport Division.

Massachusetts Airspace

The Massachusetts Department of Transportation – Aeronautics Division (MassDOT Aeronautics) oversees the State's public-use general aviation airports, private use landing areas, and seaplane bases. In addition, MassDOT Aeronautics is responsible for certifying airports and heliports within the state (MassDOT, 2009). The mission of the MassDOT Aeronautics is to "promote aviation throughout the Commonwealth, while providing an efficient integrated airport system that will enhance airport safety, economic development, and environmental stewardship" (MassDOT, 2015c). There is one FAA FSDO for Massachusetts for the Boston area in Burlington (FAA, 2015b).

Massachusetts 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). Table 8.1.7-7 presents the different aviation airports/facilities located in Massachusetts, while Figure 8.1.7-5, Figure 8.1.7-6, and Figure 8.1.7-7 present the breakout by public and private airports. There are approximately 224 airports (public and private) within Massachusetts as presented in Table 8.1.7-7 and Figure 8.1.7-5, Figure 8.1.7-6, and Figure 8.1.7-7 (DOT, 2015).

Table 8.1.7-7: Type and Number of Massachusetts Airports/Facilities

Type of Airport or Facility	Public	Private
Airport	39	36
Heliport	0	133
Seaplane	1	14
Ultralight	0	0
Balloonport	0	1
Gliderport	0	0
Total	40	184

Source: (DOT, 2015)

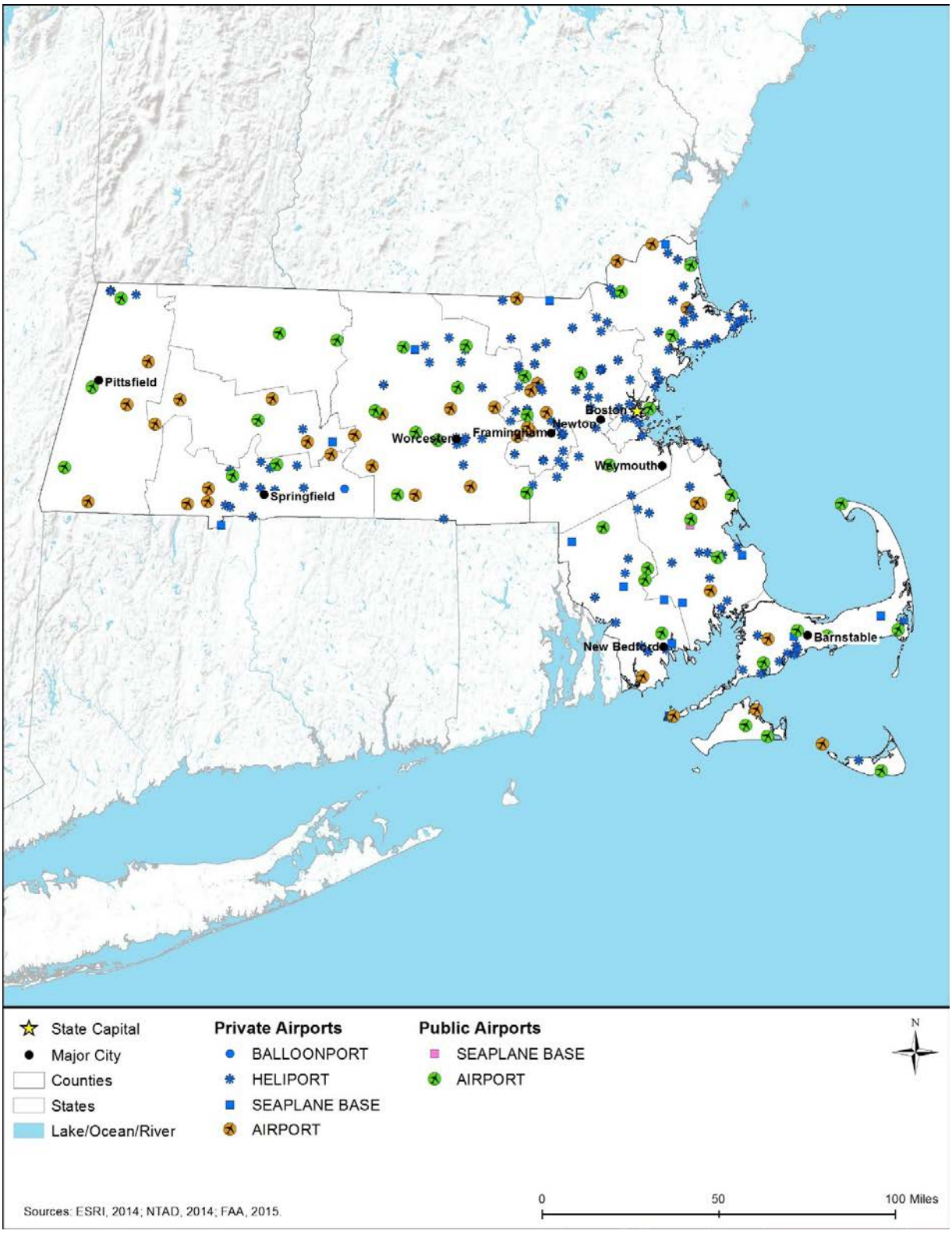


Figure 8.1.7-5: Massachusetts Public and Private Airports/Facilities

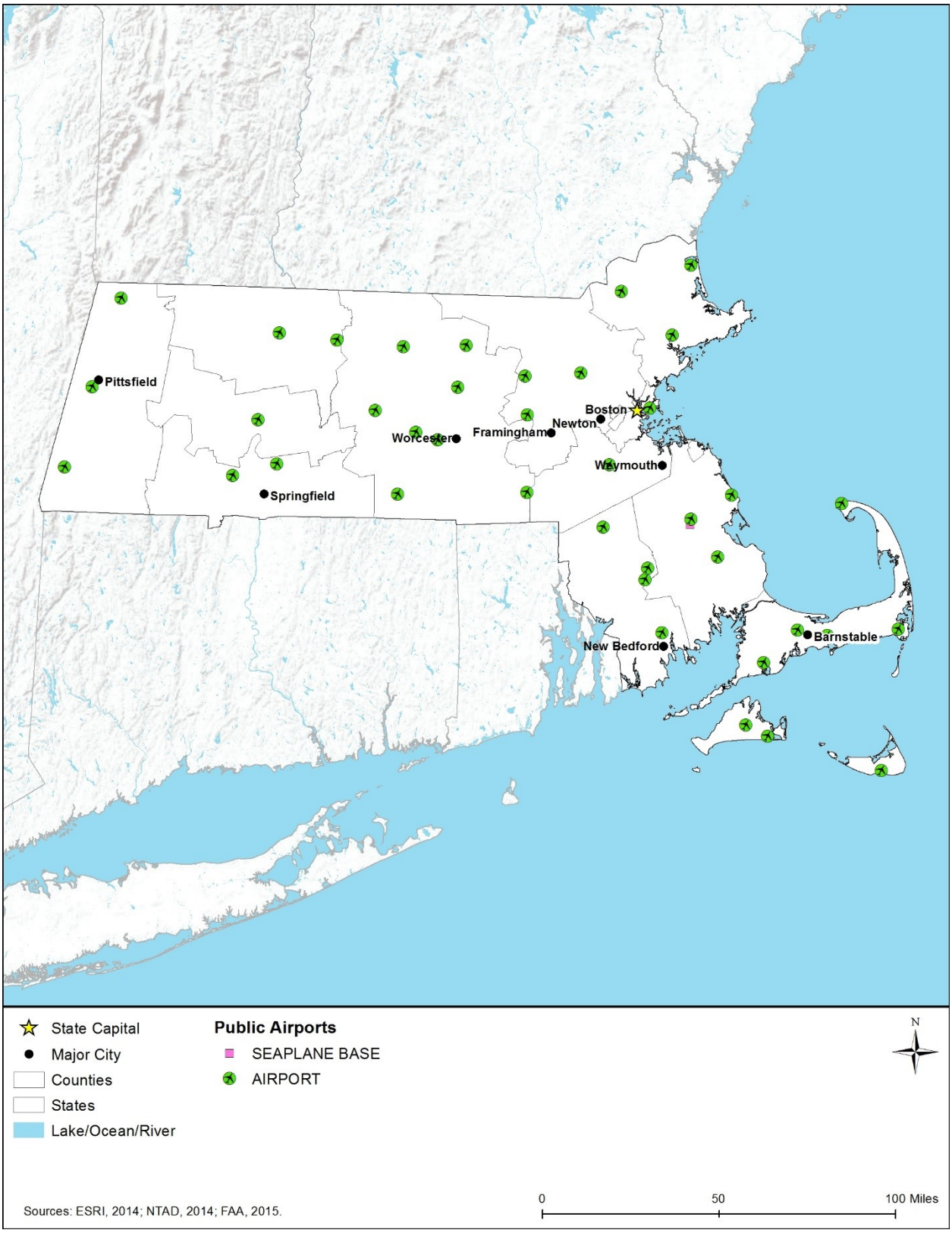


Figure 8.1.7-6: Public Massachusetts Airports/Facilities

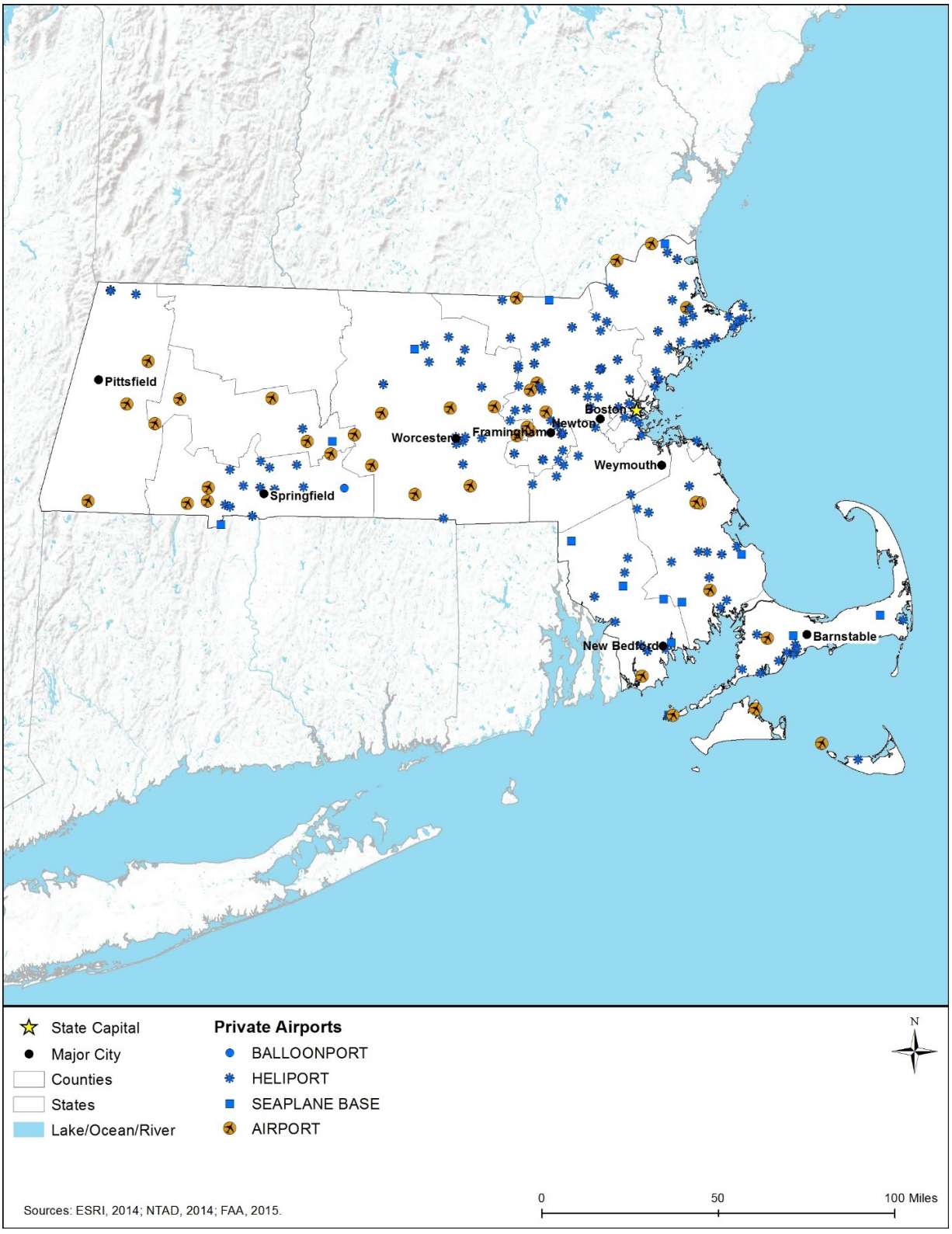


Figure 8.1.7-7: Private Massachusetts Airports/Facilities

There are Class D and E controlled airports for Massachusetts as follows:

- Twelve Class D –
  - Bedford, Lawrence G. Hanscom Field
  - Beverly Municipal
  - Falmouth, Otis Air National Guard Base
  - Hyannis, Barnstable Municipal Airport-Boardman/Polando Field
  - Lawrence Municipal
  - Martha's Vineyard Municipal
  - Nantucket Memorial
  - New Bedford Municipal
  - Norwood Memorial
  - Springfield/Chicopee, Westover Air Force Base
  - Westfield, Barnes Municipal
  - Worcester Municipal
- One Class E –
  - Worcester Municipal (FAA, 2014b)

SUAs (i.e., five restricted) located in Massachusetts are as follows:

- Camp Edwards (Restricted)
  - R-4101 Surface to 9,000 feet MSL
- Fort Devens (Restricted)
  - R-4102A – Surface to, but not including, 2,000 feet MSL
  - R-4102B – 2,000 feet to 3,995 feet MSL
- No Man's Island (Restricted)
  - R-4105A – Surface to, but not including, 10,000 feet MSL
  - R-4105B – 10,000 feet to, but not including, 18,000 feet MSL (FAA, 2015e)

The SUAs for Massachusetts are presented in Figure 8.1.7-8. MTRs in Massachusetts, presented in Figure 8.1.7-9, consist of eleven Slow Routes.

UAS Considerations

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, 2014b). There 16 national parks in Massachusetts that have to comply with this agency directive (NPS, 2015g).

Obstructions to Airspace Considerations

Any proposed construction meeting the criteria of FAA regulations and state laws requires a request for airspace for review by MassDOT's Aeronautics Division, which can be filed electronically at http://app1.massdot.state.ma.us/airspacereview/. Additionally, FAA Form 7460-1, *Proposed Construction/Alternation in Airport Zones*, must be submitted and can be filed electronically at https://oeaaa.faa.gov/oeaaa/external/portal.jsp. Any new construction or modifications to existing structures above 200 feet AGL near an airport will need to be evaluated

by the FAA. The request for review by the State should allow 30 days for completion of the study prior to planned construction start date, although average completion time is about two weeks (MassDOT, 2016).

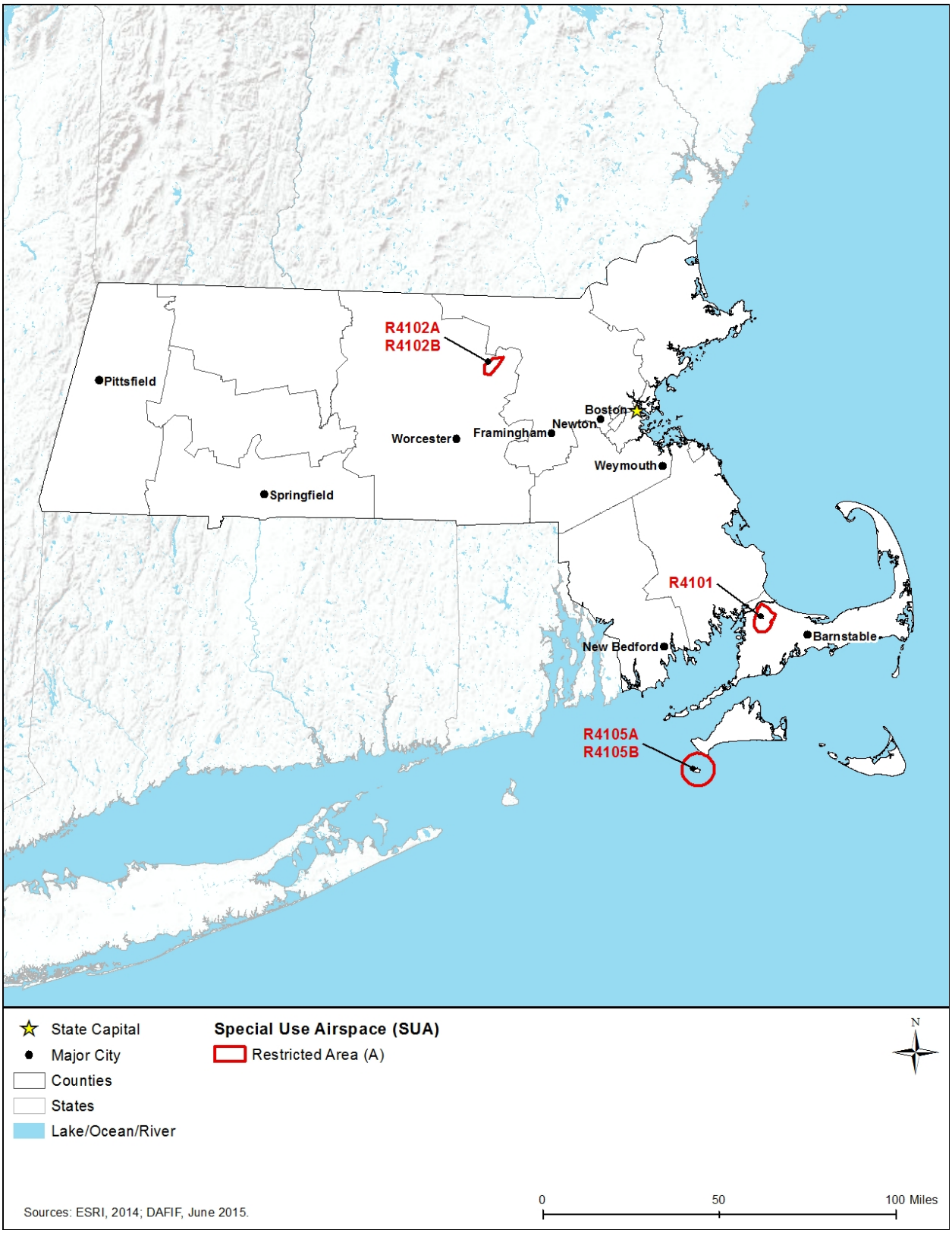


Figure 8.1.7-8: SUAs in Massachusetts

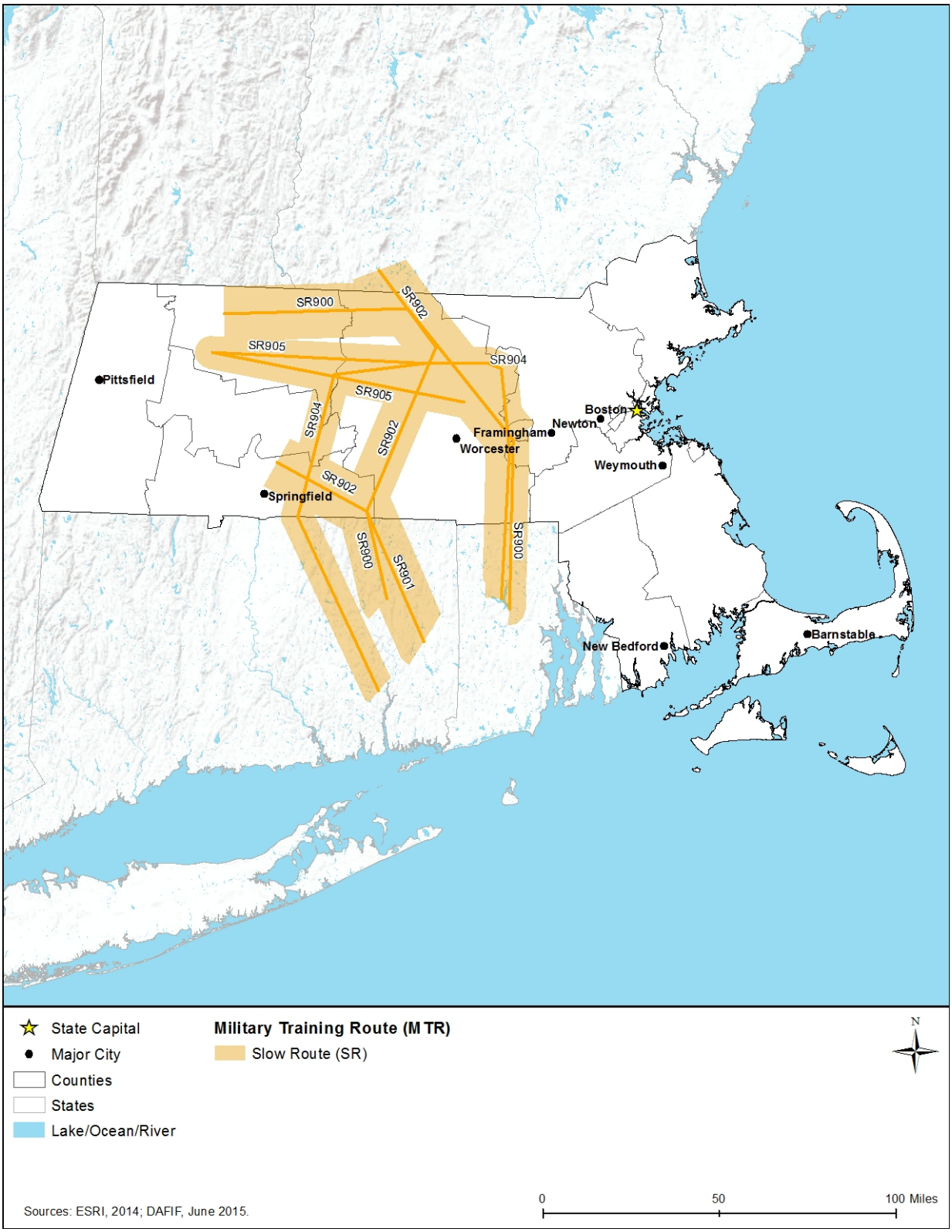


Figure 8.1.7-9: MTRs in Massachusetts

8.1.8. Visual Resources

8.1.8.1. 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, views 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 NHPA compliance. A general definition of visual resources used by the Bureau of Land Management is "the visible physical features on a landscape (e.g., land, water, vegetation, animals, structures, and other features)" (BLM, 1984).

8.1.8.2. Specific Regulatory Considerations

Table 8.1.8-1 presents state and local laws and regulations that relate to visual resources.

Table 8.1.8-1: Relevant Massachusetts Visual Resources Laws and Regulations

State Law/Regulation	Responsible Agency	Applicability
Massachusetts General Law, Chapter 184, Sections 31-33	State Historic Preservation Office (SHPO)	Created the requirement of preservation restrictions as a condition of local community preservation grants.
State Building Code Section 3409	SHPO	Prescribes requirements for building of structures.
Community Preservation Act, MGL c.44B	Cities and Towns	Allows cities and towns to exercise control over local planning decisions.
Constitution of the Commonwealth of Massachusetts, Article XCVII (97)	Various Agencies	Establishes the right to "clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and aesthetic qualities" of the environment.

In addition to the state laws and regulations, local zoning laws may apply related to visual resources. Viewsheds and scenic vistas are increasingly important to the state's towns, cities, and villages as they look at the future planning of their municipalities. Where counties, cities, towns, or villages have planning documents that address scenery, character, or visual resources, the placement of towers or temporary transmission structures would be required to comply with the management or provide mitigation measures to meet compliance.

8.1.8.3. Character and Visual Quality of the Existing Landscape

Massachusetts has a wide range of visual resources. The commonwealth is endowed with historic and natural resources, both of which provide scenic and aesthetic qualities for those who live there and who visit. With locations such as Martha's Vineyard, Walden Pond, and other landscapes containing pristine woodlands, beaches, and waterways, Massachusetts has many visually stunning attributes. Visual resources

within the commonwealth are managed by agencies charged with land, vegetation, and wildlife preservation. These include the Office of Energy and Environment, the Department of Conservation and Recreation, the Division of Fisheries and Wildlife, the USFWS, NPS, and several other state and federal agencies.

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

8.1.8.4. 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 8.1.7-1 shows areas that are included in the National Register of Historic Places (NRHP) that may be considered visually sensitive. In Massachusetts, there are 4,286 NRHP listed sites, which include 189 National Historic Landmarks, 7 National Historical Sites, 5 National Heritage Areas, and 6 National Historical Parks. Section 8.1.11 provides details on the historic resources in Massachusetts. Some State Historic Sites and Districts may also be included in the NRHP, whereas others may not.

The NPS 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, 2016). 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, 2016).

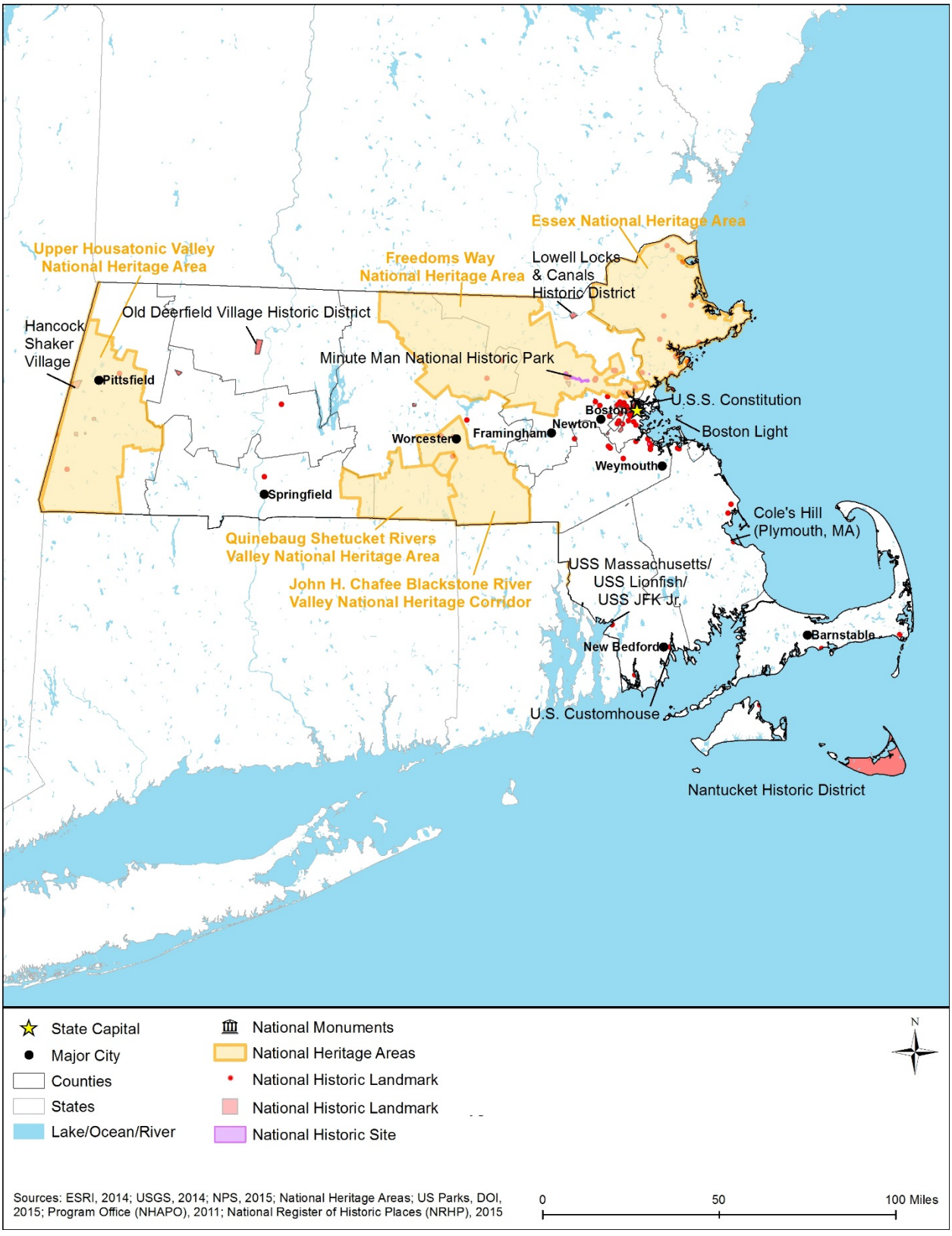


Figure 8.1.8-1: Cultural and Heritage Resources that May Be Visually Sensitive

National Heritage Areas

National Heritage Areas (NHAs) are "places where natural, cultural, and historic resources combine to form a cohesive, nationally important landscape" (NPS, 2011). These areas help tell the history of the United States. Based on this criteria, NHAs in Massachusetts may contain scenic or aesthetic areas considered visual resources or visually sensitive. There are five NHAs in Massachusetts: Essex NHA, Freedom's Way NHA, John H. Chafee Blackstone River Valley NHA, The Last Green Valley NHA, and Upper Housatonic Valley NHA (Figure 8.1.8-1).

National Historic Landmarks

National Historic Landmarks (NHLs) are defined as "nationally significant historic places designated by the U.S. Secretary of the Interior because they possess exceptional value or quality in illustrating or interpreting the heritage of the United States" (NPS, 2015i). Generally, NHLs are comprised of historic buildings such as residences, churches, civic buildings, and institutional buildings. Other types of NHLs 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 Massachusetts, there are 189 NHLs, including sites such as the John Quincy Adam's birthplace, Fort Warren, the Paul Revere house, and Walden Pond (Figure 8.1.8-1) (NPS, 2015i). By comparison, there are over 2,500 NHLs in the U.S., with 8% of these located in Massachusetts.

National Historic Trails

There is one multi-state National Historic Trail within Massachusetts, the Washington-Rochambeau. The Washington-Rochambeau Revolutionary Route passes through natural areas and historic sites along the 680-mile land and water route that General Washington and General Rochambeau traveled for the siege of Yorktown through Delaware, District of Columbia, Connecticut, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, and Virginia (NPS, 2015j).

National Historic Sites and Historical Parks

Massachusetts has 7 National Historic Sites and 6 National Historical Parks, which are preserved by the NPS to "commemorate persons, events, and activities important in the nation's history." (NPS, 2003). Parks are generally larger in size and complexity than sites (NPS, 2003). The seven national historic sites in Massachusetts include Boston African American, Frederick Law Olmstead, John Fitzgerald Kennedy, Longfellow House Washington's Headquarters, Salem Maritime, Saugus Iron Works, and Springfield Armory. The six National Historical Parks include Adams National, Blackstone River Valley, Minute Man, Boston National, Lowell National, and New Bedford Whaling. These sites, parks, and battlefields may contain aesthetic and scenic values associated with history. Locations of the above are identified on the map in Figure 8.1.8-1. (NPS, 2015g)

State Historic Sites and Historic Districts

Massachusetts maintains an inventory of historic and archaeological sites and assets with an estimated 200,000 properties (MHC, 2011). Historic sites include buildings, objects, areas, parks, landscapes, structures, and burial grounds. State historic sites are likely to contain scenic or aesthetic components that may be considered visual resources or visually sensitive. For additional information regarding these properties and resources, see Section 8.1.11, Cultural Resources. In addition, the Massachusetts SHPO maintains an online property database at http://mhc-macris.net/ that includes information on historic properties and areas in the Commonwealth. In addition to historic sites, there are over 200 local historic districts within Massachusetts. These districts contain "historic and architectural values in which historic buildings and their settings are protected by public review" (City of Newton, Massachusetts, 2015).

8.1.8.5. Parks and Recreation Areas

Parks 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. Figure 8.1.7-3 in Section 8.1.7, Land Use, Recreation, and Airspace, identifies parks and recreational resources that may be visually sensitive in Massachusetts. For additional information about recreation areas, including national and state parks, see Section 8.1.7, Land Use, Recreation, and Airspace.

State Parks

State parks contain natural, historic, cultural, and/or recreational resources of significance to Massachusetts residents and visitors. There are 51 state parks throughout Massachusetts, such as the Ames Nowell State Park (Figure 8.1.8-2), most of which contain scenic or aesthetic areas considered to be visual resources or visually sensitive. For a complete list of state parks, see the Massachusetts Department of Conservation and Recreation website: www.mass.gov/eea/agencies/dcr/massparks/places-to-go/massachusetts-state-parks-alpha.html. (MassDCR, 2015j)

Figure 8.1.8-2: Ames Nowell State Park

Source: (MassDCR, 2015k)

National Park Service

The National Park Service (NPS) system contains natural, historic, cultural, visual, ecological, and recreational resources of significance to the nation As a federal entity, NPS maintains these areas for the public's use. In Massachusetts, there are 16[118] officially designated National Parks in addition to other NPS affiliated areas, such as National Heritage Areas. There are 7 National Historic Sites, 6 National Historical Parks, the Boston Harbor Islands National Recreation Area, the Cape Cod National Seashore, the Essex NHA, and the Blackstone River Valley National Heritage Corridor (NPS, 2015g). Table 8.1.8-2 identifies the National Parks and affiliated areas located in Massachusetts. For additional information regarding parks and recreation areas, see Section 8.1.7, Land Use, Recreation, and Airspace.

Table 8.1.8-2: Massachusetts National Parks and Affiliated Areas

Area Name	
Adams National Historical Park	Blackstone River Valley National Heritage Corridor
Blackstone River Valley National Historical Park	Boston National Historical Park
Boston African American National Historic Site	Boston Harbor Islands National Recreation Area
Cape Cod National Seashore	Essex National Heritage Area
Frederick Law Olmsted National Historic Site	John Fitzgerald Kennedy National Historic Site
Longfellow House Washington's Headquarters National Historic Site	Lowell National Historical Park
Minute Man National Historical Park	New Bedford Whaling National Historical Park

[118] This count is based on the NPS website "by the numbers" current as of 9/30/2014 (NPS, 2015g). Actual lists of parks and NPS affiliated areas may vary here depending on when areas are designated by Congress.

Area Name	
Adams National Historical Park	Blackstone River Valley National Heritage Corridor
Salem Maritime National Historic Site	Saugus Iron Works National Historic Site
Springfield Armory National Historic Site	

Source: (NPS, 2015g)

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, 2012b). There are two National Scenic Trails within Massachusetts: the New England NST and the Appalachian NST, both administered by the NPS. The New England NST is a 215-mile-long trail extending from Long Island Sound to scenic mountain summits. The Appalachian NST is a 2,185-mile trail through the Appalachian Mountains. (NPS, 2015g)

8.1.8.6. Natural Areas

Natural areas vary by state depending on the amount of public or state lands within each state. Although many areas may not be managed specifically for visual resources, these areas exist because of their natural resources, and the resulting management may also protect the scenic resources therein.

State Forests

The Massachusetts Department of Conservation and Recreation manages 28 state forests, totaling over 310,000 acres (EEA, 2015c). Visual resources within state forestlands include scenic foliage, meandering streams, grassy meadows, rocky outcrops, pond and lake views, and wildlife viewing.

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. Portions of five rivers in Massachusetts have been designated as wild and scenic (see Figure 8.1.8-3) (National Wild and Scenic Rivers System, 2015b). These include the Sudbury River (Figure 8.1.8-4), Assabet River, Concord River, Taunton River, and the Westfield River.

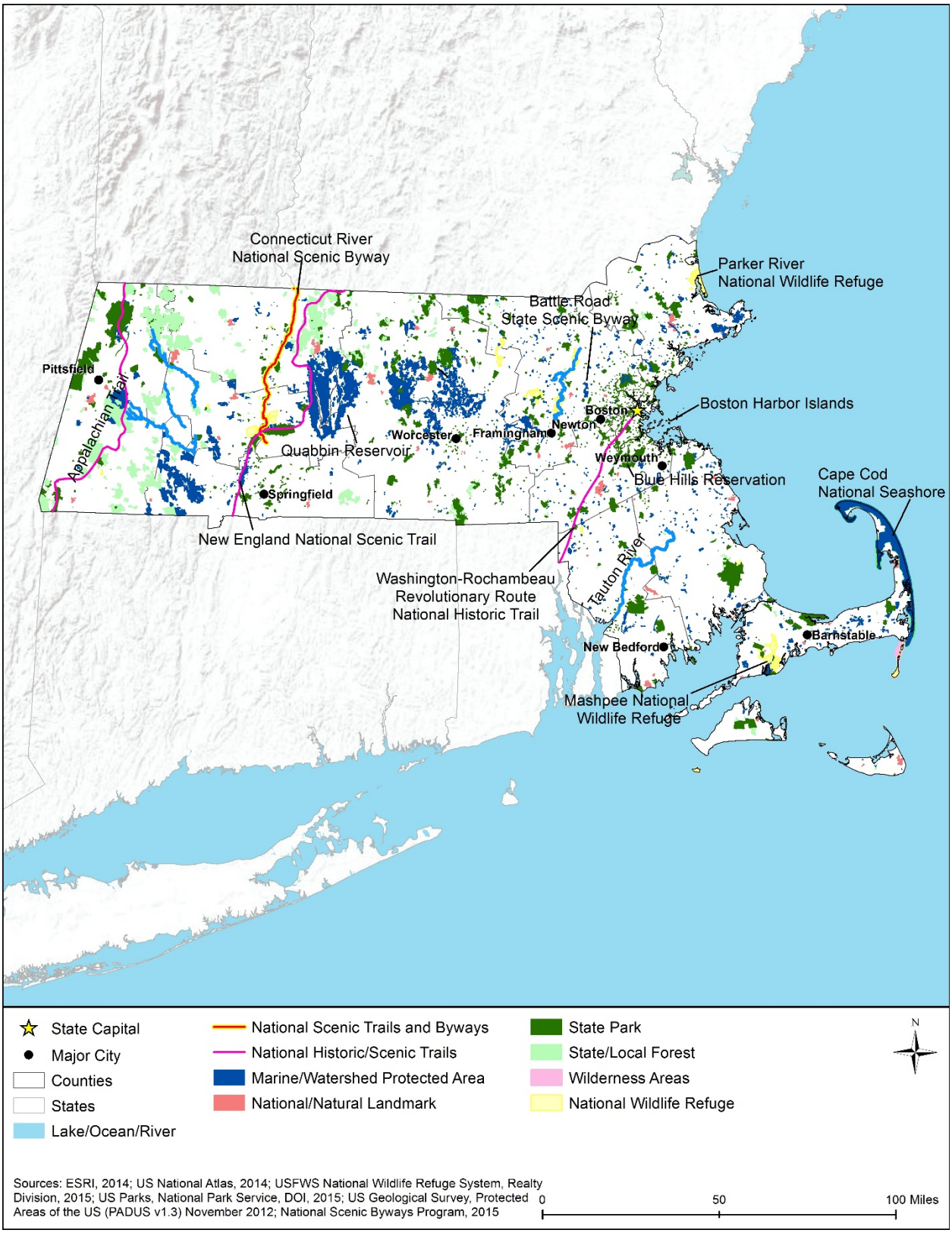


Figure 8.1.8-3: Natural Areas that May Be Visually Sensitive

Figure 8.1.8-4: Sudbury Wild and Scenic River Segment

Source: (National Wild and Scenic Rivers System, 2015b)

National Wildlife Refuges (NWRs) and State Wildlife Management Areas

NWRs are a network of lands and waters managed by the USFWS. These lands and waters are "set aside for the conservation, management and, where appropriate, restoration of fish, wildlife, and plant resources and their habitats" (USFWS, 2015q). There are 11 NWRs in Massachusetts (see Table 8.1.8-3 and Figure 8.1.8-3). Visual resources within the NWRs include views and sites of the coast, beaches, wildlife, and naturally vegetated areas.

Table 8.1.8-3: Massachusetts National Wildlife Refuges

NWR Name	
Assabet River	Great Meadows
Mashpee	Massasoit
Monomoy	Nantucket
Nomans Land Island	Oxbow
Parker River	Silvio O. Conte
Thacher Island	

Source: (USFWS, 2015q)

State Wildlife Management Areas (WMAs) are lands owned and managed by Massachusetts that are "protected to provide habitat for wildlife and to give people a place to relax and explore the great outdoors" (MassDFG, 2015b). There are nearly 400 state WMAs within Massachusetts.

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, 2012a). These landmarks may be considered visual resources or

visually sensitive. In Massachusetts, 11 NNLs, such as the North and South Rivers NNL (Figure 8.1.8-5) exist entirely or partially within the state (Table 8.1.8-4). Some of the natural features located within these areas include "the only old-growth, red spruce stands known to occur in southern New England, 150 cliffs providing the most extensive and scenic exposure of Cretaceous and Tertiary formations on the New England islands, and the terminal moraine marking the maximum extent of the last glacial ice sheet" (NPS, 2012a).

Figure 8.1.8-5: North and South Rivers NNL

Source: (NPS, 2012a)

Table 8.1.8-4: Massachusetts National Natural Landmarks

NNL Name	
Acushnet Cedar Swamp	Bartholomew's Cobble
Cold River Virgin Forest	Fannie Stebbins Refuge
Gay Head Cliffs	Hawley Bog
Lynnfield Marsh	Mt. Greylock Old Growth Spruce
Muskeget Island	North and South Rivers
Poutwater Pond	

Source: (NPS, 2012a)

8.1.8.7. 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 National Scenic Byways Program is managed by the U.S. Department of Transportation, Federal Highway Administration. Massachusetts has one designated National Scenic Byway, the Connecticut River Byway (Figure 8.1.8-3). The Connecticut River Byway travels through Massachusetts, New Hampshire, and Vermont. (FHWA, 2015b).

Similar to National Scenic Byways, Massachusetts Scenic Byways are transportation corridors that are of particular statewide interest. There are 12 State Scenic Byways in addition to the Connecticut River Byway (MassDOT, 2011).

8.1.9. Socioeconomics

8.1.9.1. Definition of the Resource

NEPA requires consideration of socioeconomics in NEPA analysis. 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, as those 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 (see Section 1.8). This PEIS addresses environmental justice in a separate section (Section 8.1.10). This PEIS also addresses the following topics, sometimes included within socioeconomics, in separate sections: land use, recreation, and air space (Section 8.1.7, Land Use, Recreation, and Airspace), infrastructure (Section 8.1.1, Infrastructure), and aesthetic considerations (Section 8.1.8, 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 and U.S. Bureau of Labor Statistics (BLS). This ensures consistency of data and analyses across the states examined in this PEIS. In all cases, this section uses the most recent data available for each geography at the time of writing. At the county, state, region, and United States levels, the data are typically for 2013 or 2014. For smaller geographic areas, this

section uses data from the Census Bureau's American Community Survey (ACS). The ACS is the Census Bureau's flagship demographic estimates program for years other than the decennial census years. This PEIS uses the 2009-2013 ACS, which 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.

8.1.9.2. Specific Regulatory Considerations

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

8.1.9.3. Communities and Populations

This section discusses the population and major communities of Massachusetts (MA) and includes the following topics:

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

Statewide Population and Population Growth

Table 8.1.9-1 presents the 2014 population and population density of Massachusetts in comparison to the East region[119] and the nation. The estimated population of Massachusetts in 2014 was 6,745,408. The population density was 865 persons per square mile (sq. mi.), which is higher than the population density of both the region (312 persons/sq. mi.) and the nation (90 persons/sq. mi.). In 2014, Massachusetts was the 14th largest state by population among the 50 states and the District of Columbia, 45th largest by land area, and had the fourth greatest population density (U.S. Census Bureau, 2015e; U.S. Census Bureau, 2015f).

Table 8.1.9-1: Land Area, Population, and Population Density of Massachusetts

Geography	Land Area (sq. mi.)	Estimated Population 2014	Population Density 2014 (persons/sq. mi.)
Massachusetts	7,800	6,745,408	865
East Region	237,157	73,899,862	312
United States	3,531,905	318,857,056	90

[119] The east region is comprised of 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.

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

Population growth is an important subject for this PEIS, given FirstNet's mission. Table 8.1.9-2 presents the population growth trends of Massachusetts from 2000 to 2014 in comparison to the East region and the nation. The state's annual growth rate more than doubled in the 2010 to 2014 period compared to 2000 to 2010, from 0.31 percent to 0.75 percent. The growth rate of Massachusetts in the latter period was greater than the growth rate of the region, at 0.50 percent, and was similar to the nation's growth rate of 0.81 percent.

Table 8.1.9-2: Recent Population Growth of Massachusetts

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 (estimated)
Massachusetts	6,349,097	6,547,629	6,745,408	198,532	197,779	0.31%	0.75%
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, 2015g; 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 U.S. Census Bureau does not prepare population projections for the states. Therefore,

Table 8.1.9-3 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 Massachusetts' population will increase by approximately 500,000 people, or 7.5 percent, from 2014 to 2030. This reflects an average annual projected growth rate of 0.46 percent, which is less than the historical growth rate from 2010 to 2014 of 0.75 percent and more than the historical growth rate from 2000 to 2010 of 0.31 percent. The projected growth rate of the state is slightly less than that of the region (0.57 percent) and less than the projected growth rate of the nation (0.80 percent).

Table 8.1.9-3: Projected Population Growth of Massachusetts

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
Massachusetts	6,745,408	7,037,976	7,470,365	7,254,171	508,763	7.5%	0.46%
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 (compound growth rate)

Population Distribution and Communities

Figure 8.1.9-1 presents the distribution and relative density of the population of Massachusetts. 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, 2015h).

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 U.S. Census Bureau based on the 2010 census (U.S. Census Bureau, 2010b) (U.S. Census Bureau, 2015i). 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. More sparsely populated areas are in the western part of the state.

Table 8.1.9-4 provides the populations of the 10 largest population concentrations in Massachusetts, based on the 2010 census. It also shows the changes in population for these areas between the 2000 and 2010 censuses.[120] In 2010, the largest population concentration by far was the Massachusetts portion of the Boston area, which had over 4 million people. The state had no other population concentrations over 1 million. It had one area, the Massachusetts portion of the Springfield area, with a population between 500,000 and 1 million, and five areas with populations between 100,000 and 500,000. The smallest of these 10 population concentrations was the North Adams area (Massachusetts portion), with a 2010 population of 18,018. The

[120] 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.

fastest growing area, by average annual rate of change from 2000 to 2010, was the Pittsfield area, with an annual growth rate of 1.14 percent. The Greenfield area and the North Adams area (Massachusetts portion) both experienced population declines during this period.

Table 8.1.9-4 also shows that the top 10 population concentrations in Massachusetts accounted for over 90 percent of the state's population in 2010. Further, population growth in the 10 areas from 2000 to 2010 amounted to 130.6 percent of the entire state's growth. This figure of over 100 percent indicates that the population of the remainder of the state, as a whole, declined from 2000 to 2010.

Table 8.1.9-4: Population of the 10 Largest Population Concentrations in Massachusetts

Area	Population				Population Change 2000 to 2010	
	2000	2010	2009–2013	Rank in 2010	Numerical Change	Rate (AARC)[a]
Barnstable Town	243,667	246,695	245,035	5	3,028	0.12%
Boston (MA/NH/RI) (MA Portion)	3,935,254	4,087,709	4,134,256	1	152,455	0.38%
Greenfield	23,574	22,965	22,822	9	(609)	-0.26%
Leominster/Fitchburg	112,943	116,960	118,432	7	4,017	0.35%
New Bedford	146,730	149,443	148,363	6	2,713	0.18%
North Adams (MA/VT) (MA Portion)*	28,335	18,018	17,989	10	(10,317)	-4.43%
Pittsfield	52,772	59,124	58,027	8	6,352	1.14%
Providence (RI/MA) (MA Portion)	247,545	260,276	261,749	4	12,731	0.50%
Springfield (MA/CT) (MA Portion)	477,551	531,589	534,544	2	54,038	1.08%
Worcester (MA/CT) (MA Portion)	418,631	453,586	456,887	3	34,955	0.81%
Total for Top 10 Population Concentrations	5,687,002	5,946,365	5,998,104	NA	259,363	0.45%
Massachusetts	6,349,097	6,547,629	6,605,058	NA	198,532	0.31%
Top 10 Total as Percentage of State	89.6%	90.8%	90.8%	NA	130.6%	NA

Sources: (U.S. Census Bureau, 2015i) (U.S. Census Bureau, 2015j) (U.S. Census Bureau, 2015k)

*The large population decrease from 2000 to 2010 reflects a similarly large change in the area definition for the North Adams urban cluster (MA portion), from about 18 sq. mi. in 2000 to 9.4 sq. mi. in 2010.
[a] AARC = Average Annual Rate of Change

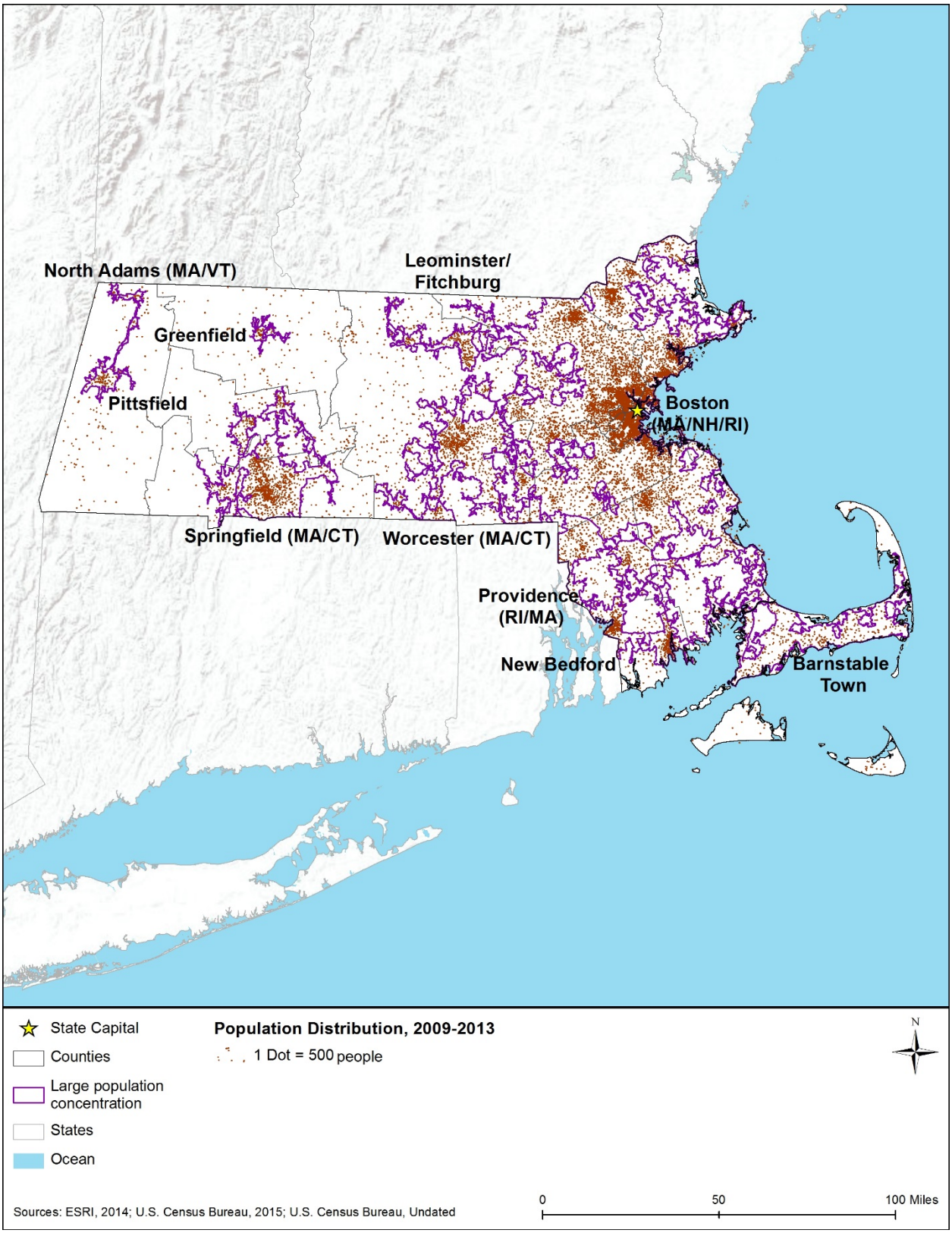


Figure 8.1.9-1: Population Distribution in Massachusetts, 2009–2013

8.1.9.4. 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 8.1.1, Infrastructure. Project-level NEPA analyses may need to examine other institutions, depending on specific locations and specific types of actions.

Economic Activity

Table 8.1.9-5 compares several economic indicators for Massachusetts to the East region and the nation. The table presents two indicators of income[121] – 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 8.1.9-5, the per capita income in Massachusetts in 2013 ($35,879) was $3,027 higher than that of the region ($32,852), and $7,695 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 8.1.9-5 shows that in 2013, the MHI in Massachusetts ($66,794) was $6,290 higher than that of the region ($60,504), and $14,544 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

[121] 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, 2015s)

by the total number of individuals in the labor force. Table 8.1.9-5 compares the unemployment rate in Massachusetts to the East region and the nation. In 2014, Massachusetts' statewide unemployment rate of 5.8 percent[122] was slightly lower than the rate for the region (6.0 percent) and lower than the rate for the nation (6.2 percent).

Table 8.1.9-5: Selected Economic Indicators for Massachusetts

Geography	Per Capita Income 2013	Median Household Income 2013	Average Annual Unemployment Rate 2014
Massachusetts	$35,879	$66,794	5.8%
East Region	$32,852	$60,504	6.0%
United States	$28,184	$52,250	6.2%

Sources: (BLS, 2015b; U.S. Census Bureau, 2015l; U.S. Census Bureau, 2015m; U.S. Census Bureau, 2015n)

Figure 8.1.9-2 and Figure 8.1.9-3 show how MHI in 2013 (U.S. Census Bureau, 2015n) and unemployment in 2014 (BLS, 2015b) varied by county across the state. These maps also incorporate the same population concentration data as Figure 8.1.9-2 (U.S. Census Bureau, 2010b) (U.S. Census Bureau, 2015i). Following these two maps, Table 8.1.9-6 present 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 Massachusetts.

Figure 8.1.9-2 shows that, in general, counties with a MHI above the national median were located in the eastern and central portions of the state. Most of the western portion of the state had MHI levels below the national average, with the exception of Hampshire County in the west-central part of the state. Table 8.1.9-6 shows that the Boston area (Massachusetts portion), is comprised of approximately 62 percent of the state's population (Table 8.1.9-4), was the only population concentration with an MHI above the state average. MHI in all other population concentrations was below the state average. MHI was lowest in the North Adams (Massachusetts portion) and Pittsfield areas, in the western part of the state. These are two of the smallest three areas (by population) shown in the table.

Figure 8.1.9-3 presents variations in the 2014 unemployment rate across the state, by county. It shows that most counties had unemployment rates below the national average (that is, better employment performance). However, a number of counties in the western part of the state had unemployment rates above the national average. The lowest unemployment rates were generally in the counties around Boston, and in Hampshire County in the west-central part of the state. When comparing unemployment in the population concentrations to the state average (Table 8.1.9-6), most areas had unemployment rates that were higher than the state average. The areas with the highest unemployment rates (10.6 to 11.6 percent) were the Leominster/Fitchburg, New Bedford, and Pittsfield areas, and the Massachusetts portions of the Providence and Springfield

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

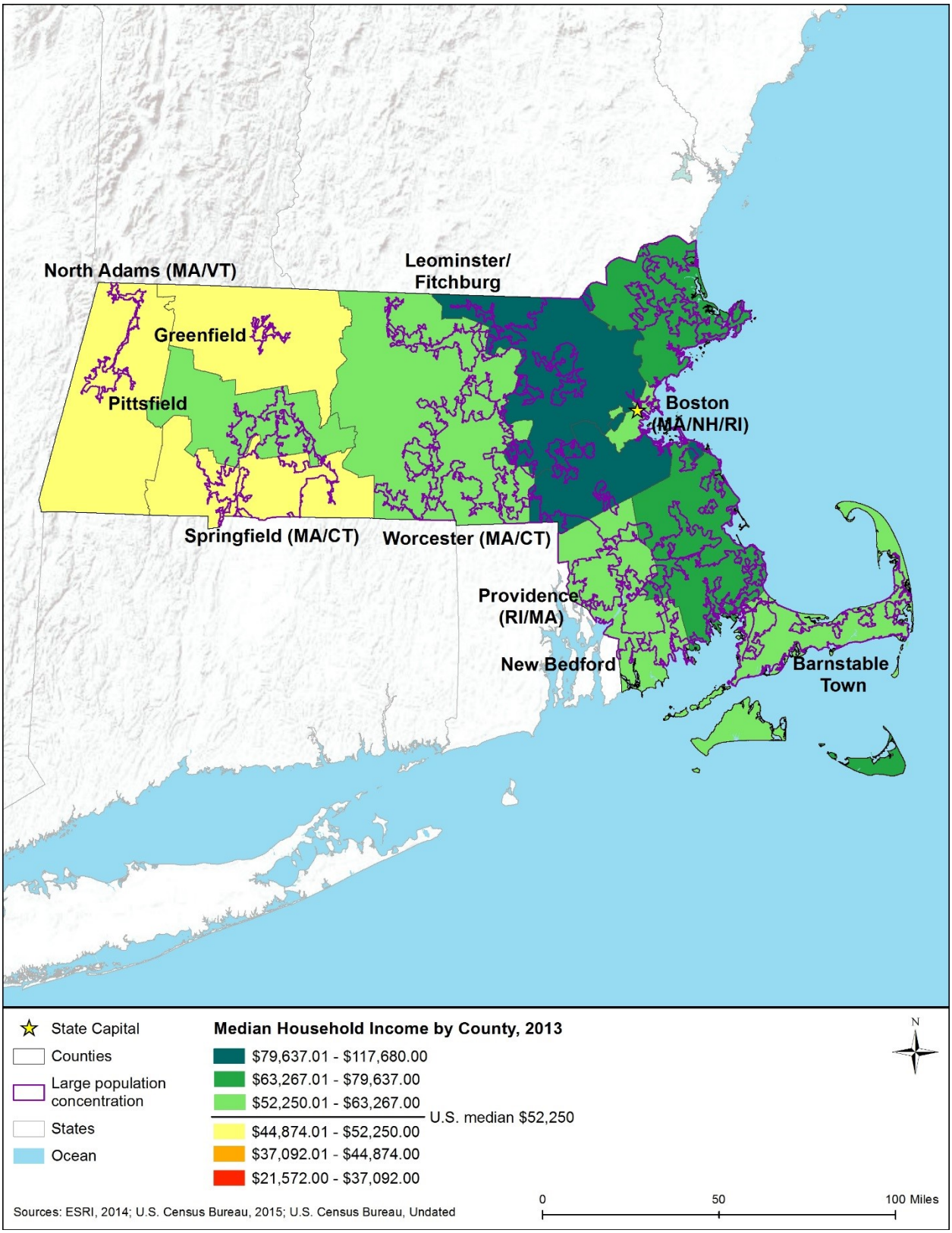


Figure 8.1.9-2: Median Household Income in Massachusetts, by County, 2013

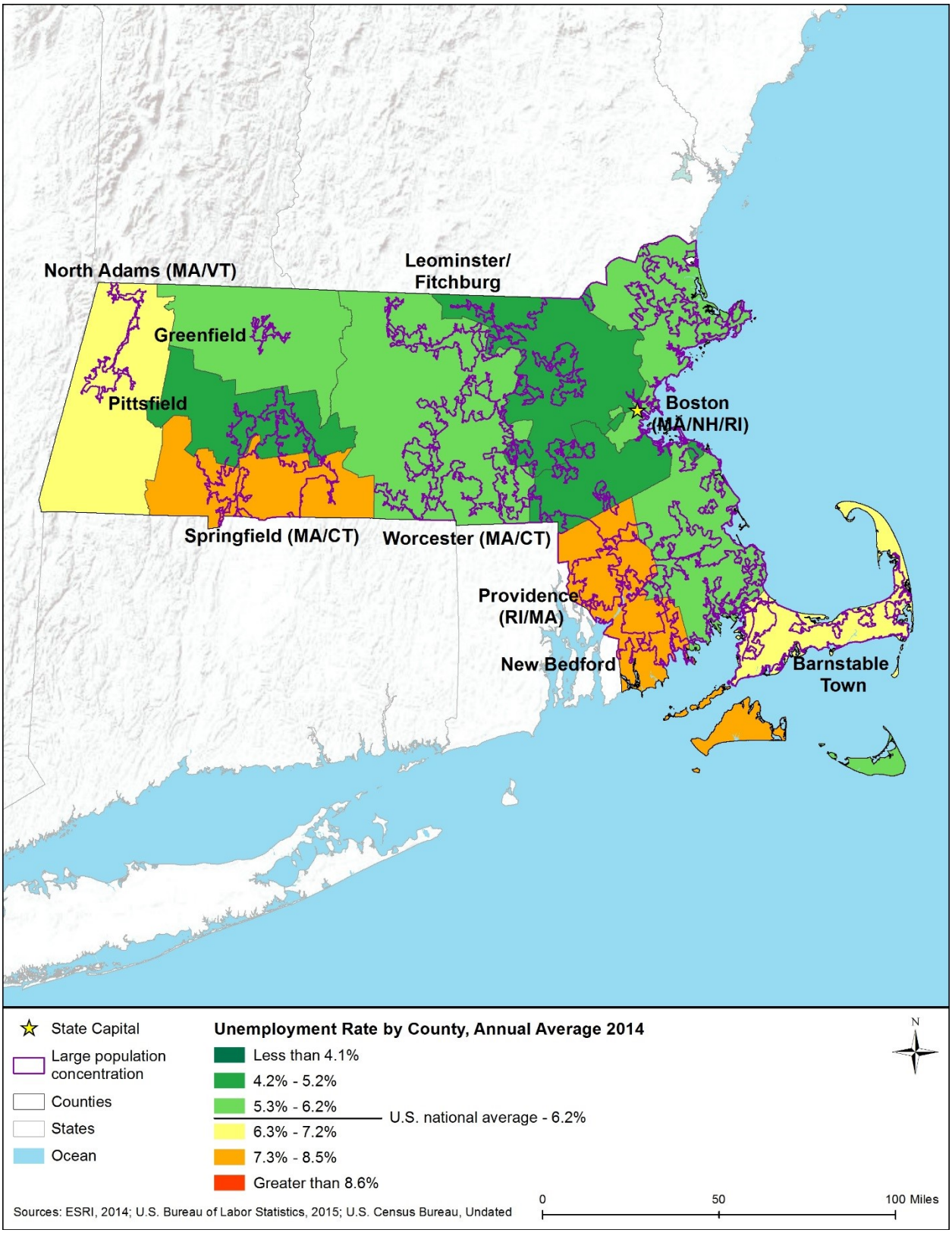


Figure 8.1.9-3: Unemployment Rates in Massachusetts, by County, 2014

areas. Only the Boston (Massachusetts portion) and Barnstable Town areas had unemployment rates that were lower than the state average. This indicates that employment conditions in the highly populated area of Boston dominated the state average.

Detailed employment data provides useful insights into the nature of a local, state, or national economy. Table 8.1.9-7 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 somewhat higher in Massachusetts than in the East region and the nation. The percentage of government workers was lower in the state than in the region and nation. Self-employed workers were a similar percentage in the state as in the region and nation.

By industry, Massachusetts has a mixed economic base and some notable figures in the table below are as follows. Massachusetts in 2013 had a considerably lower percentage of persons working in "agriculture, forestry, fishing and hunting, and mining" and in "public administration" than did the region or the nation. Compared to both the region and the nation, it had a somewhat higher percentage of workers in "finance and insurance, and real estate and rental and leasing," and in "professional, scientific, management, administrative, and waste management services." It also had a considerably higher percentage in "educational services, and health care and social assistance" than the region or nation.

Table 8.1.9-6: Selected Economic Indicators for the 10 Largest Population Concentrations in Massachusetts, 2009–2013

Area	Median Household Income	Average Annual Unemployment Rate
Barnstable Town	$62,317	8.7%
Boston (MA/NH/RI) (MA Portion)	$72,279	8.5%
Greenfield	$45,176	9.7%
Leominster/Fitchburg	$52,481	11.3%
New Bedford	$44,077	11.6%
North Adams (MA/VT) (MA Portion)	$42,723	9.6%
Pittsfield	$41,874	11.6%
Providence (RI/MA) (MA Portion)	$56,435	11.1%
Springfield (MA/CT) (MA Portion)	$48,782	10.6%
Worcester (MA/CT) (MA Portion)	$61,501	9.1%
Massachusetts (Statewide)	$66,866	8.9%

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

Table 8.1.9-7: Employment by Class of Worker and by Industry, 2013

Class of Worker and Industry	Massachusetts	East Region	United States
Civilian Employed Population 16 Years and Over	3,398,003	35,284,908	145,128,676
Percentage by Class of Worker			
Private wage and salary workers	81.8%	79.3%	79.7%

Class of Worker and Industry	Massachusetts	East Region	United States
Government workers	12.3%	15.1%	14.1%
Self-employed in own not incorporated business workers	5.8%	5.4%	6.0%
Unpaid family workers	0.1%	0.1%	0.2%
Percentage by Industry			
Agriculture, forestry, fishing and hunting, and mining	0.3%	0.9%	2.0%
Construction	5.2%	5.8%	6.2%
Manufacturing	9.4%	8.5%	10.5%
Wholesale trade	2.4%	2.5%	2.7%
Retail trade	10.7%	11.1%	11.6%
Transportation and warehousing, and utilities	3.6%	4.6%	4.9%
Information	2.3%	2.3%	2.1%
Finance and insurance, and real estate and rental and leasing	7.6%	7.3%	6.6%
Professional, scientific, management, administrative, and waste management services	13.5%	12.3%	11.1%
Educational services, and health care and social assistance	28.1%	25.6%	23.0%
Arts, entertainment, and recreation, and accommodation and food services	8.7%	8.9%	9.7%
Other services, except public administration	4.4%	4.9%	5.0%
Public administration	3.9%	5.5%	4.7%

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

Table 8.1.9-8 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 8.1.9-7 for 2013.

Table 8.1.9-8: Employment by Selected Industries for the 10 Largest Population Concentrations in Massachusetts, 2009–2013

Area	Construction	Transportation and Warehousing, and Utilities	Information	Professional, Scientific, Management, Administrative and Waste Management Services
Barnstable Town	9.1%	4.4%	2.2%	11.3%
Boston (MA/NH/RI) (MA Portion)	4.8%	3.5%	2.6%	15.0%
Greenfield	3.8%	3.6%	4.2%	4.2%
Leominster/Fitch-burg	5.2%	3.0%	1.8%	9.7%
New Bedford	7.0%	3.9%	1.6%	6.9%
North Adams (MA/VT) (MA Portion)	5.7%	1.8%	1.7%	6.3%
Pittsfield	5.3%	2.5%	2.0%	8.5%

Area	Construction	Transportation and Warehousing, and Utilities	Information	Professional, Scientific, Management, Administrative and Waste Management Services
Providence (RI/MA) (MA Portion)	6.4%	3.7%	1.6%	9.2%
Springfield (MA/CT) (MA Portion)	4.0%	4.3%	1.9%	7.5%
Worcester (MA/CT) (MA Portion)	4.6%	4.1%	2.0%	10.7%
Massachusetts (Statewide)	5.3%	3.6%	2.3%	13.0%

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

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 8.1.9-9 compares Massachusetts to the East region and nation on several common housing indicators.

As shown in Table 8.1.9-9, in 2013 Massachusetts had a higher percentage of housing units that were occupied (90.1 percent) than the region (88.4 percent) or nation (87.5 percent). Of the occupied units, Massachusetts had a somewhat lower percentage of owner-occupied units (61.5 percent) than the region (62.8 percent) or nation (63.5 percent). The lower owner-occupied rate was probably due to large numbers of apartment and other rental units in the highly developed areas of the state. This is reflected in the lower percentage of detached single-unit housing (also known as single-family homes) in Massachusetts in 2013 (51.9 percent) compared to the region (52.7 percent) and nation (61.5 percent). The vacancy rate among rental units was lower in Massachusetts (4.6 percent) than in the region (5.5 percent) or nation (6.5 percent).

Table 8.1.9-9: Selected Housing Indicators for Massachusetts, 2013

Geography	Total Housing Units	Housing Occupancy & Tenure				Units in Structure
		Occupied Housing	Owner-Occupied	Homeowner Vacancy Rate	Rental Vacancy Rate	1-Unit, Detached
Massachusetts	2,813,641	90.1%	61.5%	1.1%	4.6%	51.9%
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, 2015r)

Table 8.1.9-10 provides housing indicators 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 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 8.1.9-10, during this period the percentage of occupied housing units ranged from 89.6 to 93.7 percent for eight of these ten population concentrations, which is consistent with the state percentage (90.1 percent).

Table 8.1.9-10: Selected Housing Indicators for the 10 Largest Population Concentrations in Massachusetts, 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
Barnstable Town	163,104	64.6%	79.9%	2.2%	7.5%	82.2%
Boston (MA/NH/RI) (MA Portion)	1,679,569	93.7%	59.7%	1.1%	4.5%	44.9%
Greenfield	10,886	93.3%	52.0%	1.4%	3.5%	45.5%
Leominster/Fitchburg	51,374	90.0%	58.2%	2.4%	7.8%	47.6%
New Bedford	65,635	89.6%	54.2%	1.5%	5.8%	46.5%
North Adams (MA/VT) (MA Portion)	8,491	83.7%	55.7%	1.8%	9.8%	45.3%
Pittsfield	28,153	90.4%	61.6%	2.4%	5.3%	53.9%
Providence (RI/MA) (MA Portion)	112,065	90.9%	62.2%	1.5%	6.3%	50.8%
Springfield (MA/CT) (MA Portion)	215,487	93.3%	59.4%	1.5%	4.2%	52.2%
Worcester (MA/CT) (MA Portion)	186,637	91.9%	60.1%	1.2%	6.4%	49.2%
Massachusetts (Statewide)	2,808,549	90.1%	62.7%	1.3%	5.0%	52.3%

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

Property Values

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

Table 8.1.9-11 provides indicators of residential property values for Massachusetts 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, 2015s).

The table shows that the median value of owner-occupied units in Massachusetts in 2013 ($327,200) was higher than the corresponding values for the East region ($249,074) and for the nation ($173,900).

Table 8.1.9-11: Residential Property Values in Massachusetts, 2013

Geography	Median Value of Owner-Occupied Units
Massachusetts	$327,200
East Region	$249,074
United States	$173,900

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

Table 8.1.9-12 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. Only the Barnstable Town ($343,000) and Boston (Massachusetts portion, $370,400) areas had a median value higher than the state median value ($330,100). All other population concentrations had property values considerably below the state value. This indicates that the Boston area (Massachusetts portion), due to its size, dominates the state median value. The areas with the lowest median home values were the Pittsfield ($171,800) and North Adams ($173,800) areas, which also had very low median household incomes (Table 8.1.9-6).

Table 8.1.9-12: Residential Property Values for the 10 Largest Population Concentrations in Massachusetts, 2009–2013

Area	Median Value of Owner-Occupied Units
Barnstable Town	$343,000
Boston (MA/NH/RI) (MA Portion)	$370,400
Greenfield	$180,700
Leominster/Fitchburg	$206,500
New Bedford	$243,300
North Adams (MA/VT) (MA Portion)	$173,800
Pittsfield	$171,800
Providence (RI/MA) (MA Portion)	$279,500
Springfield (MA/CT) (MA Portion)	$203,100
Worcester (MA/CT) (MA Portion)	$257,200
Massachusetts (Statewide)	$330,100

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

Government Revenues

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

intergovernmental agreements for system development and operation. Public utility taxes[123] 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 8.1.9-13 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 were 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 8.1.9-13 shows that the state government in Massachusetts received more, and local governments received less, total revenue in 2012 on a per capita basis than their counterpart governments in the region and nation. Additionally, Massachusetts state government had higher levels of intergovernmental revenue[124] from federal sources. Massachusetts local governments received less revenue from the state than did local governments in the region and nation. The Massachusetts state government obtained very little revenue from property taxes, but local governments in Massachusetts obtained levels of property taxes per capita that were somewhat higher than local governments in the region, and considerably higher than those in the nation. General sales taxes were similar on a per capita basis for the Massachusetts state government, compared to counterparts in the nation, and higher than those for counterparts in the region. Local governments in Massachusetts received no revenue from general sales taxes. Selective sales taxes, and public utility taxes specifically, were lower on a per capita basis for Massachusetts state and local governments than for counterparts in the region and nation. Individual and corporate income tax revenues, on a per capita basis, were higher for the Massachusetts state government, but lower for Massachusetts local governments, than for counterpart governments in the region and nation (Massachusetts local governments received no revenue in 2012 from these sources).

[123] 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)

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

Table 8.1.9-13: State and Local Government Revenues, Selected Sources, 2012

Type of Revenue		Massachusetts		Region		United States	
		State Govt. Amount	Local Govt. Amount	State Govt. Amount	Local Govt. Amount	State Govt. Amount	Local Govt. Amount
Total Revenue	($M)	$49,001	$32,931	$522,354	$431,898	$1,907,027	$1,615,194
	Per capita	$7,373	$4,955	$7,132	$5,897	$6,075	$5,145
Intergovernmental from Federal	($M)	$12,920	$1,614	$135,435	$20,289	$514,139	$70,360
	Per capita	$1,944	$243	$1,849	$277	$1,638	$224
Intergovernmental from State	($M)	$0	$8,560	$0	$120,274	$0	$469,147
	Per capita	$0	$1,288	$0	$1,642	$0	$1,495
Intergovernmental from Local	($M)	$335	$0	$9,810	$0	$19,518	$0
	Per capita	$50	$0	$134	$0	$62	$0
Property Taxes	($M)	$4	$13,653	$2,215	$144,319	$13,111	$432,989
	Per capita	$1	$2,054	$30	$1,971	$42	$1,379
General Sales Taxes	($M)	$5,079	$0	$49,123	$15,874	$245,446	$69,350
	Per capita	$764	$0	$671	$217	$782	$221
Selective Sales Taxes	($M)	$2,234	$306	$38,070	$5,996	$133,098	$28,553
	Per capita	$336	$46	$520	$82	$424	$91
Public Utilities Taxes	($M)	$24	$0	$4,314	$2,261	$14,564	$14,105
	Per capita	$4	$0	$59	$31	$46	$45
Individual Income Taxes	($M)	$11,955	$0	$102,813	$18,838	$280,693	$26,642
	Per capita	$1,799	$0	$1,404	$257	$894	$85
Corporate Income Taxes	($M)	$2,002	$0	$14,112	$6,733	$41,821	$7,210
	Per capita	$301	$0	$193	$92	$133	$23

Sources: (U.S. Census Bureau, 2015t) (U.S. Census Bureau, 2015u)

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)

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

8.1.10. Environmental Justice

8.1.10.1. Definition of the Resource

EO 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 EO. The fundamental principle of environmental justice as stated in the EO is, "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (Executive Office of the President, 1994). Under the EO, each federal agency must "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its

programs, policies, and activities on minority populations and low-income populations" (Executive Office of the President, 1994). In response to the EO, the DOC developed an Environmental Justice Strategy in 1995, and published an updated strategy in 2013 (DOC, 2013).

In 1997, the Council on Environmental Quality (CEQ) issued *Environmental Justice: Guidance under the National Environmental Policy Act (NEPA)* to assist federal agencies in meeting the requirements of the EO (CEQ, 1997). Additionally, the USEPA Office of Environmental Justice (USEPA, 2015g) offers guidance on Environmental Justice issues and provides an "environmental justice screening and mapping tool," EJSCREEN (USEPA, 2015h).

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)

8.1.10.2. Specific Regulatory Considerations

The Massachusetts Executive Office of Energy and Environmental Affairs first adopted an Environmental Justice Policy in 2002. The policy emphasizes equal protection from environmental pollution and equal distribution of environmental benefits, as well as meaningful involvement in environmental decision-making, for all people. The policy stipulates that, for projects undergoing review in accordance with the Massachusetts Environmental Policy Act (MEPA), enhanced public participation and enhanced analysis of impacts and mitigation will be required if certain criteria are met (e.g., if the project is located within one mile, or in some cases five miles, of an environmental justice population)[125]. (EEA, 2002)

The 2002 Environmental Justice Policy specifically defines an "Environmental Justice Population" as a "neighborhood whose annual median household income is equal to or less than 65 percent of the statewide median or whose population is made up 25 percent Minority, Foreign Born, or Lacking English Language Proficiency" (EEA, 2002). Massachusetts has applied this definition to 2010 Census Bureau block groups (where a "neighborhood" is defined as a Census block group) in order to map environmental justice populations throughout the state.[126]

In November 2014, Massachusetts Governor Deval Patrick signed an Environmental Justice Executive Order (Executive Order No. 552). This order required the development of an updated

[125] For detailed criteria, refer to page 8 of the Environmental Justice Policy. (EEA, 2002)

[126] Maps of Massachusetts' "Environmental Justice Populations" are available at http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/cen2010ej.html.

Environmental Justice Policy, and it required the state Secretariats to take a number of actions, including developing new environmental justice strategies. In accordance with Executive Order No. 552, in August 2015 Massachusetts released an updated draft Environmental Justice Policy for public comment. This revised policy will supersede the 2002 policy when Massachusetts finalizes and executes it (EEA, 2015d).

8.1.10.3. Environmental Setting: Minority and Low-Income Populations

Table 8.1.10-1 presents 2013 data on the composition of Massachusetts' population by race and by Hispanic origin. The state's population has substantially lower percentages of individuals who identify as Black/African American (7.1 percent) in comparison to the East region (14.4 percent) and the nation (12.6 percent). The state's population of persons identifying as White (79.6 percent) is considerably larger than that of the East region (72.1 percent) or the nation (73.7 percent). For all other race categories presented in Table 8.1.10-1 (i.e., Asian, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, Some Other Race, and Two or More Races), Massachusetts' percentages are similar to those for the East region and/or the nation.

The percentage of the population in Massachusetts that identifies as Hispanic (10.5 percent) is somewhat lower than in the East region (12.2 percent), and considerably lower than in 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. Massachusetts' All Minorities population percentage (25.4 percent) is substantially lower than that of the East region (34.0 percent) and the nation (37.6 percent).

Table 8.1.10-2 presents the percentage of the population living in poverty in 2013, for the state, region, and nation. The figure for Massachusetts (11.9 percent) is lower than that for the East region (13.3 percent) and considerably lower than the figure for the nation (15.8 percent).

Table 8.1.10-1: Population by Race and Hispanic Status, 2013

Geography	Total Population (estimated)	Race							Hispanic	All Minorities
		White	Black/ African Am	Am. Indian/ Alaska Native	Asian	Native Hawaiian /Pacific Islander	Some Other Race	Two or More Races		
Massachusetts	6,692,824	79.6%	7.1%	0.2%	5.8%	0.0%	4.3%	3.0%	10.5%	25.4%
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, 2015k)

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

Table 8.1.10-2: Percentage of Population (Individuals) in Poverty, 2013

Geography	Percent Below Poverty Level
Massachusetts	11.9%
East Region	13.3%
United States	15.8%

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

8.1.10.4. Environmental Justice Screening Results

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

Figure 8.1.10-1 visually portrays the results of the environmental justice population screening analysis for Massachusetts. The analysis used block group data from the Census Bureau's American Community Survey 2009-2013 5-Year Estimates and Census Bureau urban classification data (U.S. Census Bureau, 2015e) shows that Massachusetts has many areas with high potential for environmental justice populations. These areas disproportionately occur in the more densely populated parts of the state, including the 10 largest population concentrations. The distribution of areas with moderate potential for environmental justice populations is more even across the state.

It is important to understand how the data behind Figure 8.1.10-1 affect the visual impact of this map. Block groups have similar populations (hundreds to a few thousand individuals) regardless of population density. In sparsely populated areas, a single block group may cover tens or even hundreds of square miles, while in densely populated areas, block groups each cover much less than a single square mile. Thus, while large portions of the state outside the areas defined as large population concentrations show Moderate or high potential for environmental justice populations, these low density areas reflect modest numbers of minority or low-income individuals compared to the potential environmental justice populations within densely populated areas. The overall effect of this relative density phenomenon is that the map visually shows large areas of the state having environmental justice potential, but this over-represents the presence of environmental justice populations.

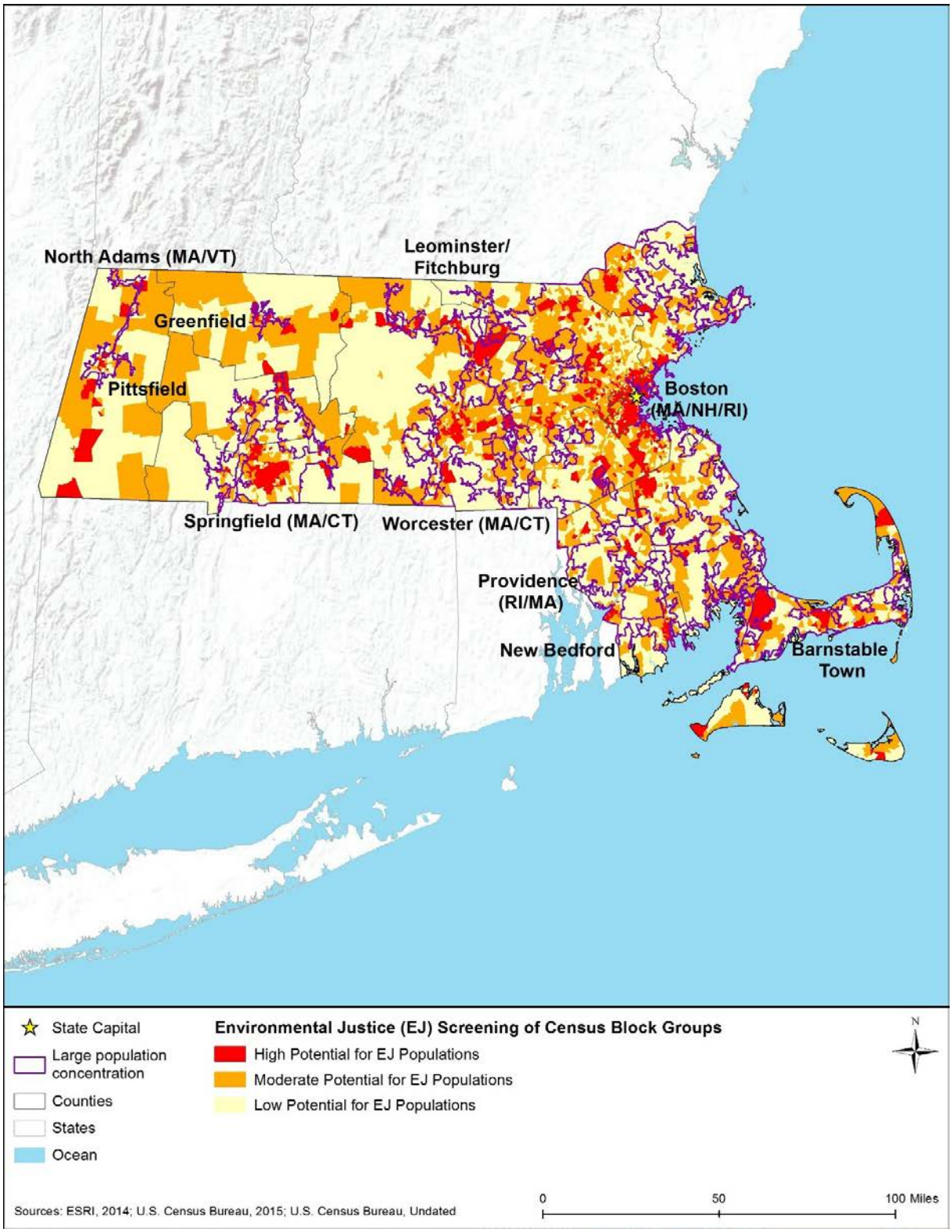


Figure 8.1.10-1: Potential for Environmental Justice Populations in Massachusetts, 2009-2013

It is also very important to note that Figure 8.1.10-1 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 NEPA 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 8.2.10) addresses the potential for disproportionately high and adverse environmental or human health impacts on environmental justice populations.

8.1.11. Cultural Resources

8.1.11.1. Definition of Resource

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

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

This definition is consistent with the how cultural resources are defined in 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);
- 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);
- 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's program support of public and private efforts to identify, evaluate, and protect America's historic and archeological resources (NPS, 2015k); and
- Advisory Council on Historic Preservation's (ACHP) guidance for protection and preservation of sites and artifacts with traditional religious and cultural importance to

American Indian tribes or Native Hawaiian organizations (Advisory Council on Historic Preservation, 2004).

8.1.11.2. Specific Regulatory Considerations

Applicable federal laws and regulations that apply to Cultural Resources, such as the NHPA (detailed in Section 1.8), the American Indian Religious Freedom Act, ARPA, and NAGPRA. Appendix C summarizes these pertinent federal laws.

Massachusetts has state laws and regulations that parallel NEPA and the NHPA (refer to Table 8.1.11-1). However, federal regulations supersede these regulations. While federal agencies may take into account compatible state laws and regulations, their actions that are subject to federal environmental review under NEPA and NHPA are not subject to compliance with such state laws and regulations.

Table 8.1.11-1: Relevant Massachusetts Cultural Resources Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Massachusetts General Laws Chapter 9, Sections 26-27C	SHPO; Office of the State Archaeologist	This Act provides for reviews of state funded or licensed projects by the SHPO. (MHC, 2015)
MEPA	Executive Office of Energy and Environmental Affairs	This state Act parallels NEPA and provides "meaningful opportunities for public review of the potential environmental impacts of projects" involving state agencies. (EEA, 2016d)

8.1.11.3. Cultural Setting

People have been living in the Massachusetts for millennia. Based on geological and archaeological evidence, the geographic area that encompasses the state has been inhabited by humans for at least twelve thousand years (Custer, 1984; Anderson, 2001). The majority of the evidence comes from the study of archeological sites that provide important information about the state's pre-European contact and historic populations, and document various cultures, traditions, and human interactions with the environment. In many cases, archeological data are the only information available about the state's early peoples and places.

Archeological sites within the state are found in a wide variety of settings, from forests and flood plains to waterways and mountaintops. Pre-European contact archeological sites range from temporary fishing encampments to large permanent villages (Moeller, 1980). There are also many "resource procurement sites" or areas where the activity appears to have consisted of a single action lasting for perhaps just a few hours, such as hunting sites that typically identify where animals were killed and butchered or well-established waterfront locations where groups of people gathered for a limited time on a regular basis to catch and prepare fish. Most archeological sites are found in relatively shallow deposits, within one to two feet of the surface. However, in some cases, natural factors have caused sites to be buried beneath multiple layers of sediment, such as the deeply stratified floodplain deposits often found along streams and rivers.

These deposits can be anywhere from one foot to more than ten feet below the current surface. These sites are typically stratified in layers, with older sites lying in the deepest sediments and more recent deposits being closer to the surface. Areas where there have been substantial changes to the ground, such as in densely populated urban settings (like Boston), may contain archaeological resources within the deeper soils (Wissler, 1947).

Archaeologists typically divide large study areas into regions as shown in Figure 8.1.11-2. Massachusetts contains two Regions: the Appalachian Highlands and Atlantic Plain, with one physiographic province in each. The New England province is further broken down into four sections. Green Mountain and Taconic sections are located in the western portion of the state. The New England Upland encompasses the central area spanning to the northern and southern borders of the state. The Seaboard Lowland is the eastern most section and extends to the Atlantic shore and border of the Atlantic Plain region.

There are three distinct periods associated with the prehistoric human populations that inhabited Massachusetts 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). Figure 8.1.11-1 shows a timeline representing the periods of the evolving culture in this region. 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, The Archaeology of New York State, 1969). Due to advancements in radiocarbon dating techniques, dates of each period in the archaeological record have been increasingly more accurate, and there is no longer much 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).

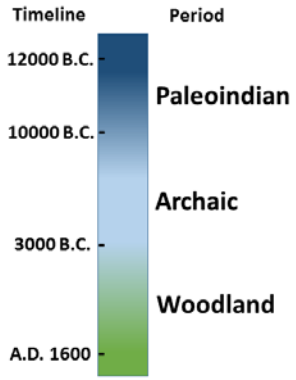


Figure 8.1.11-1: Timeline of Prehistoric Human Occupation

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

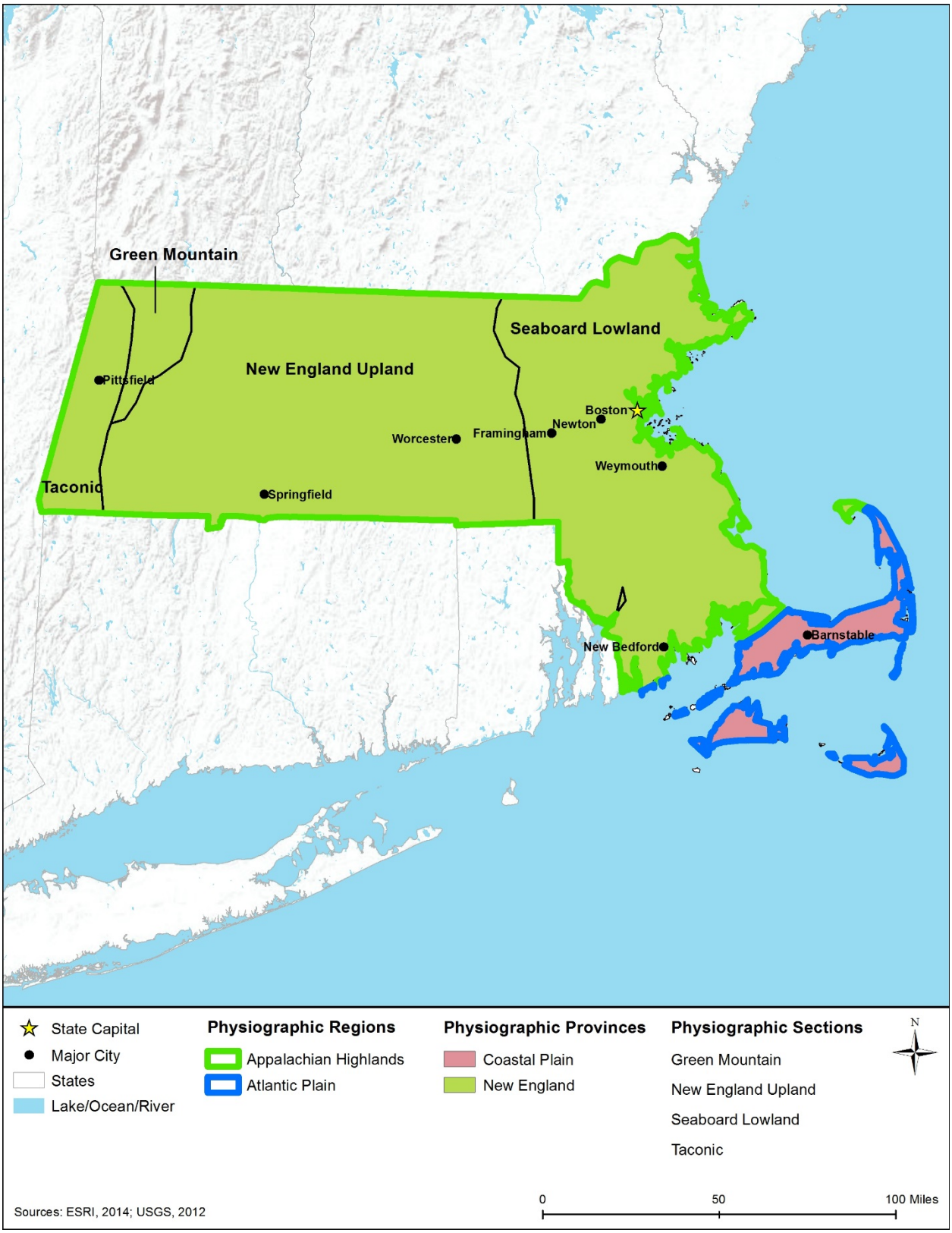


Figure 8.1.11-2: Massachusetts Physiographic Regions

Paleoindian Period (12,000 - 10,000 B.C.)

The Paleoindian Period represents the earliest known human inhabitants of Massachusetts and the Northeast region of the United States. Much research was conducted throughout the 1980s concentrating on Paleoindian occupation within this region of North America (Rainey, 2005). Evidence of early human occupation in Massachusetts is based on a variety of sources such as published site reports, and technical reports that have been prepared for various state agencies. There are also a great number of unpublished reports that archaeologists can use to help better understand the people who lived during this time. The discovery of scatters of fluted points, prehistoric campsites, and other types of sites throughout the state allow archaeologists to better understand and protect important sites. Published literature representing the early stages of the Paleoindian Period suggest that the inhabitants were few in numbers and their way of life is difficult to interpret and understand because of the scarcity of archaeological evidence (Anderson, 2001).

It is still unclear as to when precisely these people began to inhabit the region, but there have been several sites identified that have been radiocarbon dated to approximately 13,000 years ago (Anderson, 2001). Based on the evidence, it is likely that they were a highly nomadic and sparsely populated group of people. These nomadic hunters and gatherers used a small inventory of chipped-stone tools known as “fluted javelin head” spear points or Clovis-form spear points (fluted points). They probably formed small bands, which ranged freely and far, following migratory game throughout the region. The archaeological record indicates that there were seasonal camps that they returned to, which may have formed the basis for more permanent settlements within the region. No skeletal remains of these people have been identified to date within the state. Paleoindian skeletal remains have been found elsewhere in North America, however. 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 Wisconsin glacial age of the Late Pleistocene epoch (USGS, 2012e).

Archaic Period (10,000 B.C. to 3,000 B.C.)

During the Archaic period in Massachusetts and the greater northeastern portion of North America, people lived in small family based units, commonly referred to as bands. Temperatures were becoming warmer during this period because of the retreating glacial ice sheets, allowing for the plants and animals that inhabit this region today to begin to establish themselves. Much like the Paleoindian peoples that preceded them, Archaic Period people were hunter-gathers whose diet consisted of wild plants and animals. They gathered wild vegetable foods, hunted for game, and became very adept in fishing practices. Archaic Period peoples began building basic shelters and expanded on their ability to make stone weapons and stone tools. However, the culture lacked pottery, the smoking pipe, and technology associated with agriculture (Bolton, 1971) (Ritchie, W., 1980) (Wissler, 1947).

The Archaic period has been subdivided into three stages for reasons of environmental changes, expanding food resources resulting in increasing populations, and the continuing development of

different sociocultural traditions resulting from contact with other groups through travel or trade (Bolton, 1971) (Ritchie, W., 1980) (Wissler, 1947).

Relatively large populations of people inhabited the region of Massachusetts at the beginning of the Archaic Period. The forests that thrived in cold climates, such as spruce, pine, and hemlock, had been largely replaced by deciduous forests, comprised of oak, chestnut, and maple, which had gradually migrated northward as the climate gradually warmed.

The people were beginning to form small bands (groups of approximately 25-50 people related by kinship and family ties), which were able to exploit the resources that were becoming increasingly abundant as the climate continued to warm. Early Archaic people made elaborate tools, such as scrapers, cutting instruments, and piercing tools, which allowed them to process animal and plant resources for consumption and use. Wild plants and animals composed the primary diet, however, people were becoming familiar with their environment, and some plants were domesticated and harvested in abundance. As food became more abundant and populations continued to grow, the range in which the people roamed began to decrease. First settlements were along rivers and tributaries. During fall months, multiple bands of people would congregate for the purpose of trading and marriage (Anderson, 2001).

Archaeological evidence suggest that by the Middle Archaic Period, the climate of Massachusetts had changed significantly to support larger expanses of mixed deciduous forests, rich in oak and other plant communities. Ecological conditions were much like those that exist today, with minor floral and faunal variations. The region was teaming with wild game, fowl, edible nuts, berries, tubers, roots, and various herbs, all of which would have supported larger populations of semi-nomadic peoples. According to archaeologists, the Middle Archaic Period was a time of dramatic change in the region. The freshwater systems throughout the region supported settlement, rudimentary agriculture, and travel and trade among family bands. The culture began developing instruments such as choppers, narrow-bladed projectile points, beveled adzes, cobbled hammerstones, and other small tools. The inhabitants had not developed very sophisticated food storage techniques during this period, so this may have resulted in an abundance of food during the warmer months and shortages of food during the colder months. This may have allowed for a cultural shift to a more sedentary lifestyle during times of abundance and required more nomadic lifestyle during the leaner winter months. Based on the tool assemblages found, it can be inferred that the people of this period were conducting a number of different daily activities, such as the processing of game, plants, and fish.

Much like most of the northeast during this time, seasonal exploitation of the flora (plant) and fauna (animal) for food and materials was becoming the predominant way of life. The forests of oak, alder, birch, pine, hemlock, beech, hickory, and chestnut provided edible nuts, wild vegetables, and habitat for game. Adjacent waterways provided fish and shellfish. The warmer climate, and increasing abundance and variety of food sources gave rise to population increases, through new migration of extant groups within the region, an increase of indigenous populations, or both. Large Late Archaic period base camps and settlements have been discovered along major Massachusetts rivers. These camps and settlements likely facilitated exchange of ideas

and information, and allowed for the development of a more sophisticated social life, including the marrying of partners (Kerber, Jordan E., 1997).

The cultural activities associated with these sites included the use of a more advanced tool assemblage. Projectile points, scrapers, adzes, gouges, axes, drills, blades, weights, pendants, pestles, and atlatl weights for spear throwing are well documented at these sites. Flint artifacts in the archaeological record indicate trading with people from distant locations as these stone types are not found in Massachusetts. As food became seasonally scarce at these sites, people began to disperse into smaller groups of extended families. The resources for exploitation were more scattered and far less abundant, and this situation favored smaller groups that are more mobile. Smaller archaeological sites associated with these smaller bands of people are scattered throughout the state. As populations continued to expand, natural boundaries such as rivers and stream valleys shaped the variations on cultural traditions among the people of this time (Kerber J. , 2012).

Woodland Period (3,000 B.C. – A.D. 1600)

Similar to the Archaic Period, the Woodland Period is divided into three sequential sub-periods: Early, Middle, and Late. The three sub-periods are defined based on various cultural differences that can be distinguished by their temporal (place in time) location and adaptive details that come from close scientific examination. For a long time, archaeologists had a recognized difficulty with understanding this period of human development for the region around Massachusetts. By 2006, there was sufficient data to characterize how Woodland Periods American Indians lived and their social structure. The period is generally identified by home-building in geographically dispersed villages (Narragansett/Niantic semi-permanent settlement types). In the Early Woodland Period, people continued to develop means to exploit the abundant flora and fauna of the region. By the late Woodland period, they were cultivating plants such as maize and beans. The main technology that differentiates the Woodland Period from previous periods is the development of the first significant use of pottery (Leveillee, 2006).

During the Early Woodland Period, the interior lakes and streams of modern day Massachusetts drained through the salt-water marshes and lagoons along the coast of the state. The region was teaming with wildlife during this time. The glacial ice sheets had melted enough to leave the area with climate that could support an enormous amount of different food sources and other natural resources. Tool technology continued to advance. The development of such technologies as ceramics is a good indicator that the people were developing a semi-sedentary lifestyle, and living in small villages or hamlets (Leveillee, 2006).

The Middle Woodland Period is distinguished from the Early Woodland Period by the development of pottery. The pottery artifacts are attributable to an apparent center in the Upper Great Lakes region. The influence of migrations from the southern regions of North America are also prevalent in the archaeological record. Artifacts such as the elbow pipe, and the platform pipe, which are part of the Hopewellian mound-building complex (and are associated with the practice of mortuary ceremonialism), begin to appear in the archaeological record (Ritchie, W., 1980).

The Middle Woodland Phase is generally associated with a variety of plain and decorated ceramic types as well as numerous lithic and bone tool types. Shellfishing became more important economic pursuit along Massachusetts coast, while rudimentary horticulture began to make a significant contribution to the diet of the local populations. The wide range of burial practices, the use of exotic materials as grave goods, and the presence of artifact types, which are typically associated with sedentary patterns of existence, represent a transition to a drastically different form of livelihood for the peoples of this region (Anderson, 2001) (The Narragansett Society, 2015).

The archaeological record reveals a continuing change of lifestyle for the people in Massachusetts during the Late Woodland Period. The inhabitants of this time were able to exploit a variety of resources due to their ability to establish organized seasonal settlements. Wild and domesticated plants and animals provided the subsistence they needed for survival. Pottery of traditional classic Woodland lineage continued to undergo progressive modifications. This period is denoted distinctively by an increased dependence on horticulture, especially as it relates to the introduction of corn, maize, and beans. The people of this time lived in large semi-permanent, dispersed central villages, and used seasonal hunting and gathering camps on a temporary basis (Leveillee, 2006).

8.1.11.4. Federally Recognized Tribes of Massachusetts

According to the Bureau of Indian Affairs and the National Conference of State Legislators, there are two federally recognized tribes in Massachusetts: the Mashpee Wampanoag Indian Tribal Council and the Wampanoag Tribe of Gay Head (Aquinnah) of Massachusetts (NCSL, 2015) (GPO, 2015b). The location of federally recognized tribes are highlighted in bold in Figure 8.1.11-3. The other tribes depicted on the figure are general locations of tribes that were known to exist in this region of the United States, but which are federally recognized tribes and whose communities are outside the state or are not federally recognized.

Figure 8.1.11-3: Federally Recognized Tribes in Massachusetts & Historic Boundaries

8.1.11.5. Significant Archaeological Sites of Massachusetts

There are 51 archaeological sites listed on the NRHP for Massachusetts. Table 8.1.11-2 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, 2014c).

Massachusetts State Cultural Resources Database and Tools

Massachusetts Cultural Resource Information System (MACRIS)

The Massachusetts Cultural Resource Information System (MACRIS) allows searches of the Massachusetts Historical Commission (MHC) database for information on historic properties and areas in the Commonwealth. The system is maintained by the MHC, which serves as the SHPO. MACRIS and additional cultural resource links can be found on the MHC's website (http://www.sec.state.ma.us/mhc/mhcidx.htm).

Preservation Massachusetts (PM)

Preservation Massachusetts (PM) is the statewide non-profit historic preservation organization dedicated to preserving the Commonwealth's historic and cultural heritage. Their website provides information on historic resources, legislative initiatives, as well as a directory of individual consultants and firms that specialize in preservation. Users can download the registry for free: http://preservationmass.org/resources/consultant-directory/ (Preservation Massachusetts, 2016).

Table 8.1.11-2: Archaeological Sites on the National Register of Historic Places in Massachusetts

Closest City	Site Name	Type of Site
Arlington	Prince Hall Mystic Cemetery	Historic - Aboriginal
Barnstable	Sandy Neck Cultural Resources District	Historic, Prehistoric
Blackstone	Blackstone Canal Historic District	Historic - Aboriginal
Boston	Middlesex Canal Historic and Archeological District	Historic
Boston	Boston Harbor Islands Archeological District	Prehistoric
Boston	EDNA G. shipwreck (Eastern Rig dragger)	Shipwreck
Boston	Fort Independence	Historic - Military
Boxford	Rowley Village Forge Site	Historic - Aboriginal
Bridgewater	Bridgewater Iron Works	Historic
Canton	Green Hill Site	Prehistoric

Closest City	Site Name	Type of Site
Duxbury	Alden, John and Priscilla, Family sites	Historic
Eastham	Nauset Archeological District	Historic - Aboriginal
Gloucester	FRANK A. PALMER AND LOUIS B. CRARY (Shipwreck)	Shipwreck
Gloucester	LAMARTINE (shipwreck)	Shipwreck
Gloucester	PORTLAND (Shipwreck and Remains)	Shipwreck
Greenfield	Riverside Archeological District	Historic, Prehistoric, Historic - Aboriginal
Hopkinton	Cedar Swamp Archeological District	Prehistoric
Hull	Telegraph Hill	Historic - Military
Lincoln	McCune Site	Prehistoric
Massachusetts	JOFFRE, (shipwreck)	Shipwreck
Middleboro	Wampanoag Royal Cemetery	Historic - Aboriginal
Middleboro	Wampanucket Site	Prehistoric
Middleborough	Muttock Historic and Archeological District	Historic, Prehistoric
Milton	Massachusetts Hornfels-Braintree Slate Quarry	Prehistoric
North Brookfield	Matthews Fulling Mill Site	Historic
North Easton	Borderland Historic District	Historic - Aboriginal
Northfield	King Philip's Hill	Historic
Paxton	Moore State Park Historic District	Historic, Prehistoric
Petersham	Dana Common Historic and Archaeological District	Historic
Plymouth	Parting Ways Archeological District	Historic
Plymouth	Town Brook Historic and Archeological District	Historic
Provincetown	PAUL PALMER (Shipwreck and Remains)	Shipwreck
Quincy	Adams National Historic site	Historic
Quincy	Lyon's Turning Mill	Historic
Quincy	Winthrop, John, Jr., Iron Furnace Site	Historic
Randolph	Gills Farm Archeological District	Prehistoric
Richmond	Richmond Furnace Historical and Archeological District	Historic
Salem	Fort Lee	Historic - Military
Salem	Fort Pickering	Historic - Military
Salem	Winter Island Historic District and Archeological District	Historic - Aboriginal, Prehistoric
Saugus	Saugus Iron Works National Historic site	Historic
Sharon	Stoughtonham Furnace Site	Historic, Military
South Deerfield	Deerfield Economic Development & Industrial Corporation (DEDIC) Site	Prehistoric
South Hadley	South Hadley Canal Historic District	Historic
Springfield	Springfield Armory National Historic site	Historic
Stoneham	Spot Pond Archeological District	Historic
Tyringham	Tyringham Shaker Settlement Historic District	Historic
Wareham	Conant's Hill Site	Historic - Aboriginal, Prehistoric

Closest City	Site Name	Type of Site
Wellfleet	Smith, Samuel, Tavern Site	Historic
West Brookfield	Foster, Jedediah, Homesite	Historic
Whately	West Whately Historic District	Historic

Source: (NPS, 2014c)

8.1.11.6. Historic Context

European sailors likely fished in the waters near Massachusetts during the 16th Century; however, the first European known to have made landfall was Bartholomew Gosnold in 1602. While additional exploration ensued during the early 17th Century, initial European settlement occurred in 1620 with the arrival of the Pilgrims on the Mayflower, marking the first permanent English settlement in Massachusetts (MHC, 1986). The Pilgrims first landed on Cape Cod, near present day Provincetown, but continued inland and settled in Plymouth. In 1629, the Massachusetts Bay Colony was formally established. Although historically significant, Plymouth was quickly surpassed by Boston, in Massachusetts Bay, following its establishment by the Puritan John Winthrop in 1630 (MHC, 1982b).

The area that is now comprised of Boston was established as several separate small towns, including "Charlestown (1629); Boston, Roxbury, and Watertown (all 1630); and Newtown (now Cambridge, 1631)" (MHC, 1982b). The convergence of the Chelsea, Mystic, Charles, and Neponset Rivers, as well as the presence of one of the Atlantic seaboard's greatest, protected natural harbors, made the area attractive for settlement, with the city of Boston being sited on the Shawmut Peninsula on the Charles River. Relations with the native population varied during the early colonial period, being more cooperative initially, but ultimately failing and leading to the outbreak of King Phillip's War (1675 to 1676). In the late 17th Century, the Plymouth Colony and the Massachusetts Bay Colony were combined into the Provence of Massachusetts Bay, which also included present day Maine, Nova Scotia, and the islands near Cape Cod (MHC, 1982b). While the settlement activity of interior Massachusetts had increased following King Phillips War, sporadic conflicts with remaining Indian populations hampered European settlement until the mid-18th Century (MHC, 1984).

In 1646, the Saugus Iron Works were founded south of Salem, which was the first successful site of iron production in America; the Saugus Iron Works operated until 1670 (NPS, 2015l). Massachusetts' industrial production increased beginning in the early 18th Century, particularly with respect to the iron and textile industries. Periodic fighting continued between French and English settlers until the conclusion of the French and Indian War (1754 to 1763), and in the 1740s, the "Great Awakening" marked a renewed religious fervor amongst colonists (MHC, 1982a).

Massachusetts was at the center of events leading up to the American Revolution, including the Stamp Act (1765), the Boston Massacre (1770), and the Boston Tea Party (1773), and Lexington and Concord mark the sites of the first shots fired as a part of the conflict. Despite this early involvement and the Battle of Bunker Hill and burning of Charlestown (1775), Massachusetts suffered relatively little damage during the war (MHC, 1982a).

Following the American Revolution, Massachusetts experienced a degree of economic hardship, but ultimately returned to a state of prosperity. Farming practices changed, particularly in the Connecticut River Valley, where cheese, butter, and new crops grew in importance (MHC, 1984). In 1820, Maine broke away from Massachusetts, marking the end of Maine's long struggle for independence (Judd, Churchill, & Eastman, 1995). Construction of modern transportation improvements, such as canals and railroads, began in the second quarter of the 19th Century, facilitating wider settlement and increased economic growth (MHC, 1985).

Massachusetts prospered during the Civil War as a result of the production of wartime goods such as textiles, iron, and arms; however, the need for Union troops took a toll on the population (MHC, 1982a). Starting in the mid-19th Century, as a result of the Irish Famine, Massachusetts (especially the Boston area), experienced a significant influx of European immigrants who came to work in the factories and mills throughout the state (MHC, 1982b). In response to the need for additional space, the landmass of the Shawmut Peninsula was expanded throughout the 19th Century as a result of filling in portions of the surrounding bay. Today the size of the peninsula is approximately four times larger than it was when the area was settled initially (Morgan, Candee, Miller, & Reed, 2009). In the late 19th and early 20th Centuries, certain areas of the state, particularly those around Cape Cod, Martha's Vineyard, and Nantucket, became popular tourist destinations and witnessed the construction of vacation and resort oriented hotels and residences (MHC, 1986).

During World War I (WWI), Massachusetts experienced growth associated with wartime production. Afterwards, the economy began to decline as factories relocated to southern states; the Great Depression exacerbated the situation and the area experienced economic hardship. Many areas began to grow their tourism-related economies, leveraging the state's rich history, as a means of attracting visitors and sparking economic activity. At the same time, the proliferation of the automobile sparked suburban development, which began spreading outwards into the countryside (MHC, 1982a). During World War II (WWII), Massachusetts once again produced goods for the war effort, including arms and ships; however, this only marked a temporary break in the erosion of the state's former industrial base. Residential and commercial suburban development continues today.

Massachusetts has 4,268 NRHP listed sites, as well as 187 NHLs (NPS, 2015g). Massachusetts also contains five NHAs (NPS, 2015m). Massachusetts contains the largest concentration of First Period buildings in the country, particularly Essex County, which draws a tremendous amount of visitors each year as a result of these resources (Lexington Historical Commission, 1990). Figure 8.1.11-4 shows the locations of NHA and NRHP sites within Massachusetts.[127]

[127] See Section 8.1.8, Visual Resources, for a more in-depth discussion of additional historic resources as they relate to recreational resources.

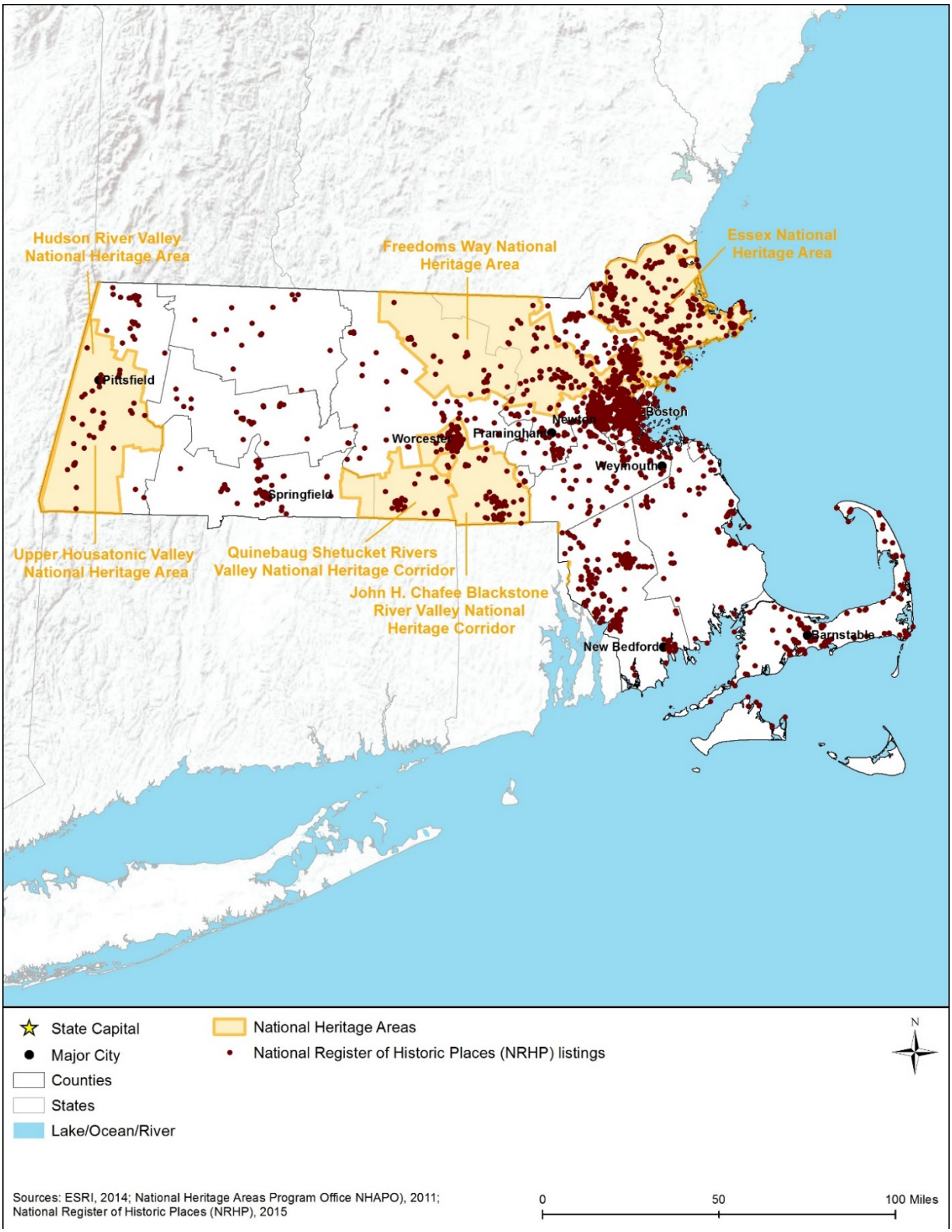


Figure 8.1.11-4: National Heritage Area (NHA) and NHRP Sites in Massachusetts

8.1.11.7. Architectural Context

Early European architecture in Massachusetts varied by region, but was similar to that of neighboring New England states. While Plymouth was settled first, Boston quickly became the colony's leading social, economic, and cultural region, pioneering many architectural trends for Massachusetts, and the country as a whole. Early structures were one and two rooms in size, with either a central chimney or a single end-chimney. These houses were usually enlarged as additional space was needed (particularly the single room varieties); storage cellars were common, as were lean-to additions in the rear (MHC, 1982b). Leaded casement windows, second floor overhangs with decorative pendants, and multiple intersecting cross-gables were common (Morgan, Candee, Miller, & Reed, 2009). The Paul Revere House (ca. 1680), located in Boston, and the House of the Seven Gables (1668), located in Salem, demonstrate these styles (Paul Revere Memorial Association, Undated) (The House of the Seven Gables, Undated). In locations with access to saw mills, such as the Cape Cod region, vertical plank construction was employed (MHC, 1986). Today, Massachusetts contains the largest collection of First Period architecture in the country (Lexington Historical Commission, 1990).

Beginning in the 18th Century, the Georgian styles began to replace Post-Medieval architecture. Symmetry became important and the center hall plan was introduced. These houses have become synonymous with colonial era architecture and featured a central entrance, flanked by one or two bays of sash windows, and matching chimneys on either side of the central hall. Central chimneys remained in use as well, often appearing in more vernacular buildings; matching rear-wall chimneys were also used less commonly (MHC, 1982b). Outside of Boston, more vernacular Georgian structures exhibited less detailing (MHC, 1982a). In western portions of the state, such as Connecticut River Valley, early settlers often lived in utilitarian log structures, or impermanent wigwams that no longer exist today (MHC, 1984).

Following the American Revolution, the Federal style became popular, drawing on classical styles and the work of Scottish architect Robert Adam. Chimney placement shifted to exterior walls, often in the form one of two matching interior end-chimneys. Roofs became shallower as building technology improved, while houses themselves became taller; three story houses were common in urban areas with smaller lot sizes. As with Georgian architecture, the Federal style was common in rural and urban settings (MHC, 1982b). In some areas of the state, such as in the southeast near Plymouth, Federal houses were constructed with steeply pitched roofs, representing a regional divergence from popular Federal trends (MHC, 1982a). Boston native Charles Bulfinch, the first American born/trained architect, built a number of structures during the Federal period. "The Massachusetts Statehouse (1795 to 1797), the original building for the Massachusetts General Hospital (1818 to 1823), and three houses on Beacon Hill for the politician Harrison Gray Otis remain the best known of Bulfinch's legacy" (Morgan, Candee, Miller, & Reed, 2009).

Greek Revival architecture became popular beginning in the second quarter of the 19th Century as architects attempted to replicate the forms of Greek temples. Houses were rotated so that their gabled-ends became the façades, large columns were used, and wide/heavy friezes were popular. Greek Revival was common in residential, industrial, commercial, and institutional architecture,

and can be found throughout the state (MHC, 1982b). In remote areas, the typical Greek Revival side-hall plan was less common than traditional center hall plans (MHC, 1984). Beginning in the 1840s, additional revival styles appeared, such as Gothic Revival, Italianate, and Second Empire. Gothic Revival lent itself to a more natural and picturesque setting and was used in more rural areas, while Italianate and Second Empire became common in cities. Italianate architecture was popular in working class architecture (commercial and residential), while Second Empire was commonly used for high-style homes (MHC, 1982b). Boston innovated several types of multiple family homes; however, the "three-decker" is most famous. Three-deckers consisted of three one story flats stacked vertically, and are commonly recognized by identical stacked rear porches. They were built in a variety of styles, but Italianate was quite common; numerous examples still exist today (MHC, 1982b).

In the late 19th Century, the Queen Anne, Shingle, and Stick styles became popular. Queen Anne was commonly used in both free standing and connected residential structures, while the Stick, and especially the Shingle style, were popular in freestanding structures. Shingle was used often in coastal regions, such as the vacation homes in the Cape Cod region (MHC, 1986). Colonial Revival became popular around the turn of the 20th Century, overlapping with several styles and lasting up through the first half of the 20th Century. Colonial Revival houses of the Cape Cod variety were popular, drawing on the early Cape Cod cottages of the colonial era. These were simple three bay plan houses with center chimneys and clapboard siding. Following WWI, bungalows were built, often in the Craftsman style. Minimal traditional houses were constructed for returning veterans, often taking the form of Cape Cod cottages. Ranch houses were also built beginning in the Mid-20th Century accompanying the growth of suburban development throughout the country (McAlester & McAlester, 2013).

In additional to residential architecture, Massachusetts contains a host of industrial, commercial, and institutional resources. Mills and mill villages were located in areas where water could power mill equipment. Many of these resources still remain today as reminders of the state's early industrial heritage (MHC, 1984). A great example of a non-mill related industrial resource is the historic Springfield Armory building, located in the town of Springfield in the Connecticut River Valley area. In 1777, during the American Revolution, General George Washington chose the site for the armory, and the Springfield Armory remained in operation going forward, producing arms for American troops until its closure in 1968 (NPS, 2015n). The Boston area is home to several historic educational institutions, including Boston Latin School (1635), the oldest public school in the country, and Harvard University (1636), the oldest college or university in the United States. Massachusetts Hall, the oldest building on the Harvard campus, was constructed in 1718 and is still in use today. Historic government buildings are common as well, including the Old State House (1712), located in downtown Boston (MHC, 1982b). Historic "meeting houses," which were structures that were used for religious and/or public functions by early settlers, still exist throughout Massachusetts as well.

Figure 8.1.11-5: Representative Architectural Styles of Massachusetts

- Left Top – Jethro Coffin House (Nantucket, MA) – (Historic American Buildings Survey, 1965)
- Left Bottom– The Arsenal at Springfield (Springfield, MA) – (Detroit Publishing Company, 1920)
- Center Top – Boston Harbor (Boston, MA) – (Detroit Publishing Company, 1906)
- Center Bottom – Paul Revere House (Boston, MA) – (Historic American Buildings Survey, 1933a)
- Right – Triple-decker House (Cambridge, MA) – (Historic American Buildings Survey, 1933b)

8.1.12. Air Quality

8.1.12.1. 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[128] 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)[129] or micrograms per cubic meter ($\mu g/m^3$) determined over various periods of time (averaging time).[130] This section discusses the existing air quality in Massachusetts. The USEPA designates areas within the United States as

[128] Topography: The unique features and shapes of the land (e.g., valleys and mountains).

[129] Equivalent to 1 milligram per liter. (mg/L)

[130] 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, 2015m)

attainment,[131] nonattainment,[132] maintenance,[133] or unclassifiable[134] 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.

8.1.12.2. Specific Regulatory Considerations

National and State Ambient Air Quality Standards

The Clean Air Act (CAA) establishes National Ambient Air Quality Standards (NAAQS) for six criteria pollutants: Carbon monoxide (CO), lead, oxides of nitrogen (NO_X), particulate matter ($PM_{2.5}$ and PM_{10}), ozone (O_3), and oxides of sulfur (SO_X). The NAAQS establish various standards, either primary[135] or secondary,[136] 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, National Ambient Air Quality Standards.

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, 2011). 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. Appendix E presents a list of federally regulated HAPs.

In conjunction with the federal NAAQS, Massachusetts maintains its own air quality standards, the Massachusetts Ambient Air Quality Standards (MassAAQS). Table 8.1.12-1 presents an overview of the MassAAQS as defined by Massachusetts.

[131] Attainment areas: Any area that meets the national primary or secondary ambient air quality standard for the pollutant. (USEPA, 2015n)
[132] 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, 2015n)
[133] 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, 2015n)
[134] 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, 2015n)
[135] 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, 2014a)
[136] 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, 2014a)

Table 8.1.12-1: Massachusetts Ambient Air Quality Standards (MassAAQS)

Pollutant	Averaging Time	Primary Standard		Secondary Standard		Notes
		µg/m³	ppm	µg/m³	ppm	
CO	8-hour	-	9	Same as Primary		Not to be exceeded more than once per year
	1-hour	-	35	Same as Primary		
Lead	3-month	1.5	-	Same as Primary		Calendar quarter
NO_X	Annual	100	0.05	Same as Primary		Annual arithmetic mean
PM_{10}	Annual	50	-	Same as Primary		Attained when the expected annual mean arithmetic concentration, as determined in accordance with Appendix K to 40 CFR Part 50, is less than or equal to 50 micrograms per cubic meter.
	24-hour	150	-	Same as Primary		Attained when the expected number of days per calendar yearwitha24 hour average concentration above 150 micro-grams per cubic meter, as determined in accordance with Appendix K to 40 CFR Part 50, is less than or equal to one.
O_3	8-hour	240	0.12	Same as Primary		Expressed in a statistical form so that determination of attainment will be made when the expected number of days per calendar year with 3 maximum hourly average concentrations above 235 ug/M (0.12 ppm) is equal to less than one.
SO_X	Annual	-	0.03	-	-	Annual arithmetic mean
	24-hour	-	0.14	-	0.5	Not to be exceeded more than once per year. Also the NAAQS maximum 3-hour is not to be exceeded more than once per year

Source: (MassDEP, 1994)

Title V Operating Permits/State Operating Permits

The Massachusetts Department of Environmental Protection (MassDEP) 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, 2015i). The overall goal of the Title V program is to "reduce violations of air pollution laws and improve enforcement of those laws" (USEPA, 2015i). MassDEP 310 CMR 7.00 describes the applicability of Title V operating permits. Massachusetts 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 8.1.12-2). The permit issued to a facility contains both state and federal portions and incorporates a reporting schedule (USEPA, 2014b).

Table 8.1.12-2: Major Air Pollutant Source Thresholds

Any Pollutant	100 Tons per Year
Single HAP	10 Tons per Year
Total/Cumulative HAPs	25 Tons per Year
Volatile Organic Compound (VOC) and NO_x	50 Tons per Year

Source: (USEPA, 2014b) and (MassDEP, 2015x)

Exempt Activities

Massachusetts requires a plan review and approval prior to "any construction, substantial reconstruction, alteration, or subsequent operation of a facility that may emit contaminants to the ambient air. The plan approval requirement of 310 CMR 7.02 are applicable to facilities constructed, reconstructed or altered after July 1, 1970 in the Metropolitan Boston Air Pollution Control District and after September 15, 1970 in all other districts." (MassDEP, 2015x)

Exemptions to the plan review are provided by 310 CMR 7.02(2)(c). "The construction, substantial reconstruction or alteration of a facility or emission unit is exempt from the requirement to obtain a plan approval under 310 CMR 7.02(4) or 310 CMR 7.02(5) if it qualifies as one or more of the following:

- De minimis Increase in Emissions. Construction, substantial reconstruction, or alteration that results in an increase in potential emissions of less than one ton of any air contaminant, calculated over any 12 consecutive month time period. In order to determine eligibility under 310 CMR 7.02(2)(b)7, emissions shall be calculated based on the increase in potential emissions (as defined in 310 CMR 7.00) of the planned action. Reductions in emissions resulting from reduced utilization or elimination of emission units cannot be deducted. Products of combustion from any fuel utilization facility and emissions from an emission unit(s) installed in compliance with 310 CMR 7.03 or 310 CMR 7.26 are not included when calculating an increase in potential emissions for the purpose of determining applicability under 310 CMR 7.02(4)(a)1 or 2, or 310 CMR 7.02(5)(a)1, 2, or 3 (See also 310 CMR 7.02(6)).
- Emergency Engines or Stand-by Engines. An individual emergency or stand-by engine that operates in compliance with 310 CMR 7.03 for units installed on or after June 1, 1990. Emergency or stand-by engines that have received plan approval must comply with the terms and conditions of the plan approval." (MassDEP, 2015x)

Emergency engines, while exempt from obtaining a plan approval (based on the exemptions in 310 CMR 7.02), are subject to additional regulations including but not limited to 310 CMR 26(42):

- Comply with all emission limits set forth in 310 CMR 7.26(42).
- "Engines with a rated power output equal to or greater than 37 kW must comply with the applicable emission limitations set by the USEPA for non-road engines (40 CFR 89 as in effect October 23, 1998) at the time of installation.
- All emergency turbines with a rated power output less than one megawatt (MW) shall comply with the emission limitations of NO_x 0.6 pounds/MW-hr and be equipped with a non-resettable hour meter." (MassDEP, 2015x)
- All fuel used must meet the USEPA sulfur limits for fuel.
- Emergency engines must not be operated more than 300 hours during a 12-month rolling period. The engine operation restrictions include maintenance and testing as recommended by the manufacturer. A non-resettable hour meter must be utilized (in perfect working order) for each unit. (MassDEP, 2015x)

- And comply with all sound, stake height and emission dispersion, and visible emissions stated in 310 CMR 7.10 (noise) and 310 CMR 7.26(42) respectively." (MassDEP, 2015x)

Temporary Emissions Source Permits

Massachusetts does not have regulations for temporary emission source permitting. Any temporary emission sources should review stationary source requirements, or contact the state for additional assistance.

Installation of a new emergency engine or turbine can increase the facility aggregate emissions to exceed thresholds for one or more air pollution control requirements in Table 8.1.12-2. "If the facility is or becomes a major source of air emissions you could be subject to Operating Permit Programs, Emission Offsets and Non-attainment Reviews, and Prevention of Significant Deterioration requirements." (MassDEP, 2015x)

Environmental Results Program

If a facility installs an emergency engine after March 23, 2006, with a power rating output "equal to or greater than 37 kW or an emergency combustion turbine with a rated power output less than one MW, [the facility] is subject to the requirements of the Environmental Results Program (ERP) for emergency engines and emergency turbines" (MassDEP, 2012b). The ERP also includes additional performance standards, including the use of clean fuels, equipment maintenance, and record keeping requirements. ERP also states that emergency engines and turbines must not operate more than 300 hours, per 12-month rolling period, for times of emergency and normal manufacturer maintenance and testing (MassDEP, 2012b).

State Preconstruction Permits

Massachusetts does not have state preconstruction permitting requirements. Installation of a new emergency engine or turbine can increase the facility aggregate emissions to exceed thresholds for one or more air pollution control requirements in Table 8.1.12-2, including New Source Review (NSR), Operating Permits, and Prevention of Significant Deterioration (PSD). (MassDEP, 2015x)

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, 2013b). An action in designated nonattainment and maintenance areas would be evaluated for the emission of those particular pollutants under the General Conformity Rule through an applicability analysis. Pursuant to Title 40 CFR 93.153(d)(2) and (e), federal actions "in response to emergencies which are typically commenced on the order of hours or days after the emergency" and actions "which are part of part of a continuing response to emergency or disaster" that are taken up to six months after beginning response activities, will be exempt from any conformity determinations (GPO, 2010).

The estimated pollutant emissions are compared to *de minimis*[137] levels. These values are the minimum thresholds for which a conformity determination must be performed (see Table 8.1.12-3). All Massachusetts counties lie in the Ozone Transport Region (OTR). As a result, lower *de minimis* thresholds for VOCs and NO_X could apply depending on the attainment status of a county.

Table 8.1.12-3: *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, Sulfur Dioxide (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)

If an action does not result in an emissions increase above the *de minimis* levels in Table 8.1.12-3, 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 8.1.12-3, 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[138], 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

[137] Small amount or minimal.
[138] Conformity: Compliance with the State Implementation Plan.

- 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, 2010a).

State Implementation Plan Requirements

The Massachusetts SIP is composed of many related actions to ensure ambient air concentrations of the six criteria pollutants comply with the NAAQS. Massachusetts's SIP is a conglomeration of separate actions taken for each of the pollutants. All of Massachusetts'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 MassDEP's website at http://www.mass.gov/eea/agencies/massdep/air/reports/state-implementation-plans.html.

8.1.12.3. 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 8.1.12-1 and Table 8.1.12-4, below, present the current nonattainment areas in Massachusetts as of January 30, 2015. Table 8.1.12-4 contains a list of the counties and their respective current nonattainment status of each criteria pollutant. The year(s) listed in the table for each pollutant indicate the date(s) when USEPA promulgated an ambient air quality standard for that pollutant. Note certain pollutants have more than one standard in effect (e.g., $PM_{2.5}$, O_3, and SO_x). Unlike Table 8.1.12-4, Figure 8.1.12-1 does not differentiate between standards for the same pollutant. Additionally, given that particulate matter is a criteria pollutant of concern, PM_{10} and $PM_{2.5}$ are merged in the figure and presented as a single pollutant.

Table 8.1.12-4: Massachusetts Nonattainment and Maintenance Areas by Pollutant Standard and County

County	Pollutant and Year USEPA Implemented Standard										
	CO	Lead		NO_X	PM_{10}	$PM_{2.5}$		O_3		SO_X	
	1971	1979	2008	1971	1987	1997	2006	1997	2008	1971	2010
Barnstable								X-4			
Berkshire								X-4			
Bristol								X-4			
Dukes								X-4	X-5		
Essex								X-4			
Franklin								X-4			
Hampden	M							X-4			
Hampshire								X-4			
Middlesex	M							X-4			
Nantucket								X-4			
Norfolk	M							X-4			
Plymouth								X-4			
Suffolk	M							X-4			
Worcester	M							X-4			

Source: (USEPA, 2015i)

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

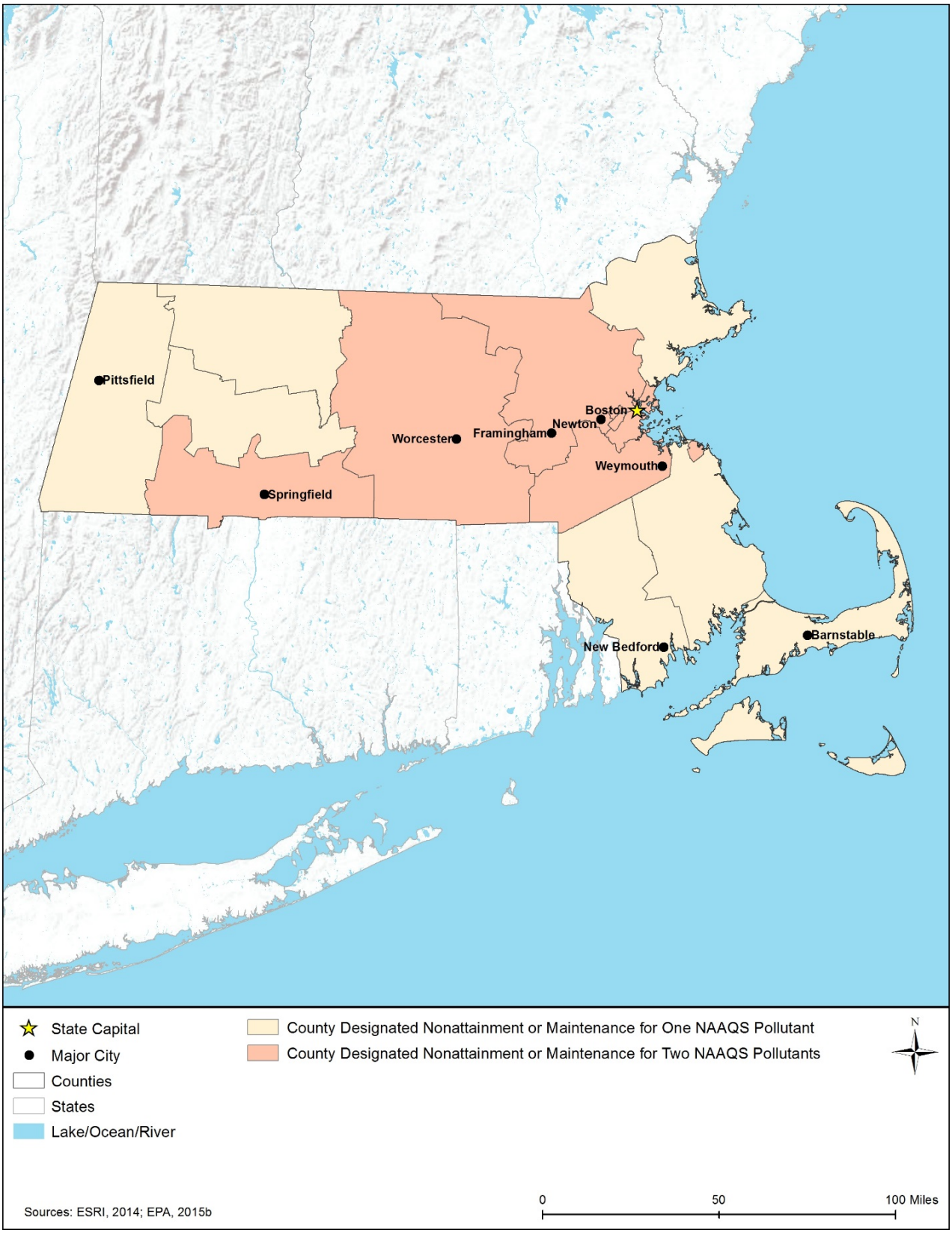


Figure 8.1.12-1: Nonattainment and Maintenance Counties in Massachusetts

Air Quality Monitoring and Reporting

MassDEP measures air pollutants at over 25 sites across the state as part of the National Air Monitoring Stations Network and the State and Local Air Monitoring Stations Network. Annual Massachusetts State Ambient Air Quality Reports are prepared, containing pollutant data summarized by region. MassDEP 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 Massachusetts (MassDEP, 2015y).

Throughout 2014, Ozone measurements in Massachusetts did not exceed the federal standard of 0.075 ppm and there were no violations of the Ozone based on 3-years of data (2012–2014). No other criteria pollutants exceed federal standards.

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 has 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 (USEPA, 2013c).

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 PSD permit requirements and within 100 kilometers[139] of a Class I area. "The USEPA'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 USEPA 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[140] (the normal useful range of USEPA-approved Gaussian plume models" (USEPA, 1992).

Massachusetts does not contain any Federal Class I areas; all 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

[139] The memorandum and associated guidance use kilometers. 100 kilometers is equal to about 62 miles.
[140] The memorandum and associated guidance use kilometers. 50 kilometers is equal to about 31 miles.

within 100 kilometers from the source (USEPA, 1992). Vermont does have a Class I area for which the 100-kilometer buffer intersects a few Massachusetts counties. Any PSD-applicable action within these counties would require FLMs notification from the appropriate Regional Office. Figure 8.1.12-2 provides a map of Massachusetts 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 8.1.12-2 correspond to the numbers and Class I areas listed in Table 8.1.12-5.

Table 8.1.12-5: Relevant Federal Class I Areas

No.	Area	Acreage	State
1	Lye Brook Wilderness	12,430	VT

Source: (USEPA, 2012c)

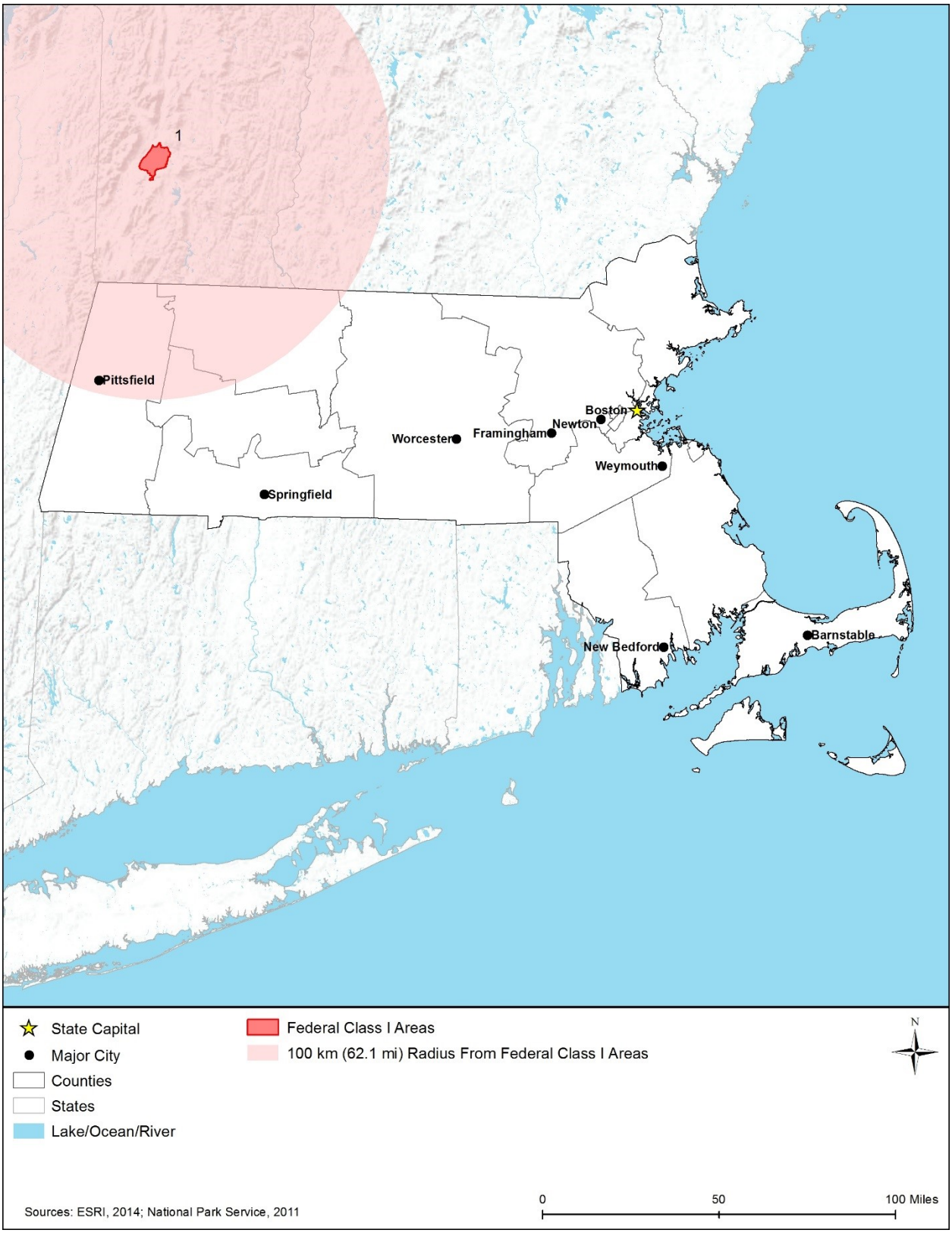


Figure 8.1.12-2: Federal Class I Areas with Implications for Massachusetts

8.1.13. Noise

This section presents a discussion of a basic understanding of environmental noise, background/ambient noise levels, noise standards, and guidelines.

8.1.13.1. Definition of the Resource

Noise is 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.

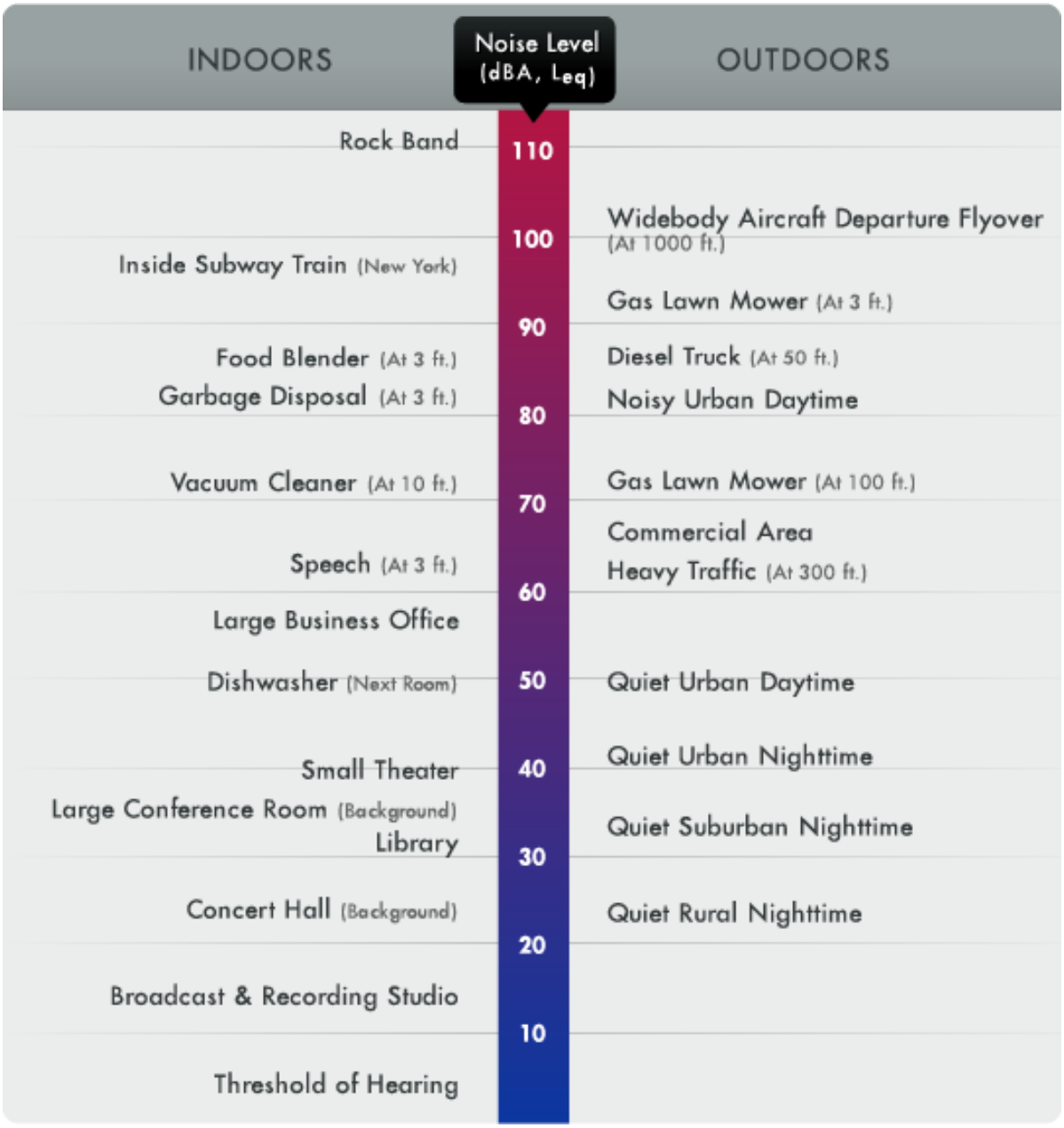
Fundamentals of Noise

For environmental noise analyses, a noise metric refers to the unit that quantitatively measures the effect of noise on the environment. The unit used to describe the intensity of sound is the decibel (dB). Audible sounds range from 0 dB ("threshold of hearing") to about 140 dB ("threshold of pain"). The normal audible frequency range is approximately 20 Hz to 20 kHz (FAA, 2007). 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 8.1.13-1 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

Figure 8.1.13-1: Sound Levels of Typical Sounds

Because of the logarithmic unit of measurement, sound levels cannot be added or subtracted linearly. However, several methods of estimating sound levels can be useful in determining approximate sound levels. First, if two sounds of the same level are added, the sound level increases by approximately three dB (for example: 60 dB + 60 dB = 63 dB). Secondly, the sum of two sounds of a different level is slightly higher than the louder level (for example: 60 dB + 70 dB = 70.4 dB).

The changes in human response to changes in dB levels is categorized as follows (FTA, 2006):

- A 3-dB change in sound level is considered a barely noticeable difference;
- A 5-dB change in sound level will typically result in a noticeable community response; and
- A 10-dB change, which is generally considered a doubling of the sound level, almost certainly causes 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.

8.1.13.2. Specific Regulatory Considerations

As identified in Appendix C, 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.

Massachusetts does not have any statewide noise laws that would apply to actions considered under the Proposed Action. Existing Massachusetts noise laws are restricted to the use of personal vehicles, motorboats, and trains (Commonwealth of Massachusetts, 2015a). However, many cities and towns may have local noise ordinances to manage community noise levels. The noise limits specified in such ordinances are typically applied to define noise sources and specify a maximum permissible noise level. Large cities and towns, such as Boston, 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).

8.1.13.3. Environmental Setting: Ambient Noise

The range and level of ambient noise in Massachusetts varies widely based on the area and environment. The population of Massachusetts can choose to live and interact in areas that are large cities, rural communities, or near national and state parks. Figure 8.1.13-1 illustrates noise values for typical community settings and events that are representative of what the population of Massachusetts may experience on a day-to-day basis. These noise levels represent a wide range and are not specific to Massachusetts. As such, this section describes the areas where the population of Massachusetts can potentially be exposed to higher than average noise levels.

- **Urban Environments:** Urban areas are likely to have higher noise levels on a daily basis due to highway traffic (70 to 90 dBA), construction noise (90 to 120 dBA), and outdoor conversations (e.g., small/large groups of people) (60 to 90 dBA) (DOI, 2008). The areas that are likely to have the highest ambient noise levels in the state are Boston, Worcester, Springfield, and Lowell.

- **Airports:** Areas surrounding airports tend to be more sensitive to noise due to aircraft operations that occur throughout the day. A jet engine aircraft can produce between 130 to

160 dBA in its direct proximity (FAA, 2007). However, commercial aircraft are most likely to emit noise levels between 70 to 100 dBA depending of the type of aircraft and associated engine (FAA, 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 are in the proximity of urban communities; therefore, aircraft operations (arrivals/departures) can result in noise exposure in the surrounding areas to be at higher levels with the potential for increased noise levels during peak operation times (early morning and evenings), when there is an increase in air traffic. The noise levels in areas surrounding commercial airports can have significantly higher ambient noise levels than in other areas. In Massachusetts, the main airports include Boston Logan International (BOS), Nantucket Memorial (ACK), Barnstable Municipal-Boardman/Polando Field (HYA), Worcester Regional (ORH), and Martha's Vineyard (MVY) with more than 660,000 annual operations combined; BOS accounts for approximately 368,000 operations annually (FAA, 2015f). These operations result in increased ambient noise levels in the surrounding communities. See Section 8.1.1, Infrastructure, and Figure 8.1.1-1 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, 2015c). There are a number of major highways within the state that may contribute to higher ambient noise levels for residents living in those areas. The major highways in the state tend to have higher than average ambient noise levels on nearby receptors, ranging from 52 to 75 dBA (FHWA, 2015c). Section 8.1.1, Infrastructure, and Figure 8.1.1-1 for more information about the major highways in the state.

- **Railways:** Like highways, railways tend to have higher than average ambient noise levels for residents living in close proximity (FTA, 2006). Railroad operations can produce noise ranging from 70 dBA for an idling locomotive to 115 dBA when the locomotive engineer rings the horn while approaching a crossing (FRA, 2015). Massachusetts has multiple rail corridors with high levels of commercial and commuter rail traffic. These major rail corridors extend from Boston to Attleboro, Middleborough, Kingston, Greenbush, Forge Park, Newburyport, Gallagher, Fitchburg, and Springfield, as well as Springfield to other major cities in New England. There are also a number of other rail corridors that join these lines and connect with other cities. Additionally, the state has seven major rail yards and terminals in West Springfield, East Deerfield, Ayer, North Station, Beacon Park, South Station, and Worcester (MassDOT, 2010). See Section 8.1.1, Infrastructure, and Figure 8.1.1-1 for more information about rail corridors in the state (MassDOT, 2013b).

- **National and State Parks:** The majority of national and state parks are likely to have lower than average ambient noise levels given their size and location in wilderness areas. National and state parks, historic areas, and monuments are protected areas with one aspect to

"maintain the resilience of the national soundscape" (Freimund, 2009). These areas typically have lower noise levels, as low as 30 to 40 dBA (NPS, 2014d). Massachusetts has 16 National Park units and 11 NHLs (NPS, 2015g). Visitors to these areas expect lower ambient noise conditions than the surrounding urban areas. See Section 8.1.8, Visual Resources for more information about national and state parks for Massachusetts.

8.1.13.4. Sensitive Noise Receptors

Noise-sensitive receptors include residences, schools, medical facilities, places of worship, libraries, churches, nursing homes, concert halls, playgrounds, and parks. Sensitive noise receptors are typically areas where the intrusion of noise can disrupt the use of the environment. A quiet urban area usually has a typical noise level in the daytime of 50 dBA, and 40 dBA during the evening. Noise levels in remote wilderness and rural nighttime areas are usually 30 dBA (BLM, 2014). Most cities, towns, and villages in Massachusetts 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 in the Massachusetts.

8.1.14. Climate Change

8.1.14.1. 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[141]), 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 million metric tons (MMT) CO_2. Where the document references emissions of multiple GHGs, the units are in MMT CO_2e.

The IPCC reports that "global concentrations of these four GHGs have increased significantly since 1750" 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 concentration of CH_4 and N_2O have increased from pre-industrial values of about 715 and 270

[141] 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, 2015o)

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 8.2.14, 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).

8.1.14.2. Specific Regulatory Considerations

The pertinent federal laws relevant to the protection and management of climate change are summarized in Appendix C. Massachusetts has established goals and regulations to reduce GHG emissions to combat climate change. As shown in Table 8.1.14-1, two key state laws/regulations are the primary policy drivers on climate change preparedness and GHG emissions.

Table 8.1.14-1: Relevant Massachusetts Climate Change Laws and Regulations

State Laws/Regulations	Regulatory Agency	Applicability
Global Warming Solutions Act (August 2008)	Massachusetts State: Department of Energy and Environmental Affairs	In August 2008, the Global Warming Solutions Act (GWSA)**,** created a framework for reducing heat-trapping emissions, which requires reductions from all sectors of the economy to reach a target of a 25% reduction of GHG emissions by 2020 and an 80% reduction by 2050. (EEA, 2015e)
Massachusetts Climate Change Adaptation Report (September 2011)	Massachusetts State: Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee	The Climate Change Adaptation Report describes the process, principles, findings, and recommendations of the Advisory Committee, and presents a first step toward the identification, development, and implementation of strategies to advance Massachusetts' ability to better adapt to a changing climate. Using this report, agencies will begin evaluating potential strategies contained in the report and work with stakeholders to prioritize them and assess feasibility of implementation. (EEA, 2011)

In addition, Massachusetts has established other goals that address various aspects of climate change such as several programs designed to reduce emissions from vehicles. For example, the Massachusetts Electric Vehicle Incentive Program (MassEVIP) provides incentives for eligible public and private entities to acquire electric vehicles (EVs) and acquire/install charging stations at reduced cost (EEA, 2015f). The state also has several other similar initiatives such as ridesharing program.

Massachusetts is also one of nine states participating in the Regional Greenhouse Gas Initiative (RGGI). RGGI is a CO_2 emissions trading scheme, launched in 2008, which sets an annual cap on CO_2 emissions from power plants over 25 MW capacity within those nine states. The cap for

2015 was set at 88.7 million short tons of CO_2, with an annual reduction of 2.5 percent per year until 2020 (RGGI, 2015).

8.1.14.3. Massachusetts Greenhouse Gas Emissions

Estimates of Massachusetts's total GHG emissions vary. The Department of Energy's Energy Information Agency (EIA) collects and disseminates national-level data on emission on CO_2 from fossil fuels by state. In addition, EIA maintains data on other GHGs such as CH_4 and nitrous oxide (NO_x), but these are not broken down by state (EIA, 2011). The USEPA also collects and disseminates national-level GHG emissions data, but by economic sector, not by state (USEPA, 2015j). Individual states have developed their own GHG inventories and these are updated with different frequencies and trace GHG in different ways.

For the purposes of this PEIS, EIA data on CO_2 emissions from fossil fuels will be used as the benchmark metric in order to ensure consistency and comparability across the 50 states. However, if additional data sources for GHGs are available for a given state, they will be noted and cited.

CO_2 emissions from fossil fuels in Massachusetts totaled 59.0 MMT in 2012 with the majority of emissions coming from petroleum products in the transportation sector (Table 8.1.14-2). Massachusetts' CO_2 emissions climbed from 1980, reaching a peak of almost 90 MMT in 1990 from which maximum they have been in steady decline, a rate which accelerated after 2005 (Figure 8.1.14-1), led by declines in petroleum use by all sectors, and coal use by the electric power sector (EIA, 2015d). Almost one third of Massachusetts residents heat their homes with fuel oil, accounting for the large proportion of petroleum products used by that sector. Massachusetts is ranked 32nd in the U.S. for CO_2 emissions from fossil fuels in 2013 (EIA, 2015e).

Table 8.1.14-2: Massachusetts CO_2 Emissions from Fossil Fuels by Fuel Type and Source, 2012

Fuel Type (MMT)		Source (MMT)	
Coal	4.0	Residential	13.6
Petroleum Products	37.2	Commercial	6.2
Natural Gas	24.1	Industrial	3.8
		Transportation	29.1
		Electric Power	12.6
TOTAL	**65.3**	**TOTAL**	**65.3**

Source: (EIA, 2015d)

The majority of Massachusetts's GHG emissions is CO_2. These emissions are the result of fossil fuel combustion for production of energy, petroleum products used in the transportation sector and for home heat, and a growing proportion of natural gas for heat and hot water in residential and commercial buildings. Other major GHGs emitted in Massachusetts are methane (CH_4), nitrous oxide (NO_x), hydrofluorocarbons, sulfur hexafluoride (SF_6) and perfluorocarbons.

Massachusetts has lower per-capita energy-related GHG emissions than the U.S. average (EIA, 2014).

According to the EIA, Massachusetts emitted 65.3 MMT of CO_2 in 2013. Transportation was the largest emitter, accounting for almost half of all CO_2 emissions. (Table 8.1.14-1) (EIA, 2015d). Massachusetts' CO_2 emissions climbed from 1980, reaching a peak of almost 90 MMT in 1990 before declining steadily, a rate that accelerated after 2005 (Figure 8.1.14-2). Emissions were at their lowest in 2012 (60.3 MMT) but increased again in 2013. Overall declines have been driven by reductions in petroleum use by all sectors, and coal use by the electric power sector. Almost one-third of Massachusetts residents heat their homes with fuel oil, accounting for the large proportion of petroleum product-derived CO_2 emissions from that sector (EIA, 2015e). Massachusetts in 2013 ranked 32nd among the 50 states and the District of Columbia for total CO_2 emissions, and 45th for per-capita CO_2 emissions (EIA, 2015f).

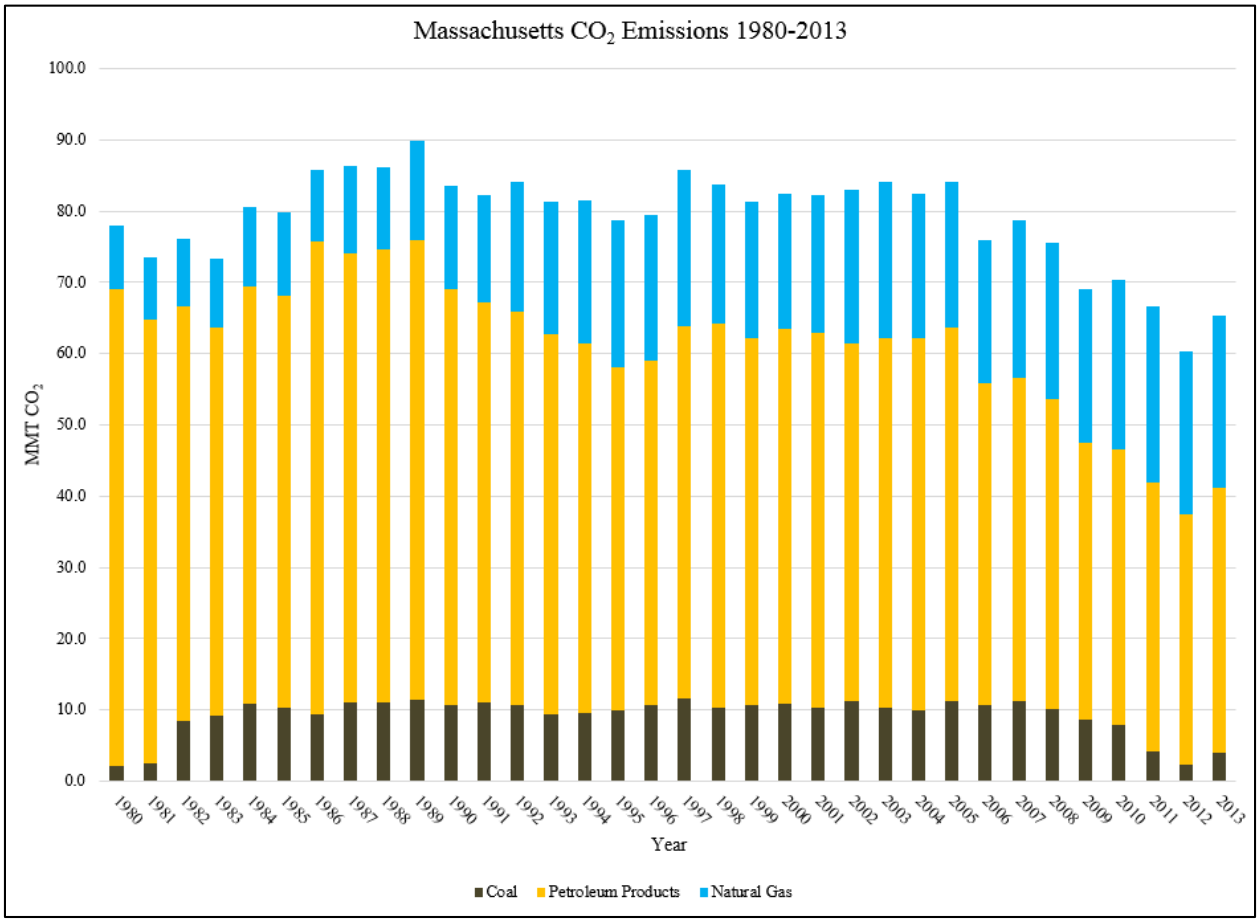


Figure 8.1.14-1: Massachusetts CO_2 Emissions from Fossil Fuels by Fuel Type 1980-2013

Source: (EIA, 2015d)

Overall GHG emissions in Massachusetts declined by 24 percent (22 MMT CO_2e) to their 2012 level or 72 MMT CO_2e. This progress is attributed to number of factors including new

regulations for larger power plants, reduced electricity consumption and fuel use, and new state programs that encourage cleaner energy. There have also been major improvements in energy efficiency in residential and commercial buildings (EEA, 2015e).

Massachusetts's electricity and waste facilities produce the most GHG emissions. Because Massachusetts is one of six states included in the ISO-New England regional power grid, electricity usage and import data is often estimated. Electricity consumption has seen major improvements between 1990 and 2011. Despite electricity consumption increasing by 22 percent, emissions dropped 37 percent as a result of cleaner fuels replacing coal and oil (EEA, 2015e).

Between 1990 and 2008, the transportation sector experienced increasing GHG emissions; however, emissions from this sector have dropped in recent years accounting for 31.6 percent of the state's emissions. These improvements could be a conservation-based response to higher gasoline diesel prices, increased public transit use, and more fuel-efficient vehicles. Massachusetts is also seeking to increase its production of renewable energy to reduce its dependence on fossil fuels and thereby its carbon footprint. The renewable energy industry in the state continues to grow each year (EEA, 2015e).

8.1.14.4. Environmental Setting: Existing Climate

The National Weather Service defines climate as the "reoccurring average weather found in any particular place" (NWS, 2011a). The widely accepted division of the world into major climate categories is referred to as the Köppen-Geiger climate classification system. Climates within this system are classified based "upon general temperature profiles related to latitude" (NWS, 2011a). The first letter in each climate classification details the climate group. The Köppen-Geiger system further divides climates into smaller sub-categories based on precipitation and temperature patterns. The secondary level of classification details the seasonal precipitation, degree of aridity, and presence or absence of ice. The tertiary levels distinguish different monthly temperature characteristics (NWS, 2011b).

Massachusetts "lies in the prevailing westerlies, the belt of generally eastward air movement which encircles the globe in the middle latitudes" (NCDC, 2015). "Embedded in this circulation are extensive masses of air originating in more northerly or southerly latitudes and interacting to produce frequent significant storm systems" (NCDC, 2015). "Relative to most other sections of the country, a large number of such storms pass over or near to Massachusetts" (NCDC, 2015).

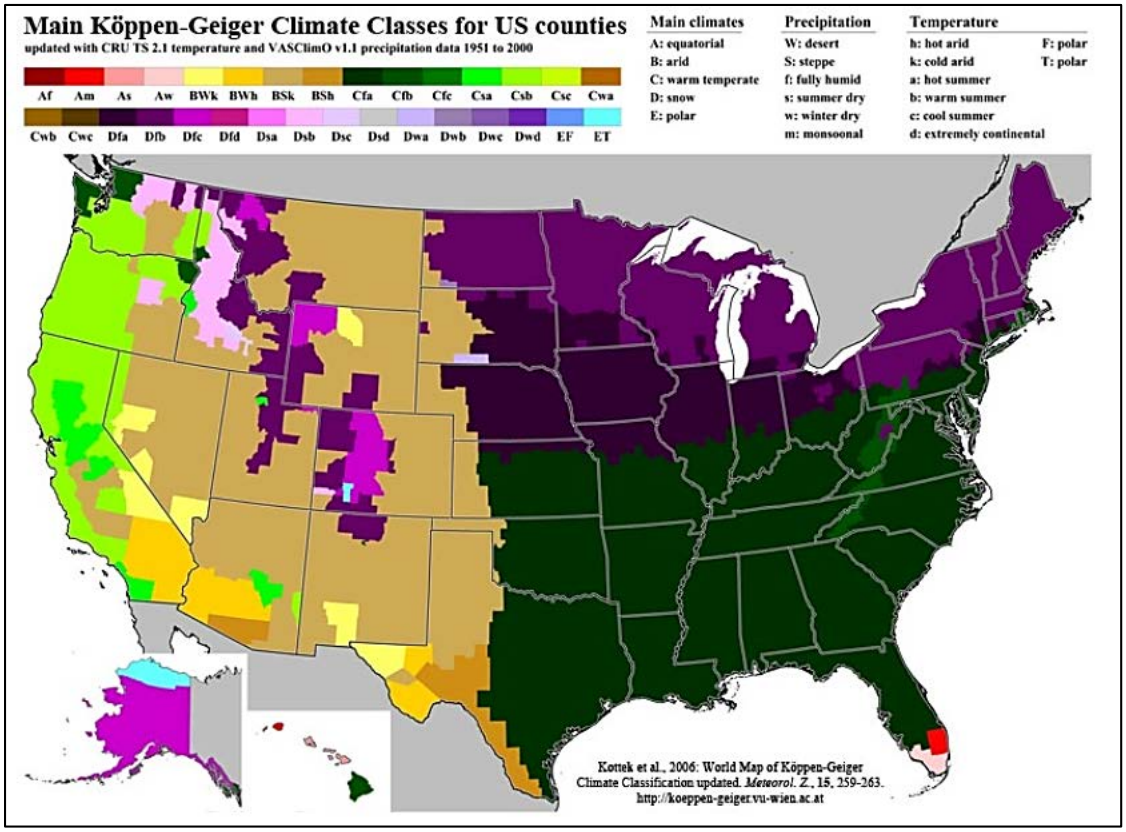


Figure 8.1.14-2: Köppen-Geiger Climate Classes for U.S. Counties

Source: (Rubel, 2010)

This section discusses the current state of Massachusetts' climate with regard to temperature, precipitation, sea level, stream flow, and extreme weather events (e.g., tropical storms, tropical cyclones, and hurricanes) in Massachusetts' three climate regions, Cfa, Dfa, and Dfb (See Figure 8.1.14-2).

Air Temperature

Statewide, the "average annual temperature ranges from about 46 degrees Fahrenheit in the Western Division to 49 in the Central, and to around 50 in the coastal division" (NCDC, 2015). "Averages can vary considerably within these divisions due to elevation, topography, and other environmental aspects including urbanization" (NCDC, 2015). The highest temperature to occur in Massachusetts was on August 2, 1975 with a record high of 107 °F (NCDC, 2015). The coldest temperature to occur in Massachusetts was on January 12, 1981 with a record low of negative 35 °F (NCDC, 2015). "Summer temperatures are delightfully comfortable for the most part, and summer averages are quite uniform all across the state" (NCDC, 2015).

The following paragraphs describe temperatures in Massachusetts as they occur within Cfa and Dfb climate classification zones:

Cfa – Boston, located in coastal Massachusetts, is within the climate classification group, Cfa. The average annual temperature for coastal areas of Massachusetts is approximately 48.7 °F

(NOAA, 2015f). The average annual temperature in Boston during winter months is 31.8 °F; 71.1 °F during summer months; 48.1 °F during spring months; and 54.5 °F during autumn months (NOAA, 2015g). Cities and towns along the coast average less than one day per year where temperatures reach 90 °F or higher (NCDC, 2015). "However, on August 2, 1975 even Cape Cod and Nantucket Island reached a record 100 °F" (NCDC, 2015). The average annual temperature for coastal areas during winter months is approximately 30 °F (NCDC, 2015). "Days with subzero readings are rare on offshore islands" of Massachusetts and "average only a few per year near the coast" (NCDC, 2015).

Dfb – Worcester, located in central Massachusetts, is within the climate classification group, Dfb. The average annual temperature for central areas of Massachusetts is approximately 46.9 °F (NOAA, 2015f). The average annual temperature in Worcester during winter months is 26.8 °F; 68.0 °F during summer months; 45.7 °F during spring months; and 50.5 °F during autumn months (NOAA, 2015g). Pittsfield, located in western Massachusetts, is also within the climate classification group, Dfb. The average annual temperature for western areas of Massachusetts is approximately 44.5 °F (NOAA, 2015f). The average annual temperature in Pittsfield during winter months is 23.6 °F; 65.8 °F during summer months; 43.6 °F during spring months; and 48.0 °F during autumn months (NOAA, 2015g). "Long-term averages for July range from 67 to 70 °F in the Western Division" (NCDC, 2015). Winter average temperatures range from "the low 20s for January in the Western Division" to "the middle to upper 20s in the Central" Division (NCDC, 2015).

Precipitation

The climate of Massachusetts is characterized by an even distribution of precipitation throughout the year (NCDC, 2015). "The state is located in one of the relatively few areas of the world that does not have 'rainy' and 'dry' seasons" (NCDC, 2015). "Storm systems are the principal year-round moisture producers" (NCDC, 2015). Although "thunderstorms produce the heaviest local rainfall," sometimes leading to "washouts of roads and soil erosion" (NCDC, 2015). Although prolonged droughts are infrequent, "every couple of decades, much of the state does experience prolonged drought conditions" (NCDC, 2015).

Total precipitation values within the state average "40 to 50 inches per year at stations having long-term records" (NCDC, 2015). Average precipitation values between coastal, central, and western divisions vary, but only slightly. "The Coastal Division (the driest) receives annually only about two inches of precipitation less than the Western Division (the wettest)" (NCDC, 2015). "Much of the winter precipitation is in the form of rain or wet snow" (NCDC, 2015). The greatest annual precipitation accumulation occurred between August 18 and 19, 1955 with a total of 18.15 inches in 24-hours (SCEC, 2015). "Most winters will have at least one snowstorm of five inches or more" (NCDC, 2015). The greatest annual snowfall accumulation occurred on April 1, 1997 with a total of 29 inches in 24-hours (SCEC, 2015). In total, this storm system produced 38.7 inches "over its 109-hour lifetime, and produced drifts of five to 10 feet across eastern Massachusetts" (NCDC, 2015).

The following paragraphs describe (Weather Works, 2012) precipitation totals in Massachusetts as they occur within Cfa and Dfb climate classification zones:

Cfa – Coastal Massachusetts is located within the climate classification group, Cfa. The average annual precipitation accumulation for this area is approximately 44.07 inches (NOAA, 2015f). The average annual precipitation in Boston, located within central Massachusetts, is 43.77 inches; 10.39 inches during winter months; 10.46 inches during summer months; 11.55 inches during spring months; and 11.37 inches during autumn months (NOAA, 2015g). Illustrating topographic and climatic differences within coastal areas of the state is a comparison between Boston and Blue Hill, two cities less than 12 miles apart. "Boston, near sea level and on the coast, "receives approximately 43.77 inches of precipitation, while Blue Hill, about 600 feet higher in elevation, receives approximately 51 inches of precipitation (NCDC, 2015). In another example, Boston received a measured 110.6 inches during the winter 2014-2015, surpassing a previous record of 107.6 inches during a winter storm in 1995-1996 (NCDC, 2015).

In addition to rainfall, coastal Massachusetts receives abundant amounts of snowfall. Cape Cod, located along the coast, receives an annual average of "about 25 to 30 inches" (NCDC, 2015). "The average number of days with one inch or more of snowfall varies from about eight to 15 [inches] in the Coastal Division" (NCDC, 2015). "The City of Boston's greatest snowstorm was the Blizzard of February 6-7, 1978 with 27.1 inches" (NCDC, 2015). "Boston's heaviest 24-hour storm was on the April Fools' Day storm of 1997, when 25.4 inches was recorded (NCDC, 2015).

Dfb – Central Massachusetts is located within the climate classification group, Dfb. The average annual precipitation accumulation for this area is approximately 44.14 inches (NOAA, 2015f). The average annual precipitation in Worcester, located within central Massachusetts, is 48.07 inches; 10.54 inches during winter months; 12.13 inches during summer months; 12.51 inches during spring months; and 12.89 inches during autumn months (NOAA, 2015g). Inland areas of Massachusetts generally receive heavier rainfall during warmer months, primarily due to "the higher frequency and greater intensity of convective showers and thunderstorms" (NCDC, 2015). Western Massachusetts is also located within the climate classification group, Dfb. The average annual precipitation accumulation for this area is approximately 46.76 inches. The average annual precipitation in Pittsfield, located within western Massachusetts, is 45.38 inches; 8.60 inches during winter months; 12.74 inches during summer months; 11.44 inches during spring months; and 12.60 inches during autumn months (NOAA, 2015g). Pittsfield receives precipitation an average of approximately four out of every 10 days. Western areas of Massachusetts are more mountainous than other areas of the state, and therefore receive the heaviest annual precipitation totals as compared to other areas of the state.

In addition to rainfall, western Massachusetts receives abundant amounts of snowfall, with an annual average of 60 to 80 inches (NCDC, 2015). "The average number of days with one inch or more of snowfall varies from 20 to 30 in the Western Division" (NCDC, 2015).

Sea Level

Massachusetts has approximately 1,500 miles of coastal shoreline (EEA, 2015g). Much of this shoreline is at risk for damage from strong winds, heavy rainfall, flooding, and hurricanes. Since 1921, sea level in Boston has risen approximately 0.92 feet, with an approximate rise of 0.11 inches per year (Commonwealth of Massachusetts, 2013b). Tide gauges along Woods Hole showed nearly identical results to Boston. However, tide gauges along Nantucket, showed approximately 1.15 feet in total rise, with an approximate rise of 3.52 inches per year (Commonwealth of Massachusetts, 2013b). Sea level rise in Massachusetts is mostly due to increasing thermal expansion and melting land-based ice sheets (Commonwealth of Massachusetts, 2013b). As sea level continues to rise, the risks associated with living along the coast also rise. Specifically, "as relative sea level rises, high water elevations will move landward, areas of coastal shorelines will retreat, and low-lying areas will be increasingly exposed to erosion, tidal inundation, and coastal storm flooding" (Commonwealth of Massachusetts, 2013b). "Developed parts of the coast are especially vulnerable because of the presence of infrastructure, homes, and businesses that can be damaged or destroyed by coastal storms" (Commonwealth of Massachusetts, 2013b).

Severe Weather Events

"Massachusetts coastal communities regularly face impacts associated with storm damage, flooding, and erosion, which affect residential and commercial development, infrastructure and critical facilities, and natural resources and ecosystems" (Commonwealth of Massachusetts, 2013b). Flooding in Massachusetts occurs "most often in spring, caused by the combination of very heavy rains which exacerbate melting of unusually deep snow covers" (NCDC, 2015). Occasionally, major flooding occurs due to heavy rainfall alone, "but this happens much less frequently" (NCDC, 2015). "Some of the severest floods, caused by heavy rains, are usually those associated with tropical storms or their remnants occurring in the late summer and fall seasons" (NCDC, 2015). Flash flooding generally occurs in the highlands, where streams are quick to rise (NCDC, 2015). By comparison, streams in the low-lying flat coastal areas are much slower to rise (NCDC, 2015).

One of Massachusetts' most damaging floods occurred recently, in March 2010. Flooding during this month "was caused by a series of moderate to heavy rainfall events" that occurred over a 5-week period (NWS, 2015a). "The successive and unrelenting nature of these moderate to heavy rainfall events saturated soils and limited opportunities for rivers and streams to recede, making the state vulnerable to flooding" (NWS, 2015a). During the mid-March storm event, approximately seven to 10 inches fell across areas of coastal Massachusetts and four to six inches fell across areas of western Massachusetts. Following this mid-March event, "widespread flooding occurred along the eastern half of Massachusetts" (NWS, 2015a). Extensive flooding also occurred in Boston, "particularly in the southern half of the city" (NWS, 2015a). During late March, another storm event occurred resulting in heavy rainfall throughout southern New England. "Rainfall totals ranged from three to six inches across central through northeastern Massachusetts" (NWS, 2015a). In southeast Massachusetts, five to eight inches of rainfall was recorded. In total, Boston reported a 14.87-inch precipitation accumulation, "a new March

record for the city" (NWS, 2015a). The previous Boston record was set in March 1953 with 11 inches in total accumulation and occurred during Hurricanes Connie and Diane (NWS, 2015a). March 2010 was also the "second all-time wettest month on record, not quite reaching the 17.09 inches of rain produced largely by Connie and Diane" (NWS, 2015a). "At the Blue Hill Observatory, 18.81 inches of rain fell, setting the all-time wettest March and monthly rainfall record for that location" (NWS, 2015a). "The previous record was 18.78 inches from August 1955" (NWS, 2015a).

"Nor'easters are one of the Commonwealth's most serious weather hazards, which often generate very strong winds and heavy rain and/or snow" (NCDC, 2015). During warmer months, Nor'easters produce high tides that lead to damage along coastal installations. During winter months, Nor'easters "produce the heaviest snowfalls, often up to a foot or more" (NCDC, 2015). Tropical storms are relatively uncommon in Massachusetts, but do affect the Commonwealth occasionally during late summer or early fall. "Maximum loss of life and property is usually concentrated along the shore, though hurricane winds and associated tropical rains may also severely damage and create extensive flooding" throughout inland areas (NCDC, 2015). Tropical storms and hurricanes "seriously affect" Massachusetts once every four to five years on average (NCDC, 2015). "Two such storms in the same year may be expected only once every 10 to 15 years" (NCDC, 2015).

Studies show that coastal storms (e.g., tropical cyclones, hurricanes, and Nor'easters) "may be intensifying and will interact with sea level rise to increase the vulnerability of coastlines and coastal habitats" (MDFW, 2015c). "Furthermore, in low-lying areas, rainfall flooding may become worse not only due to heavier rain events, but because high sea levels will reduce drainage to the ocean" (MDFW, 2015c).

8.1.15. Human Health and Safety

8.1.15.1. 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 deployment of the FirstNet telecommunication network infrastructure.

The health and safety issues reviewed in this section include occupational safety for telecommunications workers, contaminated sites, and manmade or natural disaster sites. This section does not evaluate the health and safety risks associated with radio frequency (RF) radiation, vehicular traffic, or the transportation of hazardous materials and wastes. Vehicle

traffic and the transportation of hazardous materials and wastes are evaluated in Section 8.1.1, Infrastructure.

8.1.15.2. Specific Regulatory Considerations

Federal organizations, such as the Occupational Safety and Health Administration (OSHA), USEPA, the U.S. Department of Health and Human Services, and others protect human health and the environment. In Massachusetts, public sector occupational safety is regulated by the Massachusetts Workplace Safety and Health Program and the Department of Environmental Protection (MassDEP) regulates waste and environmental pollution. Federal Occupational Safety and Health (OSH) regulations apply to workers through either OSHA, or stricter state-specific plans, which must be approved by OSHA. Massachusetts does not have an U.S. OSHA-approved "State Plan," so private and public sector occupational safety and health programs in the state are enforced by OSHA. Health and safety of the general public is regulated by the Massachusetts Department of Public Health.

Federal laws relevant to protecting occupational and public health and safety are summarized in Appendix C. Table 8.1.15-1 below summarizes the major Pennsylvania laws relevant to the state's occupational health and safety, hazardous materials, and hazardous waste management programs.

Table 8.1.15-1: Relevant Massachusetts Human Health and Safety Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
310 CMR 30	Massachusetts Department of Environmental Protection (MassDEP)	Regulations to protect public health and the environment regarding the generation, storage, transport, treatment, and disposal of hazardous waste.
310 CMR 40	MassDEP	Provides for public health and safety by preventing and controlling activities that may cause a release of hazardous material, as well as assessing contamination and implementing remedial action.
310 CMR 50	MassDEP	Promotes the reduction in use of toxic materials to prevent risks to workers, the public, and the environment.
454 CMR 25.00	Massachusetts Executive Office of Labor and Workforce Development (EOLWD)	Ensures that employees are provided with a safe work environment free from hazards.

8.1.15.3. 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 waterbodies, 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, 2016a). A summary description of the health and safety hazards present in the telecommunication occupational work environment is listed below.

Working from height, overhead work, and slips, trips, or falls – At tower and building-mount sites, workers regularly climb structures using fixed ladders or step bolts to heights exceeding 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. (IFC, 2007)

Trenches and confined spaces – Installation of underground utilities, building foundations, and work in utility manholes[142] are examples of when trenching or confined space work is necessary. Installation of telecommunication activities involves laying conduit and limited trenching (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. The general public can be at risk of stepping or driving motor vehicles into open trenches, or falling into uncovered confined spaces. (OSHA, 2016b)

Heavy equipment and machinery – New and replacement facility construction and maintenance can involve the use of heavy equipment and machinery. During the lifecycle of a telecommunication site, heavy equipment such as bulldozers, backhoes, dump trucks, cement trucks, and cranes are used to prepare the ground, transport materials and soil, and raise large sections of towers and antennas. Telecommunication workers may be exposed to the additional site traffic and often work near heavy equipment to direct the equipment drivers and to accomplish work objectives. Accessory machinery such as motorized pulley systems, hydraulic metal shears, and air driven tools present additional health and safety risks as telecommunication work sites. These pieces of machinery can potentially sever skin and bone, or cause other significant musculoskeletal injuries to the operator. (OSHA, 2016b)

Energized equipment and existing utilities – Electrical shock from energized equipment and utilities is an elevated risk at telecommunication sites due to the amount of electrical energy

[142] 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.

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. (USGS, 2000)

Optical fiber safety – Optical fiber cable installation and repair presents additional risks to telecommunications workers, including potential eye or tissue damage, through ingestion, inhalation, or other contact with glass fiber shards. The shards are generated during termination and splicing activities, and can penetrate exposed skin (IFC, 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 (FOA, 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 8.1.13, Noise) (OSHA, 2002). Fugitive noise may emanate beyond the telecommunication work site and impact the public living in the vicinity, observing the work, or transiting through the area. (OSHA, 2016b)

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. (OSHA, 2016b)

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. (OSHA, 2016b)

Outdoor elements – Weather conditions have the potential to quickly and drastically reduce safety, and increase hazards at telecommunication work sites. Excessive heat and cold conditions impact judgement, motor skills, hydration, and in extreme cases may lead to hyper- or hypothermia. Precipitation, such as rain, ice, and snow, create slippery climbing conditions and wet or muddy ground conditions. Lightning strikes are risks to telecommunication workers climbing towers or working on top of buildings. (OSHA, 2016b)

Telecommunication Worker Occupational Health and Safety

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), and telecommunication line installers and repairers (SOC code 49-9052). Both occupations are reported under the installation, maintenance and repair occupations (SOC code 49-0000).

As of May 2014, Massachusetts employed 2,960 telecommunication line installers and repairers (BLS, 2015c), and 3,730 telecommunication equipment installers and repairers (Figure 8.1.15-1) (BLS, 2015d). In 2013, the most recent data available, Massachusetts had 1.3 reportable cases of nonfatal occupational injuries or illnesses in the telecommunications industry per 100 full-time workers (BLS, 2013a). By comparison, there were 2.1 nonfatal occupational injuries or illnesses reported nationwide per 100 full-time workers in the telecommunications industry (BLS, 2013b).

Nationwide in 2013, there were 18 fatalities reported across the telecommunications industry (BLS, 2015e). That same year, telecommunications line installer and repairer occupations reported 15 fatalities, with an hours-based fatal injury rate of 7.9 per 100,000 full-time equivalent workers (BLS, 2015f). Massachusetts has not reported fatalities in the telecommunications industry or telecommunications occupations since 2003, when data were are first available. However, in the broader installation, maintenance, and repair occupations (SOC code 49-0000), there were 62 total fatalities in Massachusetts between 2003 and 2010, with the highest being 12 fatalities in 2007 (BLS, 2015g).

Public Health and Safety

The general public are not likely to encounter occupational hazards at telecommunication sites, due to limited access. Massachusetts 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 health and safety hazards.

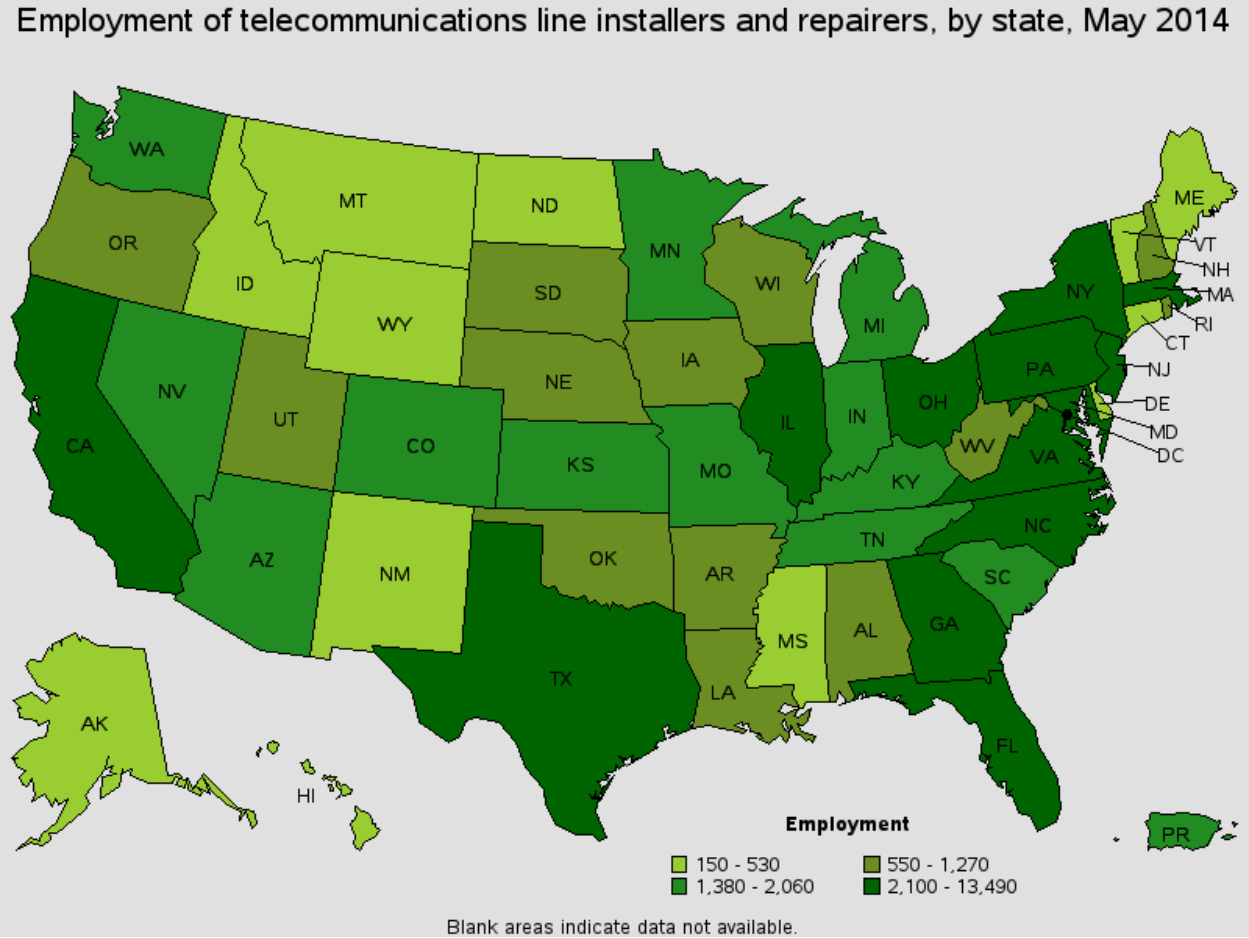


Figure 8.1.15-1: Number of Telecommunication Line Installers and Repairers Employed per State, May 2014

Source: (BLS, 2015c)

8.1.15.4. 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[143] or listed on the National Priorities List (NPL), as well as the Resource Conservation and

[143] The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) enacted in 1980, commonly referred to as the Superfund Program, governs abandoned hazardous waste sites, and collects a tax on chemical and petroleum industries. CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) in 1986; see Appendix A, Environmental Laws and Regulations (USEPA, 2015p).

Recovery Act (RCRA) Corrective Action sites and Brownfields. These regulated cleanup sites are known to contain environmental contaminants at concentrations exceeding acceptable human health exposure thresholds. Contact with high concentrations of contaminated media can result in adverse health effects, such as dermatitis, pulmonary and cardiovascular events, organ disease, central nervous system disruption, birth defects, and cancer. It generally requires extended periods of exposure over a lifetime for the most severe health effects to occur.

The MassDEP's Federal Site Program provides guidance and oversight at Superfund/NPL sites and Brownfields sites in Massachusetts (MassDEP, 2015z). The MassDEP coordinates with the USEPA and responsible parties to clean up the sites. As of September 2015, Massachusetts had 41 RCRA Corrective Action sites,[144] 227 brownfields, and 9 proposed or final Superfund/NPL sites (USEPA, 2015k). Based on a September 2015 search of USEPA's Cleanups in My Community (CIMC) database, three Superfund sites still exist in Massachusetts where contamination has been detected at an unsafe level, or a reasonable human exposure risk exists (GE Pittsfield Housatonic River, Ironhorse Park, and New Bedford) (USEPA, 2015k).

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, Massachusetts had 435 TRI reporting facilities. According to the USEPA, in 2013, the most recent data available, Massachusetts released 3,604,517 pounds of toxic chemicals through onsite and offsite disposal, transfer, or other releases, largely from the fabricated metals industry. This accounted for 0.09 percent of total nationwide TRI releases, ranking Massachusetts 37 of 56 states and territories (USEPA, 2014c).

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, 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 8.1.15-2 provides an overview of potentially hazardous sites in Massachusetts.

[144] Data gathered using the USEPA's Cleanups in My Community (CIMC) search on September 24, 2015, for all sites in the State of Massachusetts, where cleanup type equals "RCRA Hazardous Waste – Corrective Action," and excludes sites where cleanup phase equals "Construction Complete" (i.e., no longer active).

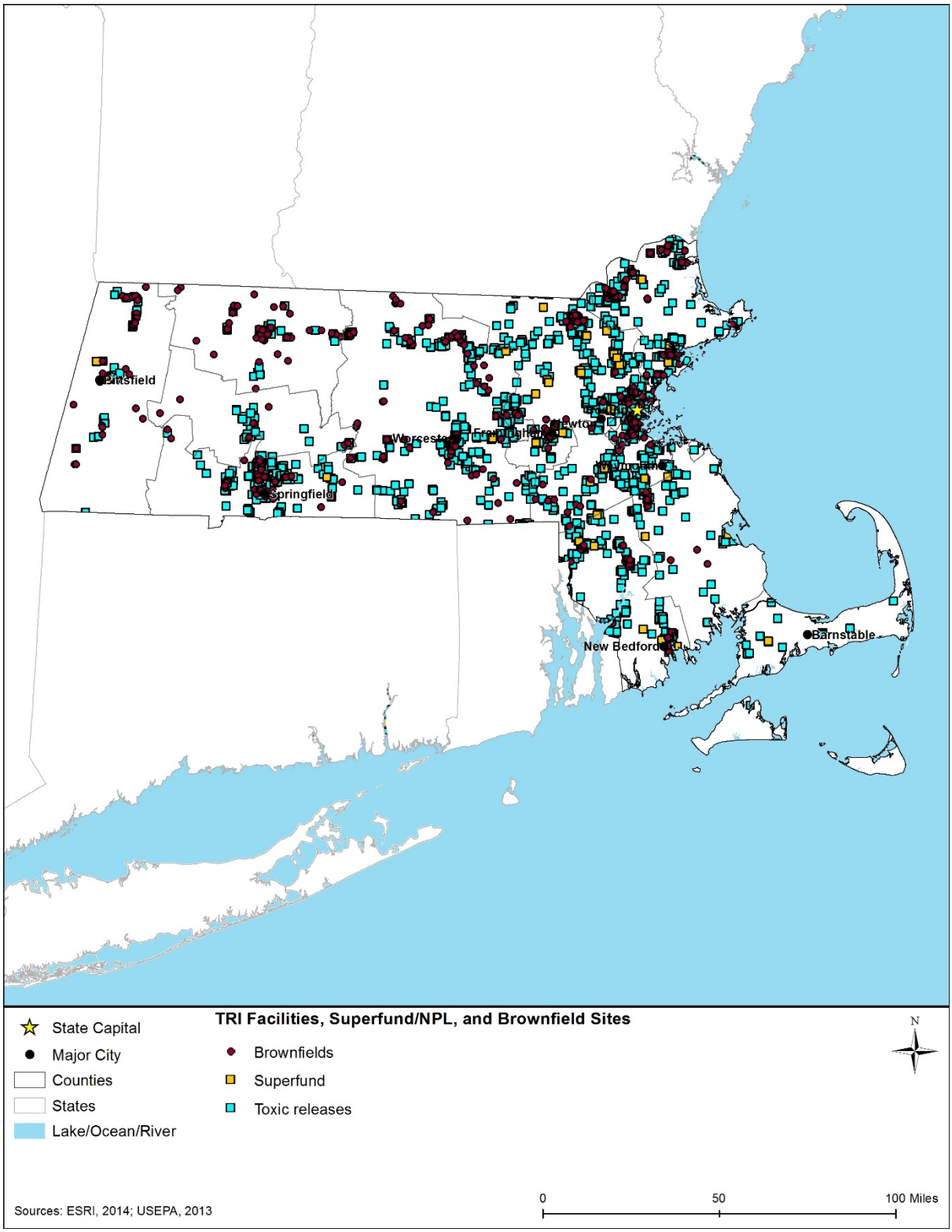


Figure 8.1.15-2: TOXMAP Superfund/NPL and TRI Facilities in Massachusetts (2013)

Source: (NIH, 2015b)

In addition to hazardous waste contamination, another health and safety hazard includes surface and subterranean mines. Health and safety hazards known to be present at active mines and abandoned mine lands (AML) include falling into open shafts, cave-ins from unstable rock and decayed support, deadly gases and lack of oxygen inside the mine, unused explosives and toxic chemicals, horizontal and vertical openings, high walls, and open pits (Federal Mining Dialogue, 2015). Gradual settling or sudden sinking of the Earth's surface, also known as subsidence, presents additional risks and is further discussed in Section 8.1.3, Geology. As of May 2015, there were no high priority AMLs (sites posing health and safety hazards) in Massachusetts (DOI, 2015).

Telecommunication Worker Occupational Health and Safety

Telecommunications sites may be at or near contaminated land, industrial discharge facilities, or sites presenting additional hazards. Occupational exposure to contaminated environmental media can occur during activities like soil excavating, trenching, other earthwork, and working over waterbodies. Indoor air quality may be impacted from vapor intrusion infiltrating indoors from contaminated soil or groundwater that are present beneath a building's foundation.

Spotlight on Massachusetts Superfund Sites: Iron Horse Park

Beginning in 1913, activities at the Iron Horse Park site included manufacturing, rail yard maintenance, and wastewater lagoons with an adjacent asbestos landfill. The 553-acre former industrial complex, near North Billerica, MA, contains groundwater and surface water contaminated with organic and inorganic chemicals, asbestos, and heavy metals, as well as soil contaminated with PCBs, petroleum, and heavy metals. Approximately 61,000 people live within 3 miles of the site. The site contamination presents high risk to people who may come in contact with the contaminated soil and groundwater.

Since cleanup work began, asbestos materials have been removed, and the landfills capped with impermeable fabric to prevent exposure and mitigate migration of contaminants from the site. A 6-Megawatt solar array was installed over the site to bring economic use to the otherwise uninhabitable area.

Solar Array over Landfill

Source: (USEPA, 2010b)

According to BLS data, Massachusetts had four occupational fatalities in 2006 within the installation, maintenance, and repair occupations from exposure to "harmful substances or environments," although these were not specific to telecommunications (BLS, 2006). By

comparison, the BLS reported three fatalities in 2011 and three preliminary fatalities[145] in 2014 nationwide within the telecommunications industry (NAICS code 517), due to exposure to harmful substances or environments (BLS, 2015h). 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 equipment installers and repairers occupation (SOC code 49-2022) due to exposure to harmful substances or environments (BLS, 2014).

Public Health and Safety

As described earlier, access to telecommunication sites is nearly always restricted to occupational workers. Although site access control is one of the major reasons telecommunication sites present an inherent low risk to non-occupational workers, the 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 Massachusetts Department of Public Health (MassDPH), Bureau of Environmental 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 (MassDPH, 2015).

8.1.15.5. Environmental Setting: Natural & Manmade Disaster Sites

Natural and manmade disaster events can create health and safety risks, as well as present unique hazards, to telecommunication workers and the general public. Telecommunications, including public safety communications, can be unavailable (temporarily or permanently) during disaster events. Examples of manmade disasters are train derailments, refinery fires, or other incident involving the release of hazardous constituents. A common example of a natural disaster is flooding. Floodwaters damage transportation infrastructure (roads, railways, etc.) and utility lines (sewer, water, electric power, broadband, natural gas lines, etc.). 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).

[145] BLS Census of Fatal Occupational Injuries data for 2014 is for preliminary reporting only. Final data is expected to be released in spring 2016. (BLS, 2015i)

Spotlight on Massachusetts Natural Disaster Sites: Hurricane Irene

During Hurricane Irene in August 2011, the Massachusetts coastline experienced high winds, and flooding from precipitation, runoff, and a coastal storm surge. Many rivers and streams flooded, causing culvert damage and road washouts.

In western Massachusetts, half of the U.S. Geological Survey's stream gauges reported record peak stream levels, with one stream gauge rising nearly twenty feet in less than four hours (USGS, 2011). Hundreds of trees were downed and roads were closed. Four landslides along the Cold River closed a six-mile section of Route 2, a major thoroughfare in northwestern Massachusetts for over three months, and cost over $22.5 million to repair (USGS, 2013d). Power outages to 567,000 customers were reported, equating to 16 percent of Massachusetts residents (DOE, 2013). In a 2012 briefing, Massachusetts Attorney General Martha Coakley cited the local utility provider, NSTAR, with failing to respond to 235 of more than 1,000 priority downed wire calls within 24 hours, "creating dangerous public safety decisions for several municipalities" (Massachusetts Attorney General, 2012).

Hurricane Irene Passes through the Town of Williamstown, MA

Source: (FEMA, 2011)

Physical hazards may also be present at disaster sites, such as downed utility lines, debris blockage or road washout conditions, which increases exposure risks to telecommunication workers. Climbing and working from tower structures damaged by wind increases the risk of slips, trips, or falls. During natural and manmade disasters, access to the telecommunication sites can be obstructed by debris.

Telecommunication Worker Occupational Health and Safety

Telecommunication workers are often called upon to provide support to natural and manmade disaster response efforts because of the critical need to restore and maintain telecommunication capabilities. The need to enter disaster areas as part of the recovery effort exposes telecommunication workers to elevated risks because chemical, biological, and physical hazards might not have not been fully identified or assessed. Transportation infrastructure and utilities in the affected areas are often compromised and present unknown chemical and biologic hazards. Correspondingly, if telecommunication workers are injured during response and repair

operations, their rescue and treatment might over-extend first responder staff and medical facilities that are delivering care to victims of the initial incident.

Currently, MALWD and U.S. 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. For example, during Hurricane Irene in 2011, five reported incidents involved dislodged pole-mounted transformers releasing transformer oil (estimated total of 33 gallons). In one incident, 19 gallons washed down the road into a wetland area (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, potential for exposure to unknown chemical and biologic hazards, and inadequate medical support. Infrastructure damage was extensive during Hurricane Irene, with several storage tank spills due to flooding and fallen transformers. According to the NRC, one incident in Massachusetts involved two fuel oil storage tanks were swept away in floodwaters. Eighty gallons of fuel oil spilled onto neighboring properties, and flowed down a creek and into a water supply area (USCG, 2011). In 2014, Massachusetts experienced four weather-related injury and two fatalities (NWS, 2015b). For comparison, in 2011, the year Hurricane Irene affected the northeast; there were also 4 weather-related fatalities, but 206 weather-related injuries (NWS, 2012).

8.2. Environmental Consequences

This section describes the potential environmental impacts, beneficial, or adverse, resulting from the Proposed Action and Alternatives. As this is a programmatic evaluation, site- and project-specific issues are not assessed. The categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Each resource area identifies the range of possible impacts on resources for the Proposed Action and Alternatives include the No Action Alternative. The No Action Alternative provides a comparison to describe the effects of environmental resources of the existing conditions to the proposed Alternatives.

NEPA requires agencies to assess the potential direct and indirect impacts each alternative could have on the existing environment (as characterized earlier in this section). Direct impacts are those impacts that are caused by the Proposed Action and occur at the same time and place, such as soil disturbance. Indirect impacts are those impacts related to the Proposed Action but result from an intermediate step or process, such as changes in surface water quality because of soil erosion.

For each resource, the potential impact is assessed in terms of context of the action and the intensity of the potential impact, per CEQ regulations (40 CFR §1508.27). *Context* refers to the timing, duration, and where the impact could potentially occur (i.e., local vs. national; pristine vs. disturbed; common species vs. protected species). In terms of duration of potential impact, context is described as short or long term. *Intensity* refers to the magnitude or severity of the effect as either beneficial or adverse. Resource-specific significance rating criteria are provided at the beginning of each resource area section.

8.2.1. Infrastructure

8.2.1.1. Introduction

This section describes potential impacts to infrastructure in Massachusetts 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 partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

8.2.1.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on infrastructure were evaluated using the significance criteria presented in Table 8.2.1-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to infrastructure addressed in this section are presented as a range of possible impacts.

Table 8.2.1-1: Impact Significance Rating Criteria for Infrastructure

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Transportation system capacity and safety	Magnitude or Intensity	Creation of substantial traffic congestion/delay and/or a substantial increase in transportation incidents (e.g., crashes, derailments)	Effect that is potentially significant, but with mitigation is less than significant	Minimal change in traffic congestion/delay and/or transportation incidents (e.g., crashes, derailments)	No effect on traffic congestion or delay, or transportation incidents
	Geographic Extent	Regional impacts observed throughout the state/territory		Effects realized at one or multiple isolated locations	NA
	Duration or Frequency	Permanent: Persisting indefinitely		Short-term effects will be noticeable for up to the entire construction phase or a portion of the operational phase	NA
Capacity of local health, public safety, and emergency response services	Magnitude or Intensity	Impacted individuals or communities cannot access health care and/or emergency services, or access is delayed, due to the project activities	Effect is potentially significant, but with mitigation is less than significant	Minor delays to access to care and emergency services that do not impact health outcomes	No impacts on access to care or emergency services
	Geographic Extent	Regional impacts observed ("regional" assumed to be at least a county or county-equivalent geographical extent, could extend to state)		Impacts only at a local/neighborhood level	NA
	Duration or Frequency	Duration is constant during construction and deployment phase		Rare event during construction and deployment phase	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Modifies existing public safety response, physical infrastructure, telecommunication practices, or level of service in a manner that directly affects public safety communication capabilities and response times	Magnitude or Intensity	Substantial adverse changes in public safety response times and the ability to communicate effectively with and between public safety entities	Effect that is potentially significant, but with mitigation is less than significant	Minimal change in the ability to communicate with and between public safety entities	No perceptible change in existing response times or the ability to communicate with and between public safety entities
	Geographic Extent	Local/City, County/Region, or State/Territory		Local/City, County/Region, or State/Territory	Local/City, County/Region, or State/Territory
	Duration or Frequency	Permanent or perpetual change in emergency response times and level of service		Change in communication and/or the level of service is perceptible but reasonable to maintaining effectiveness and quality of service	NA
Effects to commercial telecommunication systems, communications, or level of service	Magnitude or Intensity	Substantial adverse changes in level service and communications capabilities	Effect that is potentially significant, but with mitigation is less than significant	Minor changes in level of service and communications while transitioning to the new system	No perceptible effect to level of service or communications while transitioning to the new system
	Geographic Extent	Local/City, County/Region, or State/Territory		Local/City, County/Region, or State/Territory	Local/City, County/Region, or State/Territory
	Duration or Frequency	Persistent, long-term, or permanent effects to communications and level of service		Minimal effects to level of service or communications lasting no more than a short period (minutes to hours) during the construction and deployment phase	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Effects to utilities, including electric power transmission facilities and water and sewer facilities	Magnitude or Intensity	Substantial disruptions in the delivery of electric power or to physical infrastructure that results in disruptions, including frequent power outages or drops in voltage in the electrical power supply system ("brownouts"). Disruption in water delivery or sewer capacity, or damage to or interference with physical plant facilities that impact delivery of water or sewer systems	Effect that is potentially significant, but with mitigation is less than significant	Minor disruptions to the delivery of electric power, water, and sewer services, or minor modifications to physical infrastructure that result in minor disruptions to delivery of power, water, and sewer services	There would be no perceptible impacts to delivery of other utilities and no service disruptions.
	Geographic Extent	Local/City, County/Region, or State/Territory		Local/City, County/Region, or State/Territory	Local/City, County/Region, or State/Territory
	Duration or Frequency	Effects to other utilities would be seen throughout the entire construction phase		Effects to other utilities would be of short duration (minutes to hours) and would occur sporadically during the entire construction phase	NA

NA = not applicable

8.2.1.3. 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 8.2.1-1, 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 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 local health, public safety, and emergency response services through enhanced communications infrastructure, thereby increasing capacity for and enhancing the ability of first responders to communicate during emergency response situations. Based on the impact significance criteria presented in Table 8.2.1-1, such potential negative and positive impacts would be less than significant.

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 8.2.1-1, any potential impacts would be less than significant during deployment. As described above, during deployment and system optimization, existing services would likely remain operational in a

redundant manner ensuring continued operations and availability of services to the public. Once operational, state and local public safety organizations would need to evaluate telecommunication practices and standard operating procedures (SOPs). FirstNet's mission is to 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 enhance 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.[146] Such leases would then have less than significant positive impacts on commercial telecommunication systems, communications, or level of service, per the impact significance criteria presented in Table 8.2.1-1.

Effects to Utilities, Including Electric Power Transmission Facilities, and Water and Sewer Facilities

The activities proposed by FirstNet would have less than significant impacts 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.

8.2.1.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

[146] 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, Impact Assessment, 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 depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Impact Assessment, the following are likely to have no impacts to infrastructure under the conditions described below:

- Wired Projects
    - Use of Existing Conduit: New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be no impacts to infrastructure resources since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes or disruption of transportation, telecommunications, or utility services.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber would have no impacts to infrastructure resources because there would be no ground disturbance and no interference with existing utility, transportation, or communication systems.
- Satellites and Other Technologies
    - Satellite-Enabled Devices and Equipment: It is anticipated that the use of portable devices that use satellite technology would not impact infrastructure resources because there would be no change to the built or natural environment from the use of portable equipment. Installation of satellite-enabled equipment would not be expected to have any impacts to infrastructure resources, given that construction activities would occur on existing structures, would not be expected to interfere with existing equipment, and transportation capacity and safety, and access to emergency services would not be impacted.
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN, however it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact infrastructure resources, it is anticipated that this activity would have no impact on infrastructure resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to infrastructure as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur as a result of direct interface with existing infrastructure, most notably existing telecommunication infrastructure. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to infrastructure include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence (POPs)[147,] huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to infrastructure resources, depending on the specific assets connected on either end of the buried fiber. If a fiber optic plant is being used to tie into existing telecommunications assets, then localized impacts to telecommunications sites could occur during the deployment phase , however, it is anticipated that this tie-in would cause less than significant impacts as the activity would be temporary and minor.
  - New Build – Aerial Fiber Optic Plant: Installation of a new aerial fiber optic plant could impact new telecommunications infrastructure through the installation of new, or replacement of, existing telecommunications poles.
  - Collocation on Existing Aerial Fiber Optic Plant: Similar to new build activities (above), collocation on existing aerial fiber optic plant could include installation of new or replacement towers requiring ground disturbance.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in 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: Installation of transmission equipment such as small boxes or huts, or access roads, could potentially impact infrastructure. Impacts could include disruption of service in transportation corridors, disruption of service to telecommunications infrastructure, or other temporary impacts.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads might result in temporary or unintended impacts to current utility services during installation or

[147] Points of Presence are connections or access points between two different networks, or different components of one network.

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 and 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 Cell on Wheels (COWs), Cell on Light Trucks (COLTs), and Satellite on Wheels (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 Rights-of-Way (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 launched or recovered on existing paved surfaces, it is anticipated that there would be no impacts to infrastructure resources because there would be no disturbance of the natural or built environment.

In general, the abovementioned activities could potentially impact infrastructure resources in different ways, resulting in both potentially negative and potentially positive impacts. Potential negative impacts to infrastructure associated with deployment could include temporary disruption of various types of transportation corridors, temporary impacts on existing or new telecommunications sites, and more permanent impacts on utilities, if new infrastructure required tie-in to the electric grid. These impacts are expected to be less than significant 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 partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Positive impacts to infrastructure resources may result from the expansion of public safety and commercial telecommunications capacity and an improvement in public safety telecommunications coverage, system resiliency, response times, and system redundancy.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned deployment impacts. It is anticipated that there would be no impacts to infrastructure associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if further construction related activities are required along public road and utility ROWs, increased traffic congestion, current telecommunication system interruption, and utility interruptions could occur. These potential impacts would be expected to be minor and temporary as explained above.

Numerous beneficial impacts would be associated with operation of the NPSBN. The new system is intended to result in substantial improvements in public safety response times and the ability to communicate effectively with and between public safety entities, and would 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.

8.2.1.5. Alternatives Impact Assessment

The following section assesses potential impacts to infrastructure associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the

Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to infrastructure as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts 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 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 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 deployment or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to infrastructure as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.1, Infrastructure. The state also would not realize positive, beneficial impacts to infrastructure resources described above.

8.2.2. Soils

8.2.2.1. Introduction

This section describes potential impacts to soil resources in Massachusetts 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.

8.2.2.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on soil resources were evaluated using the significance criteria presented in Table 8.2.2-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to soil resources addressed in this section are presented as a range of possible impacts.

Table 8.2.2-1: Impact Significance Rating Criteria for Soils

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

8.2.2.3. 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 Massachusetts 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 Massachusetts that have steep slopes (i.e., greater than 20 percent) or where the erosion potential is medium to high, including locations with Aquepts, Fluvents, Hemists, Orthods, Saprists, Udepts, and Udults (see Section 8.1.2.4, Soil Suborders and Figure 8.1.2-2).

Based on the impact significance criteria presented in Table 8.2.2-1, building of some of FirstNet's network deployment sites could cause potentially significant erosion at locations with highly erodible soil and steep grades.

To the extent practicable, FirstNet would attempt to minimize ground disturbing construction in areas with high erosion potential due to steep slopes or soil type. Where construction is required in areas with a high erosion potential, FirstNet could implement BMPs and mitigation measures 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 8.2.2-1, and due to the relatively small-scale (less than 1 acre) of most FirstNet project sites, as well as the implementation of BMPs and mitigation measures (Chapter 17), minimal topsoil mixing is anticipated.

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 8.1.2.4, Soil Suborders). The most compaction susceptible soils in Massachusetts are hydric soils with poor drainage conditions, which include Aquepts, Hemists, and Saprists. These soils are found in approximately 40 percent of Massachusetts,[148]

[148] 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.

throughout the state (see Figure 8.1.2-2). 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 8.2.2-1, the risk of soil compaction and rutting resulting from FirstNet deployment activities would be low, due to the small extent of susceptible soils in the state (see Chapter 17).

8.2.2.4. 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 could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to soil resources under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of fiber optic cable in existing conduit through existing hand-holes, pulling vaults, junction boxes, huts, and POP structures and would not impact soil resources because it would not produce perceptible changes to soil resources because it would not require any ground disturbing activity. Impacts associated with those activities that would require construction of new vaults, huts, junction boxes, or other equipment are described 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. If physical access is required to light dark fiber, it would be through existing hand holes, pulling vaults, junction boxes, huts, and similar existing structures.
- Satellites and Other Technologies
    - Satellite-Enabled Devices and Equipment: Deployment of temporary or portable equipment that use satellite technology, including COWs, COLTs, SOWs, satellite phones, and video cameras, would not impact soil resources because those activities would not require ground disturbance.

- 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 on soil resources.

Activities with the Potential to Have Impacts

Implementation of the Preferred Alternatives could include potential construction/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: Topsoil removal, soil excavation, and excavated material placement during the replacement of poles and structural hardening could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in soil compaction and rutting.
  - New Build – Submarine Fiber Optic Plant: Installation of fiber optic plants in limited nearshore and inland bodies of water could potentially impact soil resources at and near the landings or facilities on shore to accept submarine cable. Soil erosion and topsoil mixing could potentially occur as result of grading, foundation excavation, or other ground disturbance activities. Perceptible soil compaction and rutting could potentially occur due to heavy equipment use during these activities depending on the duration of the construction activity.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Installation of optical transmission equipment or centralized transmission equipment, including

associated new utility poles, hand holes, pulling vault, junction box, hut, and POP structure installation, would require ground disturbance that could potentially impact soil resources. Potential impacts to soils resulting from soil erosion, topsoil mixing, soil compaction, and rutting are anticipated to be small-scale and short-term.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures, such as generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads, or access roads could result in impacts to soil resources. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads could result in soil erosion or topsoil mixing, and heavy equipment use during these activities could result in soil compaction and rutting.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to soils. However, if additional power units, structural hardening, and physical security measures required ground disturbance, such as grading, or excavation activities, impacts to soil resources could occur, including soil erosion and topsoil mixing, as well as soil compaction and rutting associated with heavy equipment use.
  - Deployable Technologies: Implementation of deployable technologies could result in potential impacts to soil resources depending on the technology and location for deployment. Potential impacts may result if deployment of vehicles (i.e., SOWs, COWs, COLTs, 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. Where technologies such as COWs, COLTs, and SOWs are deployed on existing paved surfaces, there would be no impacts to soil resources because there would be no ground disturbance.

In general, the abovementioned activities could potentially involve land/vegetation clearing, topsoil removal, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to soil resources associated with deployment of this infrastructure could include soil erosion, topsoil mixing, or soil compaction and rutting. These impacts are expected to be less than significant as the activity would likely be short term, localized to the deployment locations, and would return to normal conditions as soon as revegetation occurs, often by the next growing season. It is expected that heavy equipment would utilize existing roadways and utility rights-of-way for deployment activities. 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, 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 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. These impacts are expected to be less than significant 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.

8.2.2.5. Alternatives Impact Assessment

The following section assesses potential impacts to soils associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to soil resources as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts to soil resources if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. In addition, impacts to soils could occur on paved surfaces if the acceptable load of the surface is exceeded. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing,

excavation, and paving. These activities could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities may result in soil compaction and rutting. In addition, implementation of deployable technologies themselves could also result in soil compaction and rutting if deployed in unpaved areas. However, these potential impacts are expected to be less than significant 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 deployable assets, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if the acceptable load of the surface is exceeded, less than significant soil compaction and rutting impacts could result 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 as descried 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. As a result, there would be no impacts to soil resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.2, Soils.

8.2.3. Geology

8.2.3.1. Introduction

This section describes potential impacts to Massachusetts geology 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 partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

8.2.3.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on geology resources were evaluated using the significance criteria presented in Table 8.2.3-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to geology addressed in this section are presented as a range of possible impacts.

Table 8.2.3-1: Impact Significance Rating Criteria for Geology

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
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
	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

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
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.
	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

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
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

8.2.3.3. Description of Environmental Concerns

Environmental concerns regarding geology can be viewed as two distinct types, those that would potentially provide impacts to the project, such as seismic hazards, landslides, and those that would be impacts from the project, such as land subsidence, mineral and fossil fuel resources, paleontological resources, and surface geology, bedrock, topography, physiography, and geomorphology. These concerns and their impacts on geology are discussed below.

Seismic Hazard

A concern related to deployment is placement of equipment in highly active seismic 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.

As discussed in Section 8.1.3, the majority of Massachusetts is not at risk to significant earthquake events. As shown in Figure 8.1.3-5, northeastern Massachusetts is at greatest risk to earthquakes within the state; a magnitude 6.0 to 6.9 earthquake occurred off the coast of Massachusetts in 1755. Based on the impact significance criteria presented in Table 8.2.3-1, seismic impacts from deployment or operation of the Proposed Action would have no impact on seismic activity; however, seismic impacts to the Proposed Action could be potentially significant if FirstNet's deployment locations were within high-risk earthquake hazard zones or active fault zones. Given the potential for moderate earthquakes in/near Massachusetts, 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.

Landslides

As discussed in Section 8.1.3.8, portions of Massachusetts are at moderate to high risk of experiencing landslide events. Based on the impact significance criteria presented in Table 8.2.3-1, potential impacts to landslide potential from deployment or operation of the Proposed Action would have less than significant impacts as it is likely that the project would attempt to avoid areas that are prone to landslides; however, landslide impacts to the Proposed Action could be potentially significant if FirstNet's deployment locations were within areas in which landslides are highly prevalent. Equipment that is exposed to landslides is subject to misalignment, alteration, or, in extreme cases, destruction; all of these activities could result in connectivity loss. The highest potential for landslides in Massachusetts is found in the New England Upland and Taconic sections in areas that are underlain by glacial till. To the extent practicable, FirstNet would avoid deployment in areas that are susceptible to landslide events. However, given that several of Massachusetts' major cities, including Boston and Springfield, are in areas that are moderately to highly susceptible to landslides, 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

As discussed in Section 8.1.3, portions of Massachusetts are vulnerable to land subsidence due to glacial sediment compaction. Based on the impact significance criteria presented in Table 8.2.3-1, potential impacts to soil subsidence from deployment or operation of the Proposed Action would have less than significant impacts; however, subsidence impacts to the Proposed Action could be potentially significant to the Proposed Action if FirstNet's deployment locations were within areas at high risk to karst topography or mining areas. 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[149] and inundation of equipment. All of these activities could result in connectivity loss. To the extent practicable, FirstNet would avoid deployment in known areas of karst topography or in areas that are subject to sea level rise. However, where infrastructure is subject to landslide hazards, BMPs and mitigation measures, as discussed in Chapter 17, could help avoid or minimize the potential impacts.

Mineral and Fossil Fuel Resource Impacts

Equipment deployment near mineral and fossil fuel resources are not likely to affect these resources. Rather the new construction is only likely to limit access to extraction of these resources. Based on the impact significance criteria presented in Table 8.2.3-1 impacts to mineral and fossil fuel resources is unlikely as the Proposed Action could only be potentially significant if FirstNet's deployment locations were to cause severe, widespread, observable impacts to mineral and/or fossil fuel resources. To the extent practicable, FirstNet would avoid construction in areas where these resources exist.

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 8.2.3-1, impacts to paleontological resources could be potentially significant if FirstNet's buildout/deployment locations uncovered paleontological resources during construction activities. As discussed in Section 8.1.3.6, Paleontological Resources, fossils are abundant throughout parts of Massachusetts. It is anticipated that potential impacts to specific areas known to contain paleontological resources would be avoided, minimized, or mitigated, and any potential impacts would be limited and localized. Potential impacts to fossil resources should be considered on a site-by-site basis, and BMPs and mitigation measures (see Chapter 17) could further help avoid or minimize the potential impacts.

[149] 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, 2016b)

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 8.2.3-1, impacts could be potentially significant 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 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.

8.2.3.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

Implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities have the potential to be impacted by geologic hazards, some activities could result in potential impacts to geology, and other activities would have no impacts. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to geology under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. In most cases, there would be no impacts to geologic resources since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts to geologic resources because there would be no ground disturbance.

- Satellites and Other Technologies
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN, however it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact geologic resources, it is anticipated that this activity would have no impact on geologic resources.

Activities with the Potential to Have Impacts

Potential construction/deployment-related impacts to geologic resources, or resulting from geologic hazards due to implementation of the Preferred Alternative, would encompass a range of impacts that could occur as a result of ground disturbance activities, including loss of mineral and fuel resources and paleontological resources. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to geologic resources, or impacts from geologic hazards, include the following:

- Wired Projects
    - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POP huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to geologic resources due to associated ground disturbance, such as impacts to fuel and mineral resources or paleontological resources. Where equipment is installed in locations that are susceptible to landslides, earthquakes, and other 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 landslides, earthquakes, and other geologic hazards, it is possible that equipment could be affected by that hazard.
    - Collocation on Existing Aerial Fiber Optic Plant: Replacement of utility poles and structural hardening, and associated use of heavy equipment during construction, could result in potential impacts to geologic resources due to associated ground disturbance. Where equipment is installed in locations that are susceptible to landslides, earthquakes, and other geologic hazards, it is possible that equipment could be affected by that hazard.
    - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water is not expected to impact geologic resources including marine paleontological resources. However, where landings and/or facilities for submarine cable are installed at locations that are susceptible to landslides, earthquakes, and other geologic hazards, it is possible that equipment could be affected by that hazard.
    - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require ground disturbance in locations that are susceptible to geologic hazards (e.g., land

subsidence, landslides, or 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 landslides, earthquakes, and other geologic hazards, it is possible that equipment could be affected by that hazard.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in ground disturbance. However, if additional power units, structural hardening, and physical security measures required ground disturbance, such as grading, or excavation activities, impacts to geologic resources could occur due to ground disturbance. Where equipment is installed in locations that are susceptible to landslides, earthquakes, and other geologic hazards, it is possible that equipment could be affected by that hazard.
  - Deployable Technologies: Implementation of deployable technologies could result in potential impacts to geologic resources depending on the technology and location proposed for deployment. Potential impacts may result if deployment of vehicles (i.e., SOWs, COWs, COLTs, 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. Where deployable technologies would be implemented on existing paved surfaces, there would be no impacts to/from geologic resources because there would be no ground disturbance and mobile technologies could be moved to avoid geologic hazards.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: In most cases, the installation of permanent equipment on existing structures, adding equipment to satellites launched for other purposes, or the use of portable devices that use satellite technology would not impact geologic resources because those activities would not require ground disturbance. However, where equipment is permanently installed in locations that are susceptible to landslides, earthquakes, and other geologic hazards, 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 as a result, these potential 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.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. It is anticipated that there would be no impacts to geology 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 seismic activity, landslides, and land subsidence. However, potential impacts would be anticipated to be less than significant 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.

8.2.3.5. Alternatives Impact Assessment

The following section assesses potential impacts to geology associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration.

Therefore, potential impacts to geology as a result of implementation of this alternative could be as described below.

Deployment Impacts

Implementation of deployable technologies on existing paved surfaces would not result in impacts to geologic resources (or from geologic hazards) as there would be no ground disturbance and mobile technologies could be moved to avoid geologic hazards. Potential impacts may result if deployment of vehicles (i.e., SOWs, COWs, COLTs, 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 impacts are expected to be less than significant 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 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. As a result, there would be no impacts to geologic resources (or from geologic hazards) as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.3, Geology.

8.2.4. Water Resources

8.2.4.1. Introduction

This section describes potential impacts to water resources in Massachusetts 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.

8.2.4.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on water resources were evaluated using the significance criteria presented in Table 8.2.5-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to water resources addressed in this section are presented as a range of possible impacts.

Table 8.2.4-1: Impact Significance Rating Criteria for Water Resources

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Water Quality (groundwater and surface water) - sedimentation, pollutants, nutrients, water temperature	Magnitude or Intensity	Groundwater contamination creating a drinking quality violation, or otherwise substantially degrade groundwater quality or aquifer; local construction sediment water quality violation, or otherwise substantially degrade water quality; water degradation poses a threat to the human environment, biodiversity, or ecological integrity. Violation of various regulations including: CWA, SDWA	Effect that is potentially significant, but with mitigation is less than significant.	Potential impacts to water quality, but potential effects to water quality would be below regulatory limits and would naturally balance back to baseline conditions.	No changes to water quality; no change in sedimentation or water temperature, or the presence of water pollutants or nutrients.
	Geographic Extent/Context	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Chronic and long term changes not likely to be reversed over several years or seasons		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 mitigation is less than significant.	Activities occur inside the 500-year floodplain, but do not use fill, do not substantially increase impervious surfaces, or place structures that will impede or redirect flood flows or impact floodplain hydrology, and do not occur during flood events. Low likelihood of encountering a 500-year floodplain within a state or territory.	Activities occur outside of floodplains and therefore do not increase fill or impervious surfaces, nor do they impact flood flows or hydrology within a floodplain.

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Chronic and long term changes not likely to be reversed over several years or seasons		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 mitigation is less than significant.	Any alterations to the drainage pattern are minor and mimic natural processes or variations.	Activities do not impact drainage patterns
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Impact occurs in perennial streams, and is ongoing and permanent		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 mitigation is less than significant.	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 mitigation is less than significant.	Any potential impacts to groundwater or aquifers are temporary, lasting no more than a few days, with no residual impacts	Activities do not impact groundwater or aquifers
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Impact is ongoing and permanent		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).

8.2.4.3. Description of Environmental Concerns

Potential Water Quality Impacts

Water quality impaired waterbodies are those waters that have been identified as not supporting their appropriate uses. Projects in watersheds of impaired waters may be subject to heightened permitting requirements. For example, the CWA requires states to assess and report on the quality of waters in their state. Section 303(d) of the CWA requires states to identify impaired waters. For these impaired waters, states must consider the development of a Total Maximum Daily Load (TMDL) or other strategy to reduce the input of the specific pollutant(s) restricting waterbody uses, in order to restore and protect such uses.

All of the surface waters in the state have been degraded to some extent (see Table 8.1.4-2, Figure 8.1.4-5) (USEPA, 2015a). According to the USEPA, 64 percent of assessed rivers and streams in Massachusetts, and 88 percent of the state's estuaries and bays are impaired (USEPA, 2015a). For example, the Charles River is impaired due to elevated nutrient levels, specifically phosphorus, and MassDEP and USEPA work to reduce these levels by limiting storm water runoff entering the river (USEPA, 2015b). Approximately 98 percent of the waters assessed for the state's lakes, reservoirs, and ponds are impaired, with designated uses including fish and wildlife habitat, fish consumption, and recreation. Lake Rohunta's waters are threatened by non-native aquatic vegetation and elevated mercury levels in fish (Millers River Watershed Advisory Committee, 2004). Groundwater quality within the state is generally good.

Deployment 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, 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 Massachusetts Pollutant Discharge Elimination System (MPDES) Construction General Permit (CGP) would be required. As part of the permit application for the CGP, a storm water 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 help prevent sediment and suspended solids from entering the waterways and ensure that effects on water quality during construction would not be adverse.

Deployment activities associated with the Proposed Action have the potential to increase erosion and sedimentation around construction and staging areas. Grading activities associated with construction would potentially result in a temporary increase in the amount of suspended solids

running off construction sites. If a storm event were to occur, construction site runoff could result in sheet erosion of exposed soil. If not adequately controlled, water runoff from these areas would have the potential to degrade surface water quality. Implementing BMPs could reduce potential impacts to surface water quality.

Expected deployment activities would not violate applicable state, federal (e.g., CWA, and Safe Drinking Water Act), and local regulations, cause a threat to the human environment, biodiversity, or ecological integrity through water degradation, or cause a sediment water quality violation from local construction, or otherwise substantially degrade water quality.

Therefore, based on the impact significance criteria presented in Table 8.2.5-1, water quality impacts would likely be less than significant and could be further reduced if BMPs and mitigation measures were to be incorporated where practicable and feasible.

During implementation of the Proposed Action and Alternatives, there is the potential to encounter shallow groundwater due to clearing and grading activities, shallow excavation, or relocation of utility lines. This is unlikely, as trenching is not expected to exceed a 48-inch depth. However, groundwater contamination may exist in areas directly within or near the project area. If trenching[150] 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 Massachusetts 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 Massachusetts aquifers, there is little 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 8.2.5-1, there would likely be less than significant impacts on groundwater quality within most of the state. In areas where groundwater is close to the surface, then site-specific analysis, BMPs, and mitigation measures could be implemented to further reduce potential impacts.

Floodplain Degradation

Floodplains are low-lying lands next to rivers and streams. When left in a natural state, floodplain systems store and dissipate floods without adverse impacts on 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 8.2.5-1, floodplain degradation impacts would be potentially less than significant since the majority of FirstNet's likely

[150] Telecommunications activities involve laying conduit, with minimal trenching. Trenching activities would likely be at a minimal depth (less than 36 inches) and width (6 to 12 inches).

deployment activities, on the watershed or subwatershed level, would occur inside the 500-year floodplain, would use minimal fill, would not substantially increase impervious surfaces, structures would not impede or redirect flood flows or impact floodplain hydrology, and would not occur during flood events with the exception of deployable technologies which may be deployed in response to an emergency. Additionally, any effects would be temporary, lasting no more than one season or water year,[151] or occur only during an emergency.

Examples of activities that would have less than significant impacts include:

- Construction of any structure in the 500-year floodplain but is built above base flood elevation pursuant to floodplain management regulations.
- Land uses that include pervious surfaces such as gravel parking lots.
- Land uses that do not change the flow of water or drainage patterns.
- Limited clearing or grading activities.

Implementation of BMPs and mitigation measures would reduce the risk of additional impacts to floodplain degradation (see Chapter 17).

Drainage Pattern Alteration

Flooding and erosion from land disturbance can changes drainage patterns. Storm water 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 storm water drains, storage, and retention areas designed to slow water and allow sediments to settle out. Improperly handled drainage can cause increased erosion, changes in storm water 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); storm water increases; or altered flow patterns.

According to the significance criteria in Table 8.2.5-1, any temporary (lasting less than six months) alterations to drainage patterns that are minor and mimic natural processes or variations within the watershed or subwatershed level would be considered less than significant.

Example of projects that could have minor changes to the drainage patterns include:

- Land uses with pervious surfaces that create limited storm water runoff.
- Where storm water is contained on site and does not flow to or impact surface waterbodies offsite on other properties.
- Activities designed so that the amount of storm water generated before construction is the same as afterwards.
- Activities designed using low impact development techniques for storm water.

[151] 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, 2015a)

Since the proposed activities would not substantially alter drainage patterns in ways that alter the course of a stream or river, create a substantial and measurable increase in the rate and amount of surface water, or change the hydrologic regime, and any effects would be short-term, impacts to drainage patterns would be less than significant. BMPs, mitigation measures, and avoidance could be implemented to further reduce any 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 8.2.5-1. Projects that include minor consumptive use of surface water with less than significant impacts on discharge (do not direct large volumes of water into different locations) on a temporary (no more than six months) are likely to have less than significant impacts on flow alteration, on a watershed or subwatershed level. Examples of projects likely to have less than significant impacts include:

- Construction of any structure in a 100-year or 500-year floodplain that is built above base flood elevation pursuant to floodplain management regulations.
- Land uses that are maintaining or increasing pervious surfaces.
- Land uses that do not change the flow of water or drainage patterns offsite or into surface waterbodies that have not received that volume of storm water 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. BMPs, mitigation measures, and avoidance could be implemented to further reduce any impacts.

Changes in Groundwater or Aquifer Characteristics

As described in Section 8.1.4.7, most of Massachusetts residents (approximately two-thirds) receive their drinking water from surface water supplies, while groundwater is the water supply for nearly all of Cape Cod and the Islands, as well as small communities throughout the state (MassDEP, 2012a). Groundwater is an important natural resource used by industrial, commercial, agricultural, and residential uses for manufacturing, irrigation, and drinking water purposes. Generally, the water quality of Massachusetts's aquifers is suitable for drinking and

daily water needs. Once a groundwater supply is exhausted or contaminated, it is very expensive, and sometimes impossible, to replace. Water supply demand from the deployment activities is unlikely to exceed safe and sustainable withdrawal capacity rate of the local supply or aquifer.

Storage of generator fuel over groundwater or an aquifer would unlikely cause any impacts to water quality. Activities that may cause changes is groundwater or aquifer characteristics include:

- Excavation, mining, or dredging during or after construction.
- Any liquid waste, including but not limited to wastewater, generation.
- Storage of petroleum or chemical products.

Private and public water supplies often use groundwater as a water source. To maintain a sustainable system, the amount of water withdrawn from these groundwater sources must be balanced with the amount of water returned to the groundwater source (groundwater recharge).

Deployment activities should be less than significant since they would not substantially deplete supplies of potable groundwater, as any construction dewatering would be short-term. The siting of deployment activities should be considered to avoid areas that would extract groundwater from potable groundwater sources in the area.

8.2.4.4. 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 water resources and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result in a range of no impacts to potentially significant impacts depending on the deployment scenario or site-specific conditions. The impact on the water resources that could be affected would depend on the watershed, duration (chronic or short-term) and frequency (many years or a few months) the resource would be used, and the water resource's current use (sole source for drinking water, considered exceptional value for recreation, or provides critical habitat for a species).

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to water resources under the conditions described below:

- Wired Projects
  - *Use of Existing Conduit – New Buried Fiber Optic Plant:* Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be no impacts to water resources since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - *Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable:* Lighting up of dark fiber would have no impacts to water resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - *Satellite-Enabled Devices and Equipment:* It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact water resources because those activities would not require ground disturbance.
  - *Deployment of Satellites:* FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it 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.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to water resources because of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including impaired water quality. The types of deployment activities that could be part of the Preferred Alternative and result in potential impacts to water resources include the following:

- Wired Projects
  - *New Build – Buried Fiber Optic Plant:* Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to water resources. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites. The amount of impact depends on the land area affected, installation technique, and location. Trenching would not be expected to occur near or below the existing water table (depth to water). Implementing BMPs and mitigation measures could reduce impact intensity.
  - *New Build – Submarine Fiber Optic Plant:* The installation of cables in limited nearshore and inland bodies of water would impact water resources from a short-term increase in suspended solids in the water. Site-specific impact assessment could be required to

marine and shoreline environments prior to installation to fully assess potential impacts to lake or river coastal environments.

- *New Build – Aerial Fiber Optic Plant:* Potential impacts would be similar to Buried Fiber Optic Plant. Ground disturbance activities could cause impacts to water quality from increased suspended solids; groundwater impacts from trenching activities are not expected. If a new roadway were built, additional impervious surface would not be expected to impact water resources or the overall amount of runoff and nonpoint pollution.
- *Collocation on Existing Aerial Fiber Optic Plant:* Replacement of poles or structural hardening could result in ground disturbance that could cause impacts to water quality from increased suspended solids.
- *Installation of Optical Transmission or Centralized Transmission Equipment:* If installation of transmission equipment required grading or other ground disturbance to install small boxes or huts, or access roads, there could potentially be direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites. The amount of impact depends on the land area affected, installation technique, and location. Trenching would not be expected to occur near or below the existing water table (depth to water). If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be no impacts to water resources.

- Wireless Projects
  - *New Wireless Communication Towers:* Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites. The amount of impact depends on the land area affected, installation technique, and location. Trenching would not be expected to occur near or below the existing water table (depth to water). Implementing BMPs could reduce impact intensity. If a new roadway were built, additional impervious surface would not be expected to impact water resources or the overall amount of runoff and nonpoint pollution.
  - *Deployable Technologies:* Implementation of land-based deployable technologies could result in potential impacts to water resources if deployment involves movement of equipment through streams, occurs in riparian or floodplain areas, occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites or 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 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. 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.

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 due to the limited geographic scale of individual activities and would likely return to baseline conditions once revegetation of disturbed areas is complete. BMPs to help mitigate or reduce any potential impacts are described in Chapter 17.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities, and are expected to have no impacts as there would be no ground disturbing activity and it is likely routine maintenance activities would be conducted along exiting roads and utility rights-of way. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. Impacts to surface and groundwater quality from routine operations and maintenance, such as herbicide application to control vegetation, are not expected.

8.2.4.5. Alternatives Impact Assessment

The following section assesses potential impacts to water resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred

Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to water resources as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts to water resources if deployment occurred on paved surfaces if there is any runoff into the surface water. 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. 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 the BMPs and mitigation measures identified in Chapter 17 could further avoid or reduce potential impacts. The activities could also result in indirect impacts on water quality if fuels leak into surface or groundwater.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Deployable Technologies 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 less than significant impacts to water resources associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off 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. 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, it is anticipated that these potential

impacts would be less than significant. Site maintenance, including mowing or herbicides, may result in less than significant effects to water quality, 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.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to water resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.4, Water Resources.

8.2.5. Wetlands

8.2.5.1. Introduction

This section describes potential impacts to wetlands in Massachusetts 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 partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

8.2.5.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on wetlands were evaluated using the significance criteria presented in Table 8.2.5-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to wetlands addressed in this section are presented as a range of possible impacts.

Table 8.2.5-1: Impact Significance Rating Criteria for Wetlands

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Direct wetland loss (fill or conversion to non-wetland)	Magnitude[1] or Intensity	Substantial loss of high-quality wetlands (e.g., those that provide critical habitat for sensitive or listed species, are rare or a high-quality example of a wetland type, are not fragmented, support a wide variety of species, etc.); violations of Section 404 of the CWA	Effect that is potentially significant, but with mitigation is less than significant.	Impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity)	No direct loss of wetlands.
	Geographic Extent/Context	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level.	NA
	Duration or Frequency	Chronic and long term changes not likely to be reversed over several years or seasons		Periodic and/or temporary loss reversed over 1-2 growing seasons with or without active restoration	NA
Other direct effects: vegetation clearing; ground disturbance; direct hydrologic changes (flooding or draining); direct soil changes; water quality degradation (spills or sedimentation)	Magnitude or Intensity	Substantial and measurable changes to hydrological regime of the wetland impacting salinity, pollutants, nutrients, biodiversity, ecological integrity, or water quality; introduction and establishment of invasive species to high quality wetlands	Effect that is potentially significant, but with mitigation is less than significant.	Impacts to lower quality wetlands affecting the hydrological regime including salinity, pollutants, nutrients, biodiversity, ecological integrity, or water quality; introduction and establishment of invasive species to high quality wetlands	No direct impacts to wetlands affecting vegetation, hydrology, soils, or water quality
	Geographic Extent	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	Duration or Frequency	Long-term or permanent alteration that is not restored within 2 growing seasons, or ever		Periodic and/or temporary loss reversed over 1-2 growing seasons with or without active restoration	NA
Indirect effects[2]: change in function(s)[3] change in wetland type	Magnitude or Intensity	Changes to the functions or type of high quality wetlands (e.g., those that provide critical habitat for sensitive or listed species, are rare or a high-quality example of a wetland type, are not fragmented, support a wide variety of species, etc.)	Effect that is potentially significant, but with mitigation is less than significant	Impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity)	No changes in wetland function or type
	Geographic Extent	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level	NA
	Duration or Frequency	Long-term or permanent		Periodic and/or temporary loss reversed over 1-2 growing seasons with or without active restoration	NA

NA = not applicable

[1] "Magnitude" is defined based on the type of wetland impacted, using U.S. Army Corps of Engineers (USACE) wetland categories (USACE 2014). Category 1 are the highest quality, highest functioning wetlands.

[2] 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.

[3] 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, threatened/endangered (T/E) species habitat, biodiversity, recreational/social value.

8.2.5.3. Description of Environmental Concerns

Potential Direct Wetland Loss (Fill or Conversion to Non-Wetland)

Construction-related impacts from several of the deployment activities have the potential for direct wetland impacts such as filling, draining, or conversion to a non-wetland. Examples include placement of fill in a wetland to construct a new tower, trenching through a wetland or directly connected waterway to install a cable, and placement of a structure (tower, building) within the wetland.

Wetlands regulate the quality and quantity of surface and groundwater supplies, reduce flood hazards by serving as retention basins for surface runoff, and maintain water supplies after floodwaters subside. If wetlands were filled, the entire area may be at risk for increased flooding. There could be a loss of open space to be enjoyed by the community, and decreased wildlife populations may be observed due to displacement and increased noise, light, and other human disturbance. To the extent practicable or feasible, FirstNet and/ or their 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 given the amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities. Additionally, all site-specific locations will be subject to an environmental review to help ensure environmental concerns are addressed. Potential wetlands impacts can be further reduced by implementing BMPs and mitigation measures (see Chapter 17).

There are approximately 540,000 acres of wetlands throughout Massachusetts (USFWS, 2014a). Palustrine (freshwater) wetlands are found on river and lake floodplains across the state, and estuarine/marine (tidal) wetlands around the Atlantic shoreline, bays, and barrier islands, as shown in Section 8.1.5, Figure 8.1.5-1.

Based on the impact significance criteria presented in Table 8.2.5-1, and given the temporary nature of most proposed activities, the deployment activities would most likely have less than significant direct impacts on wetlands. Additionally, most of the deployment activities would not violate applicable federal (e.g., CWA Section 404), state, and local regulations.

In Massachusetts, as discussed in Wetlands, Section 8.1.5.4, regulated high quality wetlands include areas of critical environmental concern (ACECs). ACECs receive "special recognition because of the quality, uniqueness, and significance of their natural and cultural resources." As of 2010, Massachusetts designated approximately 268,000 acres of ACECs. (MassDCR, 2015d) Visit www.mass.gov/eea/docs/dcr/stewardship/acec/listacec.pdf for a complete list of ACECs in Massachusetts.

If any of the proposed deployment activities were to occur in these ACECs, potentially significant impacts could occur. ACECs occur throughout the state, and are not always included on state maps; therefore, site-specific analysis would be required, in addition to BMPs and mitigation measures to avoid potentially significant impacts to wetlands.

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 storm water discharges or water withdrawals that alter the functions of the wetlands.

Based on the impact significance criteria presented in Table 8.2.5-1, construction-related deployment activities that result in long-term or permanent, substantial, and measurable changes to hydrological regime of the wetland (i.e., changes in salinity, pollutants, nutrients, biodiversity, ecological integrity, or water quality) may cause potentially significant impacts. In addition, introduction and establishment of invasive species to high quality wetlands within a watershed or multiple watersheds are potentially significant. Other direct effects to high- and low-quality wetlands would be less than significant given the amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities and the application of federal, state, and local wetlands regulations. Additionally, all site-specific locations will be subject to an environmental review to help ensure environmental concerns are addressed. Potential wetlands impacts can be further reduced by implementing BMPs and mitigation measures (see Chapter 17).

Examples of activities that could have other direct effects to wetlands in Massachusetts 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 storm water 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 Hydrologic Changes (flooding or draining)*: Greater frequency and duration of flooding can destroy native plant communities, as can depriving them of their water supply. Hydrologic changes can make a wetland more vulnerable to pollution. Increased water depths or flooding frequency can distribute pollutants more widely through a wetland. Sediment retention in wetlands is directly related to flow characteristics, including degree and pattern of channelization, flow velocities, and storm surges.
- *Direct Soil Changes*: Changes in soil chemistry 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, both of which support rare habitat in Massachusetts.
- *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:[152] Change in Function(s)[153] or Change in Wetland Type

Indirect effects to wetlands could include change in wetland function or conversion of a resource to another type (i.e., wetland to an open body of water). The construction of curb and gutter systems diverts surface runoff and 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 given the amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities and the application of federal, state, and local wetlands regulations. Additionally, all site-specific locations will be subject to an environmental review to help ensure environmental concerns are addressed. Potential wetlands impacts can be further reduced by implementing BMPs and mitigation measures (see Chapter 17).

- *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.

[152] 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.

[153] 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.

- *Groundwater Recharge:* Wetlands retain water, allowing time for surface waters to infiltrate into soils and replenish groundwater.

According to the significance criteria defined in Table 8.2.5-1, impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity), would be considered potentially less than significant. Since the majority of wetlands in Massachusetts are not considered high quality, deployment activities could have less than significant indirect impacts on wetlands in the state. BMPs and mitigation measures could be implemented, as feasible and practicable, to reduce potential impacts to all wetlands.

In areas where there are high quality wetlands, there could be potentially significant impacts at the project level that would be analyzed on a case-by-case basis. If avoidance were not possible, BMPs and mitigation measures would help to mitigate impacts.

8.2.5.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities. To determine the magnitude of potential impacts of site-specific activities, wetland delineations would be required to determine the exact location of all wetlands, including high quality wetlands, as well as a functional assessment by an experienced wetland delineator.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to wetlands and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result in a range of no impacts to potentially significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to wetlands under the conditions described below:

- Wired Projects
    - *Use of Existing Conduit – New Buried Fiber Optic Plant:* Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be no impacts to wetlands since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.

- *Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable:* Lighting up of dark fiber would have no impacts to wetlands 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, 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 may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact wetlands, it is anticipated that this activity would have no impact on wetlands.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to wetlands because of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct effects, other direct effects, and indirect effects on wetlands. The types of deployment activities that could be part of the Preferred Alternative and result in potential impacts to wetlands include the following:

- Wired Projects
  - *New Build – Buried Fiber Optic Plant:* Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to wetlands. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct and indirect impacts to wetlands. The amount of impact depends on the land area affected, installation technique, proximity to wetlands, and type of wetland that could be affected (e.g., high quality). Any ground disturbance could cause direct and indirect impacts wetlands, depending on the proximity to wetlands and type of wetlands that could be affected. Implementing BMPs and mitigation measures could reduce impact intensity.
  - *New Build – Submarine Fiber Optic Plant: The* installation of cables in limited nearshore and inland bodies of water would potentially impact wetlands found along shorelines. Additional project-specific environmental reviews would be required to assess potential impacts to wetland environments, including coastal and marine environments.
  - *New Build – Aerial Fiber Optic Plant:* Potential impacts would be similar to Buried Fiber Optic Plant. Any ground disturbance could cause direct and indirect impacts wetlands, depending on the proximity to wetlands and type of wetlands that could be affected.
  - *Collocation on Existing Aerial Fiber Optic Plant:* Any ground disturbance could cause direct and indirect impacts to wetlands from increased suspended solids and runoff from

activities, depending on the proximity to wetlands and type of wetlands that could be affected.

- *Installation of Optical Transmission or Centralized Transmission Equipment:* If installation of transmission equipment required grading or other ground disturbance to install small boxes or hunts, or access roads, there could potentially be direct and indirect impacts to wetlands. The amount of impact from a temporary increase in the amount of suspended solids running off construction sites and into wetlands, depends on the land area affected, installation technique, and location. If trenching were to occur near wetlands, it could cause impacts on wetlands. Implementing BMPs and mitigation measures could reduce impact intensity.

- Wireless Projects
  - *New Wireless Communication Towers:* Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could potentially cause direct and indirect impacts to wetlands. The activities could cause a temporary increase in the amount of suspended solids running off construction sites and into wetlands, depending on their proximity. The amount of impact depends on the land area affected, installation technique, and proximity to wetlands, and wetland type. If trenching were to occur near wetlands, it could cause impacts on wetlands. Implementing BMPs and mitigation measures could reduce impact intensity.
  - *Collocation on Existing Wireless Tower, Structure, or Building:* Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to wetlands. However, if additional power units, structural hardening, and physical security measures required ground disturbance, such as grading, or excavation activities, impacts to wetlands could occur near wetlands, it could cause impacts on wetlands. Implementing BMPs and mitigation measures could reduce impact intensity.
  - *Deployable Technologies:* Implementation of deployable technologies could result in potential impacts to wetlands if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. The amount of impact depends on the land area affected, installation technique, and location. Implementing BMPs and mitigation measures could reduce impact intensity. The activities could also result in other direct impacts on wetlands if fuels leak into nearby waterbodies or wetlands. Deployment of drones, balloons, or blimps 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). Any ground disturbance could cause direct and indirect impacts wetlands, depending on the proximity to wetlands and type of wetlands that could be affected. These impacts are expected to be less than significant due to the small about of land disturbance (generally less than one acre) and the short timeframe of deployment activities. To minimize any potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, state, and local permits. 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 construction impacts. It is anticipated that there could be ongoing potential other direct impacts to wetlands if heavy equipment is used for routine operations and maintenance application of herbicides occurs to control vegetation along all ROWs and near structures, depending on the proximity to wetlands. The intensity of the impact depends on the amount of herbicides used, frequency, and location of nearby sensitive wetlands. These impacts are expected to be less than significant due to the limited nature of deployment activities. It is also anticipated that routine maintenance activities would be conducted on existing roads and utility ROW. 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.

8.2.5.5. Alternatives Impact Assessment

The following section assesses potential impacts to water resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to wetlands as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts to wetlands. 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 due to the small-scale and temporary duration of expected FirstNet deployment activities in any one location. To minimize any potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, state, and local permits. See Chapter 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 Deployable Technologies would consist of routine maintenance and inspection of the deployable technologies. Any major infrastructure replacement as part of ongoing system maintenance could result in impacts similar to the abovementioned deployment impacts. The wetlands impacts would depend on the watershed, duration (chronic or short-term) and frequency (many years or a few months) the resource would be used, and the wetland's quality and function.

It is anticipated that there would be less than significant impacts to wetlands associated with routine inspections of the Deployable Technologies Alternative as it is likely existing roads and utility rights-of-way would be utilized for maintenance and inspection activities. Site maintenance, including mowing or herbicides, is anticipated to result in less than significant effects to wetlands due to the limited nature of site maintenance activities, including mowing and application of herbicides.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to wetlands from construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.5, Wetlands.

8.2.6. Biological Resources

8.2.6.1. Introduction

This section describes potential impacts to terrestrial vegetation, wildlife, fisheries and aquatic habitat, and threatened and endangered species in Massachusetts 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 partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

8.2.6.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on terrestrial vegetation, wildlife, fisheries, and aquatic habitats were evaluated using the significance criteria presented in Table 8.2.6-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to terrestrial vegetation, wildlife, and fisheries and aquatic habitat addressed in Sections 8.2.6.3, 8.2.6.4, and 8.6.2.5, respectively, are presented as a range of possible impacts.

Refer to Section 8.2.6.6 for impact assessment methodology and significance criterial associated with threatened and endangered species in Massachusetts.

Table 8.2.6-1: Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, Fisheries, and Aquatic Habitats

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 Massachusetts 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
	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,	Magnitude or Intensity	Population-level or sub-population effects observed for at least one species or vegetation cover type,	Effect that is potentially significant, but	Habitat alteration in locations not designated as vital or critical for any period. Temporary losses to	Sufficient habitat would remain functional to

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	Less than Significant with BMPs and Mitigation Measures Incorporated	Less than Significant	No Impact
Alteration, or Fragmentation		depending on the distribution and the management of the subject species. Impacts to terrestrial, aquatic, or riparian habitat or other sensitive natural community vital for feeding, spawning/breeding, foraging, migratory rest stops, refugia, or cover from weather or predators. Violation of various regulations including MMPA, MSFCMA, MBTA, and BGEPA.	with mitigation is less than significant.	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.	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 Massachusetts for at least one species. Anthropogenic disturbances that lead to the loss or alteration of nutritional or habitat resources for endemics or a significant portion of the population or sub-population located in a small area during a specific season.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated or short-term effects that are reversed within one to three years.	NA
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, including those from RF emissions, that lead to mortality, disorientation, the avoidance or exclusion from	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, including exposure to	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
		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.		RF emissions, are measurable but minimal as determined by individual behavior and propagation, and the potential for habituation or adaptability is high given time.	
	Geographic Extent	Regional or site specific effects observed within Massachusetts 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 Massachusetts 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 Massachusetts for at least one species. Anthropogenic disturbances that lead to exclusion from prey or habitat resources required for breeding/spawning, or anthropogenic disturbances, including exposure to RF emissions, 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.
	Geographic Extent	Regional impacts observed throughout Massachusetts.		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

8.2.6.3. Terrestrial Vegetation

Impacts to terrestrial vegetation occurring in Massachusetts 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 8.2.6-1, 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, some limited amount of infrastructure may be built in sensitive or rare regional vegetative communities, in which case BMPs and mitigation measures would be recommended to minimize or avoid potential impacts.

Indirect Injury/Mortality

"Indirect effects" are effects that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (40 CFR 1508.8[b]). Indirect injury/mortality 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, although this is unlikely to occur due to the small size of expected FirstNet activities. Increasing or decreasing hydrology in an area as an indirect effect 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 terrestrial vegetation (e.g., forest migration) are expected as a result of the Proposed Action given the small-scale of deployment activities.

Reproductive Effects

No reproductive effects to terrestrial vegetation are expected as a result of the Proposed Action given the small-scale of deployment activities.

Invasive Species Effects

When human activity results in a species entering an ecosystem new to it, the species is classified as introduced or, depending on its ability to spread rapidly and outcompete native species, invasive. The introduction of invasive species 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. MIPAG recognized over 65 species of plants as invasive; these species are regulated on a state noxious weed list (EEA, 2015h). 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. BMPs and mitigation measures would help to minimize or avoid the potential for introducing invasive plant species during implementation of the Proposed Action.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to terrestrial

vegetation resources and others would not. In addition, and as explained in this section, the same type of Proposed Action infrastructure could result in a range impacts, from no impacts to less than significant impacts, depending on the deployment scenario or site-specific conditions. The terrestrial vegetation that would be affected would depend on the ecoregion, the species' phenology,[154] and the nature as well as the extent of the habitats affected.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have no impacts to terrestrial vegetation under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Although terrestrial vegetation could be impacted, it is anticipated that effects to vegetation would be minimal since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts to terrestrial vegetation because there would be no ground disturbance.
- Satellites and Other Technologies
    - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures, attaching equipment to satellite launches for other purposes, and the use of portable devices that use satellite technology would not impact terrestrial vegetation because those activities would not require ground disturbance.
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact biological resources, it is anticipated that this activity would have no impact on terrestrial vegetation.

Activities with the Potential to Have Impacts

Potential construction/deployment-related impacts to terrestrial vegetation as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; indirect injury/mortality; and invasive species effects. The types of deployment activities that

[154] Phenology is the seasonal changes in plant and animal lifecycles, such as emergence of insects or migration of birds.

could be part of the Preferred Alternative and result in potential impacts to terrestrial vegetation include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to terrestrial vegetation. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects if BMPs and mitigation measures are not implemented.
  - 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 terrestrial vegetation. Impacts may vary depending on the number or individual poles installed, but could include direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects if BMPs and mitigation measures are not implemented.
  - Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water would not impact terrestrial vegetation. However, impacts to terrestrial vegetation could potentially occur as a result of the construction of landings and/or facilities on shore to accept submarine cables could potentially occur as a result of land clearing, excavation activities, and heavy equipment use. Effects could include direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects if BMPs and mitigation measures are not implemented.
  - 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.
- 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 terrestrial vegetation. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance

activities during the installation of new wireless towers and associated structures or access roads could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to terrestrial vegetation. However, if new power units, replacement towers, structural hardening, and physical security measures require land clearing or excavation activities, impacts would be similar to new wireless construction.
- Deployable Technologies: Implementation of deployable technologies including COWs, COLTs, or SOWs could result in direct impacts to terrestrial vegetation if deployment occurs on vegetated areas, or the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects.

  Deployment of drones, balloons, blimps or piloted aircraft could potentially impact terrestrial vegetation if launching or recovery occurs on vegetated areas. Impacts would be similar to deployment of COWs, COLTs, and SOWs.

In general the abovementioned activities could potentially involve land/vegetation clearing; topsoil removal; excavation and trenching; construction of access roads; installation or restructuring of towers, poles, or cables; heavy equipment movement; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to terrestrial vegetation associated with deployment of this infrastructure, depending on their scale, could include direct or indirect injury/mortality to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species depending on the ecoregion, the species' phenology, and the nature and extent of the vegetation affected. These potential impacts are expected to be less than significant 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 terrestrial vegetation that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

It is anticipated that there would no impacts to terrestrial vegetation associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for

deployment are also used for inspections. 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 terrestrial 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 partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Alternatives Impact Assessment

The following section assesses potential impacts to terrestrial vegetation associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to terrestrial vegetation as a result of implementation of this alternative could be as described below.

Deployment Impacts

As described above, implementation of deployable technologies could result in less than significant impacts from land/vegetation clearing, excavation, and paving activities. These activities could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects. Greater frequency and duration of deployments could change the magnitude of impacts. However, impacts are expected to remain less than significant 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 to terrestrial 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. As a result, there would be no impacts to terrestrial vegetation as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.6.3, Terrestrial Vegetation.

8.2.6.4. Wildlife

Impacts to amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates occurring in Massachusetts and the 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 8.2.6-1, less than significant impacts would be anticipated given the anticipated small size and nature of the majority of the proposed deployment activities. Although anthropogenic disturbances may be measurable (although minimal) for some FirstNet projects, impacts to individual behavior of animals would be short-term and direct injury or mortality impacts at the population-level or sub-population effects would not likely be observed.

Terrestrial Mammals

Vehicle strikes are common sources of direct mortality or injury to both small and large mammals in Massachusetts. 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, 2015d). 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 scale of this impact would be expected to be small-scale and would be dependent on the location and type of deployment activity, and the amount of tree removal. Site avoidance measures could be implemented to avoid disturbance to bats.

Marine Mammals

Marine mammals swimming or hauled out on land are sensitive to boats, aircraft, and human presence. Noises, 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 likely 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 manmade object discarded, disposed of, or abandoned that enters the marine environment. Entanglements from marine debris are not anticipated from FirstNet activities.

Many of the whale species known to occur offshore of Massachusetts are also protected under the ESA. Environmental consequences pertaining to these whales are discussed in Section 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Birds

Mortalities from collisions or electrocutions with manmade cables and wires are environmental concerns for avian species and violate MBTA and BGEPA. Generally, collision events occur to "poor" fliers (e.g., ducks), night-migrating birds, heavy birds (e.g., swans and cranes), and birds that fly in flocks; while species susceptible to electrocution are birds of prey, ravens, and thermal soarers, typically having large wing spans (Gehring, 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. Removal of trees during land clearing activities could also result in direct injury/mortality to forest dwelling birds if they are utilizing them as roost trees for resting or shelter from predators and inclement weather, or as nest trees for rearing young. The scale of this impact would be associated with the amount of tree removal and the abundance of forest-dwelling birds roosting/nesting in the area. These impacts could be particularly pronounced in Important Bird Areas (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.

Direct mortality and injury to birds of Massachusetts are not likely to be widespread or affect populations of species as a whole; individual species impacts may be realized depending on the nature of the deployment activity. If siting considerations and BMPs and mitigation measures are implemented (see Chapter 17), potential impacts could be minimized. Additionally, potential impacts under MBTA and BGEPA can be addressed through BMPs and mitigation measures developed in consultation with USFWS.

Reptiles and Amphibians

The majority of Massachusetts's amphibian and reptile species are widely distributed throughout Massachusetts. 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.

Four species of marine turtles – all listed as threatened or endangered under the ESA – occur in Massachusetts's offshore environment. Environmental consequences pertaining to these reptiles are discussed in Section 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Terrestrial Invertebrates

The terrestrial invertebrate populations of Massachusetts 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 Massachusetts that have experienced extensive land use changes from urbanization and agriculture. However, there are portions of the state that 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 Massachusetts's wildlife species below.

Terrestrial Mammals

Mammals occupy a wide range of habitats throughout Massachusetts 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 could be avoided or minimized by BMPs and mitigation measures.

Marine Mammals

A number of seal species may occur in the offshore areas of Massachusetts. 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 Massachusetts (NOAA, 2015h). Seals could be temporarily excluded from a resource or abandon their haulout locations due to the presence of humans, noise, 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.

Further, whales may be temporarily excluded from a resource if they avoid it due to the increased presence of boats, humans, and associated noise. Depending on the duration of response activities, minke whales could be excluded from their environment temporarily or could abandon the habitat entirely.

The degree to which habitat exclusion affects minke whales depends on many factors. Minke whales are mobile and are found in open water habitat in both coastal inshore and offshore oceanic environments; therefore, it is expected that activities would have only a minor and temporary effect on the ability of minke whales to access important resources. Loss of habitat or exclusions from these areas could be avoided or minimized by BMPs and mitigation measures, as appropriate.

Loss of habitat or exclusions from these areas for seals and whales could be avoided or minimized by BMPs and mitigation measures (see Chapter 17). Environmental consequences pertaining to the endangered whales protected under the ESA are discussed in Section 8.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Birds

The direct removal of most bird nests is prohibited under the MBTA. The USFWS and MassDEP 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 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 if birds temporarily avoid IBAs within the state as these areas provide them with essential habitat that supports various life stages (Hill, 1997).

The degree to which habitat exclusion affects birds depends on many factors. The impact to passerine[155] 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 stopovers (e.g., shorebirds). BMPs and mitigation measures, including nest avoidance during construction-related activities, would help to avoid or minimize the potential impacts to birds from exclusion of resources, as appropriate.

Reptiles and Amphibians

Important habitats for Massachusetts's amphibians and reptiles typically consist of wetlands and, in some cases the surrounding upland forest. Impacts are expected to be less than significant. If proposed project sites were unable to avoid sensitive areas, BMPs and mitigation measures (see Chapter 17) would be implemented to avoid or minimize the potential impacts.

Filling or draining of wetland breeding habitat (see Section 8.2.4, Water Resources) and alterations to ground or surface water flow from development associated with the Proposed Action may also have effects to Massachusetts's amphibian and reptile populations, though BMPs and mitigation measures would help to avoid or minimize the potential impacts.[156]

Terrestrial Invertebrates

Habitat loss and degradation are the most common causes of invertebrate species' declines; however, habitat for many common terrestrial invertebrates is generally assumed to be abundant and widely distributed across the state, therefore no significant effects to terrestrial invertebrates are expected. Impacts to sensitive invertebrate species are discussed below in Section 8.2.6.6, 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, though BMPs and mitigation measures could help to avoid or minimize the 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 effects could occur result to roosting bats from noise, light, or human disturbance causing them to leave their roosting locations or excluding them from their summer roosting/maternity colony roosts. For example, some bat species establish summer roosting or maternity colonies in the same general area that they return to year and after year. The majority of FirstNet deployment activities would be short-term in nature, therefore, repeated disturbances would not occur.

[155] 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.
[156] See Section 8.2.5, Wetlands, for a discussion of BMPs for wetlands.

Depending on the project type and location, individual species may be disturbed resulting in less than significant 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; therefore, repeated disturbances would not occur. Depending on the project type and location, individual species may be disturbed resulting in less than significant impacts.

Reptiles and Amphibians

Changes in water quality 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; therefore, repeated disturbances would not occur. Depending on the project type and location, individual species may be disturbed resulting in less than significant impacts.

Terrestrial Invertebrates

Terrestrial 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.

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. Potential effects to migration patterns of Massachusetts's amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates are described below.

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.[157] Any clearance, drilling, and construction activities needed

[157] A location chosen by an animal for hibernation.

for network deployment, including noise 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, but are generally expected to be less than significant. BMPs and mitigation measures could help to further avoid or minimize the potential impacts.

Marine Mammals

Noise associated with the installation of cables in the near/offshore waters of coastal Massachusetts could impact marine mammal migration patterns, though impacts are likely to be short-term provided the noise sources are not wide ranging and below Level A and B sound exposure thresholds.[158] 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. BMPs and mitigation measures could help to further avoid or minimize the potential impacts.

Birds

Because many birds have extremely long migrations, protection efforts for critical sites along migratory routes must be coordinated over vast distances often involving many different countries. For example, as a group, shorebirds migrating through Massachusetts undertake some of the longest-distance migrations of all animals. Massachusetts is located within the Atlantic Flyway, which spans more than 3,000 miles from the Arctic tundra to the Caribbean. Massachusetts has 85 IBAs spread throughout the state that serve as important stopover areas for migratory birds (National Audubon Society, 2016). 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, and impacts are expected to be less than significant. BMPs and mitigation measures could help to further avoid or minimize effects to migratory pathways.

Reptiles and Amphibians

Several species of mole salamanders and the wood frog are known to seasonally migrate in Massachusetts. 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. Wood frogs use diverse vegetation types from grassy meadows to open forests. After they emerge from dormancy, wood frogs migrate up 900 feet to breeding pools, where they breed rapidly in early spring in permanent or ephemeral water (Homan, Atwood, Dunkle, & Carr, 2010). However, Berven and Grudzien found that a small percentage of juvenile wood frogs can migrate over 1.5 miles from natal ponds, suggesting juveniles may be capable of migrating

[158] 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, 2007)

relatively long distances (Berven & Grudzien, 1990). 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. BMPs and mitigation measures could help to further avoid or minimize the potential impacts.

Terrestrial Invertebrates

The proposed deployment activities would be expected to be short-term or temporary in nature. No effects to migratory patterns of Massachusetts's terrestrial invertebrates are expected as a result of the Proposed Action.

Reproductive Effects

Reproductive effects are considered those that either directly or indirectly reduce an animal's ability to produce offspring or reduce the rates of growth, maturation, and survival of offspring, which can affect the overall population of individuals.

Terrestrial Mammals

Restricted access to important winter hibernacula or summer maternity roosts for bats and calving grounds for large mammals, such as the moose, has the potential to negatively affect body condition and reproductive success of mammals in Massachusetts.

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. 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 Massachusetts. For example, the displacement of female seals from preferred pupping habitats due to deployment and operations 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 could 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 and noise) may displace birds into less suitable habitat and thus reduce survival and reproduction. These impacts could be particularly pronounced in IBAs within the state if birds temporarily avoid those areas, since they provide

essential habitat for various life stages (Hill, 1997). 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, 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.

Terrestrial Invertebrates

The majority of FirstNet deployment or operation activities are likely to be short-term in nature; no reproductive effects to terrestrial invertebrates are expected as a result of the Proposed Action.

Invasive Species Effects

When human activity results in a species entering an ecosystem new to it, the species is classified as introduced or invasive. The introduction of invasive species can have a dramatic effect on natural resources.

FirstNet deployment or operation activities could result in short-term or temporary changes to specific project sites, although these sites are expected to return to their natural state in a year or two. Invasive species are not expected to be introduced to project sites as part of the deployment activities from machinery or construction workers.

Potential invasive species effects to Massachusetts's wildlife are described below.

Terrestrial Mammals

In Massachusetts, Eurasian boars (*Sus scrofa*) adversely impact several native large and small mammals, including bear (*Ursus americanus*), turkey (*Meleagris gallopavo*), waterfowl and deer.

FirstNet deployment activities are not expected to introduce terrestrial mammal species to project sites as these activities are temporary and would not provide a mechanism for transport of invasive terrestrial mammals to project sites from other locations. Invasive species effects to terrestrial mammals could be minimized by following BMPs in Chapter 17 to reduce the introduction potential from heavy equipment or laborers.

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 marine mammal species would not occur.

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 Massachusetts, 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, Clarke, Holevinski, & Cooper, 2013). FirstNet deployment activities could result in short-term or temporary changes to specific project sites, although these sites are expected to return to their natural state in a year or two. Invasive bird species are not expected to be introduced at project sites as part of the deployment activities.

Reptiles and Amphibians

No invasive reptiles or amphibians are regulated in Massachusetts; 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 terrestrial reptile or amphibian species are not expected to be introduced at project sites from machinery or laborers.

Terrestrial Invertebrates

Terrestrial invertebrate populations are susceptible to invasive plant species that may change or alter the community composition of specific plants on which they depend. Effects from invasive plant species to terrestrial invertebrates would be similar to those described for habitat loss and degradation.

Invasive insects pose a large threat to forest and agricultural resources. Species such as the gypsy moth (*Lymantria dispar*), hemlock woolly adelgid (*Adelges tsugae*), Asian longhorn beetle (*Anoplophora glabripennis*), and emerald ash borer (*Agrilus planipennis*) are of particular concern in Massachusetts and are known to cause irreversible damage to native forests. Emerald ash borer and Asian longhorn beetle are regulated in Massachusetts. 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. BMPs and mitigation

measures would help to avoid or minimize the potential for introducing invasive plant species during implementation of the Proposed Action. Invasive species effects related to terrestrial invertebrates could be minimized with the implementation of BMPs and mitigation measures.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to wildlife resources and others would not. In addition, and as described in this section, infrastructure developed under the Preferred Alternative could result in a range of impacts, from no impacts to less than significant impacts, depending on the deployment scenario or site-specific conditions. The wildlife that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have no impacts to wildlife resources under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Noise generated by equipment required to install fiber would be infrequent and of short duration, and unlikely to produce measurable changes in wildlife behavior. It is anticipated that effects to wildlife would be temporary and would not result in any perceptible change.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts 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, attaching equipment to satellites launched for other purposes, and the use of portable devices that use satellite technology would not impact wildlife because those activities would not require ground disturbance.
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are

already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact wildlife resources, it is anticipated that this activity would have no impact on wildlife resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to wildlife resources as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; reproductive effects; and invasive species effects. The types of infrastructure deployment scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to wildlife resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to wildlife resources. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct injury/mortalities of wildlife that are not mobile enough to avoid construction activities (e.g. reptiles, small mammals, and young individuals), that utilize burrows (e.g., ground squirrels), or that are defending nest sites (such as ground-nesting birds). Disturbance, including noise, associated with the above activities involving heavy equipment or land clearing could result in habitat loss, effects to migration patterns, indirect injury/mortality, reproductive effects, and invasive species effects if BMPs and mitigation measures are not implemented.
  - New Build – Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components on public ROWs or private easements as well as the construction of access roads, POPs, huts, or facilitates to house outside plant equipment could result in potential impacts to wildlife resources. Impacts may vary depending on the number or individual poles installed and the extent of ground disturbance, but could include direct injury/mortality of individual species as described above; habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; and invasive species effects.
  - Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct injury/mortality, habitat loss or alteration, effects to migratory patterns, indirect injury/mortality, and invasive species effects. Noise disturbance from heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in migratory effects and indirect injury/mortality.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in 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, marine mammals in particular (see Section 8.2.4, 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 deployable technologies including COWs, COLTs, and SOWs could result in direct injury/mortalities to wildlife on roadways. If external generators are used, noise disturbance could potentially impact migratory patterns of wildlife. RF hazards could result in indirect injury or mortality as well as reproductive effects depending on duration and magnitude of operations. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.

    Deployment of drones, balloons, blimps, and piloted aircraft could potentially impact wildlife by direct or indirect injury/mortality from collision, entanglement, or ingestion and effects to migratory patterns and reproductive effects from disturbance and/or displacement due to noise. The magnitude of these effects depends on the timing and frequency of deployments. However, deployment activities are expected to be temporary and isolated, and likely affecting only a small number of wildlife.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers or poles; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to wildlife resources associated with deployment of this infrastructure are anticipated to be less than significant given the small-scale of likely individual FirstNet projects; however, some deployment activities could include direct injury/mortality, habitat loss, indirect injury/mortality, effects to migration, reproductive effects, and effects of invasive species depending on the project type, location, ecoregion, the species' phenology, and the nature and extent of the habitats affected. As stated above, these impacts would likely be limited to individual wildlife species and unlikely to cause population-level impacts. The specific deployment activity and where the deployment will take place will be determined based on location-specific conditions and the results of site-specific environmental reviews. 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.

It is anticipated that there would be less than significant impacts to wildlife resources associated with routine inspections of the Preferred Alternative. Site maintenance would be infrequent, including mowing or limited application of herbicides, may result in less than significant effects to wildlife 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.

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 than 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.

Alternatives Impact Assessment

The following section assesses potential impacts to wildlife resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to wildlife resources as a result of implementation of this alternative could be as described below.

Deployment Impacts

As described above, implementation of deployable technologies could result in less than significant impacts from direct and indirect injury or mortality events, changes in migratory patterns, disturbance, or displacement. Greater frequency and duration of deployments could change the magnitude of impacts depending on species, life history, and region of the state. However, impacts are expected to remain less than significant 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. 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 partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the nationwide, interoperable, public safety broadband network would not be deployed; therefore, there would be no associated construction or installation of

wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to wildlife resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.6.4, Terrestrial Wildlife.

8.2.6.5. Fisheries and Aquatic Habitats

Impacts to fisheries and aquatic habitats occurring in Massachusetts and Massachusetts'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 8.2.6-1, 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 (although 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 the 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 impacts under the MSFCMA or other sensitive aquatic habitats could be addressed through BMPs and mitigation measures.

Indirect Injury/Mortality

Water quality 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. These impacts are expected to be less than significant, and BMPs and mitigation measures to protect water resources (see Section 8.2.4, 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, 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 further 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, though BMPs and mitigation measures could help to further avoid or minimize the potential impacts.

Invasive Species Effects

The potential to introduce invasive plants within construction zones can occur from vehicles and equipment being transported from one region to another, or when conducting revegetation of a site after deployment activities are complete. FirstNet deployment activities could result in short-term or temporary changes to specific project sites and these sites are expected to return to their natural state in a year or two. Invasive species are not expected to be introduced to project sites as part of the deployment activities from machinery or construction workers, therefore impacts are expected to be less than significant. BMPs and mitigation measures could help to avoid or minimize the potential for introducing invasive aquatic plant and animal species during implementation of the Proposed Action.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to fisheries and aquatic habitats and others would not. In addition, and as explained in this section, the same type of Proposed Action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions. The fisheries and aquatic habitats that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have no impacts to fisheries and aquatic habitats under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance, including noise, associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that effects to 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 ground disturbance.
- Satellites and Other Technologies
    - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact fisheries and aquatic habitats because those activities would not require ground disturbance.
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact fisheries, it is anticipated that this activity would have no impact on the aquatic environment.

Activities with the Potential to Have Impacts

Potential construction/deployment-related impacts to fisheries and aquatic habitats as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; reproductive effects; and invasive species

effects. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to fisheries and aquatic habitats include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to fisheries and aquatic habitats. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities, particularly if they occur adjacent to water resources that support fish, could result in habitat loss, alteration and fragmentation; indirect injury/mortality; and invasive species effects if BMPs and mitigation measures are not implemented.
  - 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, if conducted near water resources that support fish, could result in habitat loss, alteration and fragmentation; indirect injury/mortality; and invasive species effects.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water and construction of landings and/or facilities on the shore to accept submarine cables could result in direct injury/mortalities of fisheries and aquatic invertebrates that are not mobile enough to avoid construction activities (e.g. mussels), that utilize burrows (e.g., crayfish), or that are defending nest sites (some fish). Disturbance, including noise, associated with the above activities could result in habitat loss, effects to migration patterns, indirect injury/mortality, reproductive effects, and invasive species effects.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required construction of access roads, trenching, and/or land clearing, particularly near water resources that support fish, such disturbance could result in habitat loss, alteration and fragmentation; indirect injury/mortality, and invasive species effects.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to fisheries and aquatic habitats, if such actions were deployed near water

resources. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads, particularly if they occur near waterbodies, could result in habitat loss or indirect injury/mortality, , although highly unlikely unless towers and structure were constructed adjacent to or within a waterbody.

- 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. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.
- Deployable Technologies: Implementation of deployable technologies including COWs, COLTs, or SOWs could result in habitat loss, alteration and fragmentation; indirect injury/mortality, and invasive species effects if new access roads or other ground disturbing activities are necessary that generate erosion, sedimentation, or water quality impacts. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.

  Deployment of drones, balloons, blimps, or piloted aircraft could potentially impact fisheries and aquatic habitat if deployment occurs within or adjacent to water resources. The magnitude of these effects depends on the timing and frequency of deployments and could result in result in habitat loss, alteration and fragmentation, indirect injury/mortality, and invasive species effects.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers, poles, or underwater cables; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to fisheries and aquatic habitats associated with deployment of this infrastructure could include direct injury/mortality, habitat loss, indirect injury/mortality, effects to migration, reproductive effects, and effects of invasive species depending on the ecoregion, the species' phenology, and the nature and extent of the habitats affected. These impacts are anticipated to be less than significant 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 8.1.2, *Proposed Action Infrastructure*, operational activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. The fisheries and aquatic

habitats that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

It is anticipated that there would be less than significant impacts to fisheries and aquatic habitats associated with routine inspections of the Preferred Alternative. Site maintenance, if conducted near water resources that support fish, including application of herbicides, may result in less than significant effects to fisheries and aquatic habitats 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 habitat may also be impacted if increased access leads to an increase in the legal or illegal take of biota. However, impacts are expected to be less than significant 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 minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to fisheries and aquatic habitats as a result of implementation of this alternative could be as described below.

<u>Deployment Impacts</u>

As explained above, implementation of deployable technologies could result in less than significant impacts from habitat loss, alteration and fragmentation, indirect injury/mortality, and invasive species effects. Greater frequency and duration of deployments could change the

magnitude of impacts depending on species, life history, and region of the state. However, impacts are expected to remain less than significant. 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

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 to fisheries and aquatic habitats associated with routine operations, management, and monitoring. 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. As a result, there would be no impacts to fisheries and aquatic habitats as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.6.5, Fisheries and Aquatic Habitats.

8.2.6.6. Threatened and Endangered Species and Species of Conservation Concern

This section describes potential impacts to threatened and endangered species in Massachusetts and Massachusetts's 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. 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.

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 8.2.6-2. The categories of impacts for threatened and endangered species and their habitats are defined as may affect, likely to adversely affect; may affect, not likely to adversely affect; and no effect. Characteristics of each effect type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes across the state, the potential impacts to threatened and endangered species addressed below are presented as a range of possible impacts.

Table 8.2.6-2: Impact Significance Rating Criteria for Threatened and Endangered Species

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.	

Type of Effect	Effect Characteristic	Impact Level		
		May Affect, Likely to Adversely Affect	**May Affect, Not Likely to Adversely Affect**	**No Effect**
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.
	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 8.2.6-2, 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, birds, reptiles, invertebrates, and plants with known occurrence in Massachusetts are described below. There are no listed marine mammals, amphibians, or fish in Massachusetts, therefore they will not be discussed in this section.

Terrestrial Mammals

The northern long-eared bat (*Myotis septentrionalis*) is found in Massachusetts. Direct mortality or injury to the bat species could occur from collisions or electrocutions with manmade cables and wires, vehicle strikes, or when nests are either disturbed or destroyed. Impacts would likely be isolated, individual events. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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.

Birds

Three federally listed birds are known to occur within coastal areas of Massachusetts. 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. If proposed project sites are unable to avoid sensitive areas, BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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.

Reptiles and Amphibians

No federally listed amphibians would be affected by the Proposed Action in Massachusetts.

The federally listed threatened bog turtle (*Clemmys muhlenbergii*) and Plymouth redbelly turtle (*Pseudemys rubriventris bangsi*) occur within wetland and floodplain areas. Direct mortality to reptiles could occur in construction zones either by excavation activities or by vehicle strikes.

Impacts would likely be isolated, individual events. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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.

Three federally listed sea turtles are also known to occur in the coastal area and offshore environment of Massachusetts. None of these turtles nest in the Massachusetts area. Direct mortality or injury from watercraft and vessels strikes 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. 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.

Invertebrates

One federally listed mollusk and three federally listed terrestrial invertebrates occur in Massachusetts. 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. Distribution of these species is limited to in or near the Connecticut River and coastal regions. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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.

Plants

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. 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.

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 Massachusetts are described below.

Terrestrial Mammals

Noise, light, and other human disturbances associated with the Proposed Action could adversely affect federally listed Northern long-eared bat 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. 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.

Birds

The piping plover, red knot, and roseate tern are known to nest in Massachusetts on sandy beaches or marshes (USFWS 2005). The majority of FirstNet deployment activities would not occur on beaches or saltmarshes; therefore, impacts to these bird species are not anticipated. Noise, light, or human disturbance within the vicinity of 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. 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.

Reptiles and Amphibians

Changes in water quality, especially during the breeding seasons, can cause stress resulting in lower productivity. Land clearing activities, noise, and human disturbance during the critical time periods (e.g., mating, nesting) could lower fitness and productivity of the two federally listed turtles that occur within wetland and floodplain areas. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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.

The three federally listed sea turtles found in the offshore areas of Massachusetts are migrants. Consequently, no long-term reproductive effects to federally listed sea turtles are expected as a result of the Proposed Action.

Invertebrates

Changes in water quality from ground disturbing activities could cause stress resulting in lower productivity for the federally listed mollusk known to occur in Massachusetts. In addition, introduction of invasive aquatic species can indirectly affect the dwarf wedgemussel as result of fish populations that they rely on for their reproductive cycle being altered (USFWS, 2016g). Impacts associated with deployment activities are expected to result in less than significant changes to water quality.

Habitat loss and degradation, primarily from coastal and shoreline development could impact the Northeastern Beach Tiger Beetle and Puritan Tiger beetle. Impacts associated with habitat loss and degradation are expected to be less than significant because the majority of FirstNet activities are not expected to take place in shoreline habitats suitable for listed species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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.

Plants

No reproductive effects to federally listed plants are expected as a result of the Proposed Action as limited pesticides would be used and avoidance measures could be undertaken.

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, invertebrates, and plants with known occurrence in Massachusetts 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 or light, bats awaken resulting in a loss of body fat needed to help them survive in the spring (USFWS, 2015r). 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. 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.

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. Disturbance in stopover, foraging, or breeding areas (visual or noise) or habitat loss/fragmentation can cause stress to individuals causing them to abandon areas for less desirable habitat and potentially reduce over fitness and productivity. Activities related to the Proposed Action, such as aerial deployment or construction activities, could result adverse effects to federally listed birds. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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.

Reptiles and Amphibians

Habitat loss or alteration, particularly from fragmentation or invasive species, could adversely affect nesting and foraging sites of the bog turtle and the Plymouth redbelly turtle, resulting in reduced survival and productivity. Disturbances during deployment activities are not anticipated to stress federally listed reptiles. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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.

Invertebrates

Changes in water quality, 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. 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.

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, birds, reptiles, invertebrates, and plants with designated critical habitat in Massachusetts.

Terrestrial Mammals

No designated critical habitat occurs for mammals in Massachusetts. 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 piping plover, red knot, or roseate tern populations that are known to occur in Massachusetts; 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

Critical habitat for the Plymouth redbelly turtle in Massachusetts is comprised of approximately 3,269 acres south of Plymouth, Massachusetts in Plymouth County (USFWS, 1994a). Land clearing, excavation activities, and other ground disturbing activities in this region of Massachusetts could lead to habitat loss or degradation, which could lead to adverse effects to the Plymouth redbelly turtle depending on the duration, location, and spatial scale of the associated activities. Disturbance to ponds or other aquatic resources in this region could similarly lead to habitat loss or degradation. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented to minimize potential impacts.

No designated critical habitat occurs for marine reptiles in Massachusetts's offshore environment. 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.

Invertebrates

No designated critical habitat occurs for terrestrial or aquatic invertebrates in Massachusetts. 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.

Plants

No designated critical habitat occurs for plants in Massachusetts. 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 construction/deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to 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 Effect

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have no effect to threatened and endangered species or their habitat under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance, including noise, associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. 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.
    - 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.
- 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 on protected species.

Activities with the Potential to Affect Listed Species

Potential deployment-related effects to threatened and endangered species and their habitats as a result of implementation of the Preferred Alternative would encompass a range of 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), or that are defending nest sites (e.g., ground-nesting birds). Disturbance, including noise, associated with the above activities could result in direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat if BMPs and mitigation measures are not implemented.

- 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 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 8.2.4, 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; FirstNet activities would be infrequent, temporary, or short-term in nature and are unlikely to result in direct injury/mortality or behavioral changes to threatened and endangered species. However, if replacement towers or structural hardening are required, impacts could be similar to new wireless construction. Hazards related security/safety lighting and fencing may produce direct injury/mortality, reproductive effects, and behavioral changes. For a discussion of 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 disturbance could potentially result in reproductive effects or behavioral changes to threatened and endangered species. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.

      Deployment of drones, balloons, piloted aircraft, or blimps could potentially impact threatened and endangered species by direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat. The magnitude of these effects depends on the timing and frequency of deployments.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers, poles, or underwater cables; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to threatened and endangered species associated with deployment of this infrastructure could include direct injury/mortality, reproductive effects, 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 adversely affect protected species; BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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, operational activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. The threatened and endangered species that would be affected would depend on the species' phenology and the nature and extent of the habitats affected.

It is anticipated that operational impacts may affect, but are not likely to adversely affect threatened and endangered species due to routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Site maintenance, including mowing or application of herbicides, may affect, but are not likely to adversely affect threatened and endangered species, as they would be conducted infrequently and 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. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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.

Threatened and endangered species may be affected, but are not likely to be adversely affected by the reduction in habitat quality associated with habitat fragmentation from the presence of access roads, transmission corridors, and support facilities. These features could also continue to disrupt movements of some species, particularly during migrations between winter and summer ranges. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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.

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 minimal new

construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to threatened and endangered species as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant adverse effects to threatened and endangered species from 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. However, impacts are expected to remain less than significant given the relatively small scale and temporary nature of expected activities. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. 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.

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 there would be less than significant impacts to 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. 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 nationwide, interoperable, public safety broadband network would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no effects to threatened and endangered species as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

8.2.7. Land Use, Recreation, and Airspace

8.2.7.1. Introduction

This section describes potential impacts to land use, recreation, and airspace resources in Massachusetts 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.

8.2.7.2. 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 8.2.7-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to land use, recreation, and airspace resources addressed in this section are presented as a range of possible impacts.

Table 8.2.7-1: Impact Significance Rating Criteria for Land Use, Recreation, and Airspace

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with 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, 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

8.2.7.3. 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 8.2.7-1, less than significant impacts would be anticipated given the size and nature of the majority of the proposed deployment activities. Direct land use changes would be minimized and isolated at specific locations and all required permits would be obtained; only short-term impacts during the construction phase would be expected.

Indirect Land Use Change

Changes in surrounding land use patterns and options for surrounding land uses could be influenced by the deployment, operation, and maintenance of facilities and the acquisition of rights-of-way or easement. The deployment, operation, and maintenance of structures, towers, roads, and other permanent features could conflict with surrounding land use patterns and options for surrounding land uses. The installation of poles, towers, structures, or other 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 ROWs or easements and the construction of roads to access facilities and locations could influence changes in surrounding land uses. The effects from these actions would depend on the geographic location; compatibility with surrounding land uses; and characteristics of the ROW, easement, or access road. These characteristics, such as the length, width, and location could conflict with surrounding land use patterns or restrict options for surrounding land uses.

Based on the impact significance criteria presented in Table 8.2.7-1, less than significant impacts would be anticipated 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 8.2.7-1, less than significant impacts would be anticipated as restricted access or a loss of access to recreation areas would not occur; only short-term impacts or small-scale limitations during the construction phase would be expected. If new construction were necessary for towers, structures, or facilities, FirstNet would apply BMPs and mitigation measures, as feasible and practicable, to avoid areas that would permanently limit or restrict access to recreational land or activities. If deployment were necessary in these areas, FirstNet would apply BMPs or mitigation measures, as appropriate or feasible, to avoid or minimize actions that would limit or restrict access to recreational land or activities.

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 impacts, and the presence of deployment or maintenance crews.

Based on the impact significance criteria presented in Table 8.2.7-1, less than significant impacts would be anticipated as only small reductions, if any, in recreational visits or durations would occur due to the relatively small-scale nature of likely FirstNet activities. Only short-term impacts during the construction phase would be expected.

Use of Airspace

Primary concerns to airspace include the following: if aspects of the Proposed Action would result in violation of FAA regulations; undermine the safety of civilian, military, or commercial aviation; or infringe on flight activity and flight corridors. 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 8.2.7-1, 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 not impact airspace resources.

It is unlikely that we would do any of this. If a drone or balloon was deployed it would be for a limited time and likely only in an emergency.

8.2.7.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure, and the specific deployment requirements, some activities would result in potential impacts to land use, recreation, and airspace resources and others would not. In addition, and as explained in this section, the same type of Proposed Action infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to land use, recreation, and airspace resources under the conditions described below:

- Wired Projects
    - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring alongside the road in utility corridors or within public road rights-of-way.
        - Land Use: See *Activities Likely to Have Impacts* below.
        - Recreation: See *Activities Likely to Have Impacts* below.
        - Airspace: No impacts to airspace would be anticipated since the activities would not affect flight patterns or cause obstructions that would require FAA and/or state review based on Federal Acquisition Regulation (FAR) 14 CFR, Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace* (See Section 8.10.5.3 Obstructions to Airspace Considerations).
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas.

- Land Use: It is anticipated that there would be no impacts to land use since the activities that would be conducted would not directly or indirectly result in changes to existing and surrounding land uses.
- Recreation: See Activities Likely to Have Impacts below.
- Airspace: It is anticipated that there would be no impacts to airspace since the activities would not affect flight patterns or cause obstructions that would require FAA and/or state review based on FAR 14 CFR, Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace* (See Section 8.10.5.3 Obstructions to Airspace Considerations).

- New Build – Aerial Fiber Optic Plant: Installing new poles and hanging cables on previously disturbed or new (undisturbed) ROWs or easements and the potential construction of access roads.

  - Land Use: See *Activities Likely to Have Impacts* below.
  - Recreation: See *Activities Likely to Have Impacts* below.
  - Airspace: Installation of new poles would not have an effect on airspace because utility poles are an average of 40 feet in height and do not intrude into useable airspace.

- Collocation on Existing Aerial Fiber Optic Plant: Installation of new fiber on existing poles would be limited to previously disturbed areas.

  - Land Use: It is anticipated that there would be no impacts to land use since the activities that would be conducted would not directly or indirectly result in changes to existing and surrounding land uses.
  - Recreation: No impacts to recreation would be anticipated since the activities that would be conducted would not cause disruption or loss of access to recreational lands or activities or the enjoyment of those lands or activities.
  - Airspace: No impacts are anticipated to airspace from collocations.

- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber and installation of new equipment in existing huts.

  - Land Use: It is anticipated that there would be no impacts to land use since the activities would not directly or indirectly result in changes to existing and surrounding land uses.
  - Recreation: Use of existing dark fiber would not impact recreation because it would not impede access to recreational resources.
  - Airspace: Lighting of dark fiber would have no impacts to airspace.

- New Build – Submarine Fiber Optic Plant: Installing cables in limited nearshore or inland bodies of water and the constructing landings and/or facilities on shore to accept submarine cable.

- Land Use: See *Activities Likely to Have Impacts* below.
- Recreation: See *Activities Likely to Have Impacts* below.
- Airspace: The installation of cables in limited nearshore or inland bodies of water and construction of landings/facilities would not impact flight patterns or cause obstructions that would require FAA and/or state review based on FAR 14 CFR, Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace* (See Section 8.10.5.3 Obstructions to Airspace Considerations).

- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of transmission equipment would occur in existing boxes or huts. The section below addresses potential impacts to land use, recreation resources, and airspace if deployment of new boxes, huts, or access roads is required.

  - Land Use: See *Activities Likely to Have Impacts* below.
  - Recreation: See *Activities Likely to Have Impacts* below.
  - Airspace: No impacts to airspace would be anticipated since the activities would not affect flight patterns or cause obstructions that would require FAA and/or state review based on FAR 14 CFR, Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace* (See Section 8.10.5.3 Obstructions to Airspace Considerations).

- Wireless Projects

  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, structure, or building.

    - Land Use: There would be no impacts to existing and surrounding land uses. The potential addition of power units, structural hardening, and physical security measures would not impact existing or surrounding land uses.
    - Recreation: See *Activities Likely to Have Impacts* below.
    - Airspace: 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 to existing or surrounding land uses because these technologies would be temporarily located in areas compatible with other land uses.
    - Recreation: No impacts to recreation are anticipated as deployable technologies would not affect the use or enjoyment of recreational lands.

        - Airspace: Use of land-based deployable technologies (COW, COLT, and SOW) is not expected to result in impacts to airspace, provided antenna masts do not exceed 200 feet Above Ground Level (AGL) or do not trigger any of the other FAA obstruction to airspace criteria listed in Section 8.10.5.3 Obstructions to Airspace Considerations.

- Satellites and Other Technologies

    - Satellite-Enabled Devices and Equipment: Installation of permanent equipment on existing structures and the use of portable devices that use satellite technology.

        - Land Use: It is anticipated that there would be no impacts to existing or surrounding land uses because these technologies would be temporarily located in areas compatible with other land uses.
        - Recreation: It is anticipated that there would be no impacts to recreational uses because these technologies would be temporarily deployed but would not restrict access to, or enjoyment of, recreational lands.
        - Airspace: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact airspace because those activities would not result in changes to flight patterns and airspace usage or result in obstructions to airspace.

    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact to land use, it is anticipated that this activity would have no impact on land use.

Activities with the Potential to Have Impacts

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 – 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.
  - 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.
- 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 – see previous section.
- New Build – Submarine Fiber Optic Plant: Installing cables in 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 bodies of water and the surrounding area during the deployment phase. Reductions in visitation may result during deployment.
  - Airspace: No impacts are anticipated – see previous section.
- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of equipment including construction of new boxes, huts, or access roads.

- Land Use: Construction activities could temporarily restrict existing and surrounding land uses at isolated locations. New boxes, huts, or access roads could have long-term impacts to existing and surrounding land uses. The magnitude of the impact would depend on the specific location and the compatibility of the new facilities with existing and surrounding land uses.
- Recreation: Deployment of installation equipment and the construction of boxes, huts, or access roads may restrict access to recreation land or activities. Reductions in visitation during deployment may occur.
- Airspace: No impacts are anticipated – see previous section.

- Wireless Projects
  - New Wireless Communication Towers: Installing new wireless towers, associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads.
    - Land Use: Construction activities could temporarily restrict existing and surrounding land uses at isolated locations. New wireless towers, associated structures, or access roads could have long-term impacts to existing and surrounding land uses. The magnitude of the impact would depend on the specific location and the compatibility of the new facilities with existing and surrounding land uses.
    - Recreation: Deployment of new towers and associated structures could result in temporary, localized restricted access for recreation land or activities for the duration of the deployment phase. Reductions in visitation or duration of recreational activity may result from restricted access.
    - Airspace: Installation of new wireless towers could result in impacts to airspace if towers exceed 200 feet AGL or meet the other criteria listed in Section 8.10.5.3 Obstructions to Airspace Considerations. An OE/AAA could be required for the FAA to determine if the proposed construction does affect navigable airways or flight patterns of an airport if the aerial fiber optic plant is located in proximity to one of Massachusetts' airports.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower.
    - Land Use: No impacts are anticipated – see previous section.
    - Recreation: Installation of antennas or microwaves to existing towers may cause temporary, localized restricted access to recreation lands or activities during installation, which may cause small reductions in visitation for the duration of installation.
    - Airspace: Collocation of mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, addition of power units, structural hardening, and physical security measures could result in impacts if located near airports or air navigation facilities.

- Deployable Technologies
    - Deployable Technologies: These technologies would be used where permanent, fixed infrastructure cannot be deployed due to a variety of factors such as the need to supplement coverage or to avoid or mitigate permanent impacts to sensitive resources or receptors.
        - Land Use: No impacts are anticipated – see previous section.
        - Recreation: No impacts are anticipated – see previous section.
        - Airspace: Implementation of deployable aerial communications architecture could result in temporary or intermittent impacts to airspace. Deployment of tethered systems (such as balloons or blimps) could pose an obstruction hazard if deployed above 200 feet and near Massachusetts airports (See obstruction criteria in Section 8.1.7.5, Airspace - 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. It is expected that FirstNet would attempt to avoid changes to airspace and the flight profiles (boundaries, flight altitudes, operating hours, etc.).
- Satellites and Other Technologies
    - Satellite-Enabled Devices and Equipment: The installation of permanent equipment on existing structures and the use of portable devices that use satellite technology.
        - Land Use: No impacts are anticipated – see previous section.
        - Recreation: It is anticipated the installation of equipment on existing structures may cause temporary, localized restricted access to recreation lands or activities during installation, which may cause small reductions in visitation for the duration of installation.
        - Airspace: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology may impact airspace if equipment creates an obstruction.

In general, the abovementioned activities could potentially involve construction activities, including the construction of access roads. 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 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 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. The degree of change in the visual environment (see Section 8.2.8, 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. 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. 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.

8.2.7.5. Alternatives Impact Assessment

The following section assesses potential impacts to land use, recreation resources, and airspace associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to land use, recreation, and airspace resources as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts to land use if deployment occurs in areas with compatible land uses. While a

single deployable technology may have imperceptible impact, multiple technologies operating in close proximity for longer periods could impact existing and surrounding land uses. There could be impacts to recreation activities during the deployment of technologies if such deployment were to occur within or near designated recreation areas. Enjoyment of activities dependent upon the visibility of wildlife or scenic vistas may be affected. Also, implementation of deployable technologies could result in less than significant impacts to airspace if deployment does trigger any obstruction criterion or result in changes to flight patterns and airspace restrictions. 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 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. 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 to land use, recreation resources, or airspace. Environmental conditions would therefore be the same as those described in Section 8.1.8, Land Use, Recreation, and Airspace.

8.2.8. Visual Resources

8.2.8.1. Introduction

This section describes potential impacts to visual resources in Massachusetts 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.

8.2.8.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on visual resources were evaluated using the significance criteria presented in Table 8.2.8-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to visual resources addressed in this section are presented as a range of possible impacts.

8.2.8.3. 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 Massachusetts, residents and visitors travel to many national historic sites, preservation areas, and state parks, such as the Cape Cod National Seashore to view its picturesque lighthouses and beaches. 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. Massachusetts has preservation laws in place for historic sites and areas, such as Massachusetts General Law, Chapter 184, Sections 31-33, which requires restrictions on development. 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.

Table 8.2.8-1: Impact Significance Rating Criteria for Visual Resources

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Adverse change in aesthetic character of scenic resources or viewsheds	Magnitude or Intensity	Fundamental and irreversibly negative change in aesthetic character	Effect that is potentially significant, but with mitigation is less than significant	Intermittently noticeable change in aesthetic character that is marginally negative	No visible effects
	Geographic Extent	Regional impacts observed throughout the state/territory		Effects realized at one or multiple isolated locations	No visible effects
	Duration or Frequency	Permanent or persistent changes to aesthetic character lasting throughout or beyond the construction or deployment phase		Persisting through the construction and deployment phase, but aesthetics of the area would be returned to original state following the construction and deployment phase	Transient or no visible effects
Nighttime lighting	Magnitude or Intensity	Lighting dramatically alters night-sky conditions	Effect that is potentially significant, but with mitigation is less than significant	Lighting alters night-sky conditions to a degree that is only intermittently noticeable	Lighting does not noticeably alter night-sky conditions
	Geographic Extent	Regional impacts observed throughout the state/territory		Effects realized at one or multiple isolated locations	No visible effects
	Duration or Frequency	Permanent or persistent changes to night-sky conditions lasting throughout or beyond the construction or deployment phase		Persisting through the construction and deployment phase, but lighting would be removed and night-sky conditions would be returned to original state following the construction and deployment phase	Transient or no visible effects

NA = not applicable

Based on the impact significance criteria presented in Table 8.2.8-1, impacts to the aesthetic character of scenic resources or viewsheds would be considered potentially significant if landscapes were permanently removed or fragmented, or if damage to historic or cultural resources occurred. Given the small-scale of likely FirstNet activities, impacts are expected to be less than significant.

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.

Based on the impact significance criteria presented in Table 8.2.8-1, lighting that illuminates the night sky on a regional basis, 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.

8.2.8.4. 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 depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to visual resources under the conditions described below:

- Wired Projects
    - Collocation on Existing Aerial Fiber Optic Plant: While the addition of new aerial fiber optic plant to an existing aerial fiber optic transmission system would likely be visible, the change associated with this option is so small as to be essentially imperceptible. This option would involve no new nighttime lighting and pole replacement would be limited.
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit

points of the existing conduit in previously disturbed areas. It is anticipated that there would be no impacts to visual resources since the activities would be conducted at small entry and exit points and are not likely to produce perceptible changes, and would not require nighttime lighting.

- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts 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 not impact visual resources since those activities would not require ground disturbance or vegetation removal.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact visual resources, it is anticipated that this activity would have no impact on visual resources.

Activities with the Potential to Have Impacts

Potential 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 or replacement poles and hanging cables could result in impacts to the aesthetic character of scenic resources or viewsheds depending on the location of the installation. In most cases, development in public rights-of-ways would not affect visual resources unless vegetation were removed or construction occurred in scenic areas. If new lighting were necessary, impacts to night skies could occur. Construction of new roadways could result

in linear disruptions to the landscape, surface disturbance, and vegetation removal; all of which could impact the aesthetic character of scenic resources or viewsheds, depending on the location of the installation.

- Collocation on Existing Aerial Fiber Optic Plant: Impacts would be similar to new build, but poles may or may not need to be installed. Construction and installation of new replacement poles would retain the viewshed of the location. In most cases, development in public ROWs would not affect visual resources unless vegetation were removed or construction occurred in scenic areas.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water would not impact visual resources. However, impacts to the aesthetic character of scenic resources or viewsheds could potentially occur as result of the construction of landings and/or facilities on 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 effects would be highly localized.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to visual resources. Land/vegetation clearing, excavation activities, landscape grading, and other surface disturbing activities during the installation of new wireless towers and associated structures or access roads could result in the degradation of the aesthetic character of scenic resources or viewsheds. Impacts may be experienced by viewers if new towers were located in or near a national park unit or other sensitive area. If new towers were constructed to a height that required aviation lighting, nighttime vistas could be impacted in areas where the night skies do not have light disruptions or are within unpopulated areas. If nighttime lighting were necessary for the operation or function of a facility, impacts to night sky conditions could occur.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower and would not likely result in additional impacts to visual resources. However, if the additional power units, structural hardening, or physical security measures required ground disturbance or removal of vegetation, impacts to the aesthetic character of scenic resources or viewsheds could occur.
  - Deployable Technologies: Implementation of deployable technologies could result in potential impacts to visual resources if long-term deployment occurs in scenic areas, or if the implementation requires minor construction of staging or landing areas, results in vegetation removal, areas of surface disturbance, or additional nighttime lightning.

In general, the abovementioned activities could potentially involve land/vegetation clearing, and potential scenic intrusion of towers, poles, roads, infrastructure, and other structures. Potential impacts to visual resources associated with deployment could include interruptions of landscapes, degradation of the aesthetic character of scenic resources or viewsheds, and overall changes in valued scenic resources, particularly for permanent fixtures such as towers or facilities. These impacts are expected to be less than significant due to the temporary and small-scale nature of deployment activities, although certain discrete locations could have potentially significant impacts to night skies or as a result of new towers. 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 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 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.

8.2.8.5. Alternatives Impact Assessment

The following section assesses potential impacts to visual resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to infrastructure as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in potential impacts to visual resources if long-term deployment occurs in scenic areas. If staging or landing areas (depending on the type of technology) require surface disturbance or vegetation clearing, or if these areas were within scenic landscapes or required new nighttime lighting, impacts could occur to the aesthetic character of scenic resources or viewsheds. These impacts are expected to be less than significant 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. 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. As a result, there would be no impacts to visual resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.8, Visual Resources.

8.2.9. Socioeconomics

8.2.9.1. Introduction

This section describes potential impacts to socioeconomics in Massachusetts 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.

8.2.9.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on socioeconomics were evaluated using the significance criteria presented in Table 8.2.9-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type,

including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to socioeconomics addressed in this section are presented as a range of possible impacts.

8.2.9.3. Description of Environmental Concerns

This section discusses at a high level the types of socioeconomic impacts that could result from deployment of the NPSBN. Socioeconomic impacts could be negative or positive. Subsections below address socioeconomic impacts in four general areas, following the breakdown of the significance rating criteria in the table above:

- Impacts to Real Estate
- Economic Benefits or Adverse Impacts related to Changes in Spending, Income, Industries, and Public Revenues
- Impacts to Employment
- 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 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 Affected Environment, property values vary considerably across Massachusetts. Median values of owner-occupied housing units in the 2009–2013 period ranged from about $370,000 in Boston, to just over $170,000 in smaller population concentration areas such as Pittsfield and North Adams. 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.

Table 8.2.9-1: Impact Significance Rating Criteria for Socioeconomics

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

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. The use of NPSBN capacity on a secondary basis for non-public safety services, including commercial services, by parties entering into a covered leasing agreement with FirstNet may also increase economic activity and generation of income for such party.

Direct spending of federal, state, and private sector funds to deploy and operate the NPSBN would likely represent new income to businesses that provide goods and services for the network, resulting in a positive impact. This direct impact would lead to indirect impacts (as directly impacted businesses purchase supporting goods and services) and induced impacts (as

the employees of all affected businesses spend the wages they have earned). Because most FirstNet infrastructure investments would be dispersed across the nation, the business income and wages generated in any particular state or community would generally be small relative to the overall state or community economy, but measurable. Based on the significance criteria above, the business income and wage impacts would be considered positive and less than significant. It is also highly unlikely that these impacts would lead to significant market shifts or other significant changes to local/regional economic structure.

Spending and income generation related to developing the NPSBN would also result in changes to public revenues. Property taxes may change as property values increase or decrease due to the installation of new infrastructure. General and selective sales taxes may change (most likely increase), reflecting expenditures during system development and maintenance. Public utility tax revenues may change. These taxes are a subcategory of selective sales taxes that includes taxes on providers of land and mobile telephone, telegraph, cable, and internet services (U.S. Census Bureau, 2006). These service providers may obtain new taxable revenues from operation of components of the public safety broadband network. In such cases, public utility tax revenues may increase, but they could also remain the same or decrease if providers are granted tax breaks in return for operating portions of the network. Individual and corporate income taxes may change as FirstNet infrastructure development and operation creates new taxable income for involved companies and workers.

FirstNet partner(s) may be given the right to use excess NPSBN capacity commercially. This would result in additional economic activity and generation of income. In turn, this could have revenue implications for federal and state governments, through taxes on sales and on corporate income generated by commercial use of the network.

FirstNet may have an additional, non-revenue benefit to the public sector. The network is likely to create operational cost savings and increased productivity for public safety personnel.

Impacts to Employment

Private companies and government organizations that receive income from deploying and operating the NPSBN would use portions of that income to hire the employees they need to provide their support to the network. This generation of new employment 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 partner(s) 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 games are beneficial, and would be especially welcomed in areas that have high unemployment. As discussed in Affected Environment, unemployment rates (as shown by the unemployment rate map and selected economic indicators table) vary considerably across Massachusetts. The average unemployment rate in 2014 was 5.8 percent, somewhat lower than the national rate of 6.2 percent. Most counties had unemployment rates below the national average (that is, better employment performance). However, a number of counties in the western part of the state had unemployment rates above the national average. The lowest unemployment rates were generally in the counties around Boston, and in Hampshire County in the west-central part of the state.

Large companies that win major contracts for deploying and operating the NPSBN may have concentrations of employees in some specific locations; for instance, engineers and other system designers may be located in one or a few specific offices. While such employment concentrations could be important to specific communities, these and other employment impacts would still not be significant based on the criteria in Table 8.2.9-1because 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.

8.2.9.4. 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. These effects are measurable by economists, even if very small, but their significance is determined by application of the criteria in Table 8.2.9-1.

Activities Likely to Have No Impacts

- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN, however it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact socioeconomic resources, it is anticipated that this activity would have no impact on those resources.

Activities with the Potential to Have Impacts

Potential impacts to socioeconomics for the Preferred Alternative would encompass a range of impacts that could result from deployment activities. The discussion below indicates which of the four types of socioeconomic impacts discussed above and listed again here apply to each type of deployment activity. For greater detail on the nature of these impacts, see the Description of the Environmental Concerns section above.

- Impacts to Real Estate;
- Changes to Spending, Income, Industries, and Public Revenues;
- Impacts to Employment; and
- Changes in Population Number or Composition.

Positive impacts on property values would generally not result from one or a few particular activities, but instead would result from the totality of the new NPSBN infrastructure and operational systems that enable improved public safety services to currently underserved areas. Similarly, any change to population numbers in a few locations as discussed above would result from large contract awards and contractor decisions about employee locations, not from specific deployment activities. Therefore, these types of impacts are not included in the activity-focused discussions below.

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of fiber optic cable in existing conduit would have the following types of socioeconomic impacts:
    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.

- Collocation on Existing Aerial Fiber Optic Plant: Collocation of new aerial fiber optic plant on existing utility poles and other structures would have the following types of socioeconomic impacts:
  - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
  - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber would be conducted electronically through existing infrastructure, and would have the following types of socioeconomic impacts:
  - Changes to Spending, Income, Industries, and Public Revenues – Labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
  - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water, and associated onshore activities at existing or new facilities would have the following types of socioeconomic impacts:
  - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
  - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of transmission equipment through existing or new boxes or huts would have the following types of socioeconomic impacts:
  - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.

        - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
    - New Build – Buried Fiber Optic Plant: New fiber optic cable installation usually requires construction activities and would have the following types of socioeconomic impacts:
        - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
        - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
    - New Build – Aerial Fiber Optic Plant: Pole/structure installation would have the following types of socioeconomic impacts:
        - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
        - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
- Wireless Projects
    - New Wireless Communication Towers: Installation of new wireless towers and associated structures, such as generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads, or access roads would have the following types of socioeconomic impacts:
        - Impacts to Real Estate – As discussed above, communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013). Such impacts, if they occur, would be limited to a small area around each project and would generally be a small percentage reduction in property value; thus, the impacts would be less than significant.
        - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
        - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would include mounting or installing equipment (such as antennas) on an existing facility would have the following types of socioeconomic impacts. While communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013), the impacts of existing wireless towers are presumably already factored into property values and would not be affected by the addition of new equipment.
  - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
  - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.
- Deployable Technologies: COWs, COLTs, and SOWs and aerial deployable technologies require storage, staging, and (for aerial deployables) launch/landing areas. Development of such areas, or enlargement of existing areas to accommodate FirstNet equipment, would have the following types of socioeconomic impacts:
  - Impacts to Real Estate – It is possible that development or enlargement of storage, staging, and launch/landing areas could have adverse impacts on nearby property values. This is because such facilities may have adverse aesthetic aspects (e.g., large areas of pavement and large numbers of parked vehicles), equipment maintenance activities at such facilities may generate noise, and operational activities may generate traffic. Such factors could affect nearby property values. These impacts, if they occur, would occur within a limited distance of each site, and would be limited to a relatively small number of sites within the region and state. Therefore, these impacts would be less than significant.
  - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
  - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the deployment of such devices and equipment would be similar to collocation of wireless equipment on existing wireless towers, structures, or buildings, and would have the following types of socioeconomic impacts:

- Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be less than significant.
- Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a less than significant number of jobs regionally and statewide.

In general, the abovementioned activities would have less than significant beneficial socioeconomic impacts. To the extent that certain activities could have adverse impacts to property values, those impacts are also 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.

The discussion above characterized the impacts of each type of activity. The socioeconomic impacts of all activities considered together would also be less than significant. Even when considered together, the impacts would be very small relative to the total economic activity and property value of any region or the state. In addition, with the possible exception of property values, all deployment impacts would be limited to the construction phase.

Operation Impacts

Activities with the Potential to Have 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 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 District. 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.

8.2.9.5. Alternatives Impact Assessment

The following section assesses potential impacts to socioeconomics associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to socioeconomics resulting from implementation of this alternative could be as described below.

Deployment Impacts

As explained above, all deployment activities represent economic activity and thus have socioeconomic impacts. These impacts would primarily be beneficial, such as generation of business income and employee wages, and creation or sustainment of jobs. The impacts would be small for each activity and therefore less than significant.

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 partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

All operational activities represent economic activity and thus have socioeconomic impacts. These impacts would primarily be beneficial, 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 and traffic) that could negatively affect the value of surrounding properties. The potential for such impacts is higher under this alternative than the Preferred Alternative because it is likely that these facilities would be more numerous, present over a larger geographic extent, and used with greater frequency and duration. These impacts, if they occur, would be less than significant as they would be limited to a relatively small number of sites within the region and District. 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. As a result, there would be no impacts to socioeconomics from deployment and operation of the No Action Alternative. Socioeconomic conditions would therefore be the same as those described in Section 8.1.9 Socioeconomics.

8.2.10. Environmental Justice

8.2.10.1. Introduction

This section describes potential impacts to environmental justice in Massachusetts 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.

8.2.10.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on environmental justice were evaluated using the significance criteria presented in Table 8.2.10-1. The categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the

potential impacts to environmental justice addressed in this section are presented as a range of possible impacts.

8.2.10.3. Description of Environmental Concerns

Effects Associated with Other Resource Areas that Have a Disproportionately High and Adverse Impact on Low-Income Populations and Minority Populations

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (Executive Office of the President, 1994), and guidance from CEQ, require federal agencies to evaluate potential human health and environmental effects on environmental justice populations. Specifically, "Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment." (CEQ, 1997) Thus, effects associated with other resource areas are of interest from an environmental justice perspective. This includes Human Health and Safety, Cultural Resources, Socioeconomics, Noise, Aesthetics and Visual Resources, and other resources.

Potential concerns noted in the impact analyses for these resources include dust, noise, traffic, and other adverse impacts of construction activities. New wireless communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013). (See Socioeconomics Environmental Consequences for additional discussion.) The presence and operation of large storage, staging, and launch/landing areas for deployable technologies could raise environmental justice concerns as described below. 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, could 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.

Table 8.2.10-1: Impact Significance Rating Criteria for Environmental Justice

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Effects associated with other resource areas (e. g., human health and safety, cultural resources, socioeconomics) that have a disproportionately high and adverse impact on low-income populations and minority populations	Magnitude or Intensity	Direct and disproportionately high and adverse effects on environmental justice communities (as defined by EO 12898) that cannot be fully mitigated	Effect that is potentially significant, but with mitigation is less than significant	Direct effects on environmental justice communities (as defined by EO 12898) that are not disproportionately high and adverse, and therefore do not require mitigation	No direct effects on environmental justice communities, as defined by EO 12898
	Geographic Extent	Effects realized within counties at the Census Block Group level		Effects realized within counties at the Census Block Group level	Effects realized within counties at the Census Block Group level
	Duration or Frequency	Persists during the life of the project		Persists for as long as the entire construction phase or a portion of the operations phase	NA

NA = Not Applicable

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 8.1.10) as having moderate potential or high potential for environmental justice populations would particularly warrant further screening. As discussed in Section 8.1.10, Massachusetts' population has lower percentages of minorities than the region or the nation, and lower rates of poverty than the region or the nation. Massachusetts has many areas with high potential for environmental justice populations. These areas disproportionately occur in the more densely populated parts of the state, including the 10 largest population concentrations. The distribution of areas with moderate Potential for environmental justice populations is more even across the state. Further analysis using the data developed for the screening analysis in Section 8.1.10 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, 2015h; USEPA, 2014d).

A 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.

8.2.10.4. 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 could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to environmental justice under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of fiber optic cable in existing conduit would be through existing hand holes, pulling vaults, junction boxes, huts, and POP structures. Activities at these small entry points would be limited and temporary and thus are not likely to produce perceptible changes affecting any surrounding communities. Therefore, they would not affect environmental justice communities.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber would be conducted electronically through existing infrastructure, and therefore would have no impacts 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.
- Satellites and Other Technologies
    - Satellite-Enabled Devices and Equipment: It is anticipated that the deployment of such devices and equipment would not involve new ground disturbance, impacts to environmental justice communities would not occur. Impacts associated with satellite-enabled devices requiring construction activities are addressed below.
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact environmental justice, it is anticipated that this activity would have no impact on environmental justice.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to environmental justice for the Preferred Alternative would encompass a range of impacts that could occur as a result of disturbance to communities from construction activities, such as noise, dust, and traffic. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to environmental justice communities include the following:

- Wired Projects
    - New Build – Buried Fiber Optic Plant: New fiber optic cable installation usually requires construction activities such as trenching, plowing (including vibratory plowing), or directional boring, as well as construction of hand holes, pulling vaults, junction boxes, huts, and POP structures. These activities could temporarily generate noise and dust, or

disrupt traffic. If such impacts occur disproportionately to environmental justice communities, they would be considered environmental justice impacts.

- New Build – Aerial Fiber Optic Plant: Pole/structure installation could temporarily generate noise and dust, or disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water would not impact environmental justice because there would be no ground disturbance or other impacts associated with this activity that would adversely impact communities. Associated onshore activities occurring at existing facilities such as staging of equipment and materials, or connection of cables, would be small in scale and temporary; thus, they would not impact environmental justice communities. Construction of new landings and/or facilities onshore to accept submarine cable could temporarily generate noise and dust, or disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts, there would be no adverse impacts on surrounding communities, and thus no potential for environmental justice impacts. Installation of optical transmission equipment or centralized transmission equipment requiring construction of new utility poles, hand holes, pulling vaults, junction boxes, huts, and POP structures could temporarily generate noise and dust, or disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures, such as generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads, or access roads requires construction activities that could temporarily generate noise and dust, or disrupt traffic. New communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013). (See Socioeconomics Environmental Consequences for additional discussion.) If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would include mounting or installing equipment (such as antennas) on an existing facility. This activity would be small in scale, temporary, and highly unlikely to produce adverse human health or environmental impacts on the surrounding community. Thus, it would not impact environmental justice communities. If collocation requires construction for additional power units, structural hardening, and physical security measures, the

construction activity could temporarily generate noise and dust and disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

- Deployable Technologies: COWs, COLTs, and SOWs and aerial deployable technologies require storage, staging, and (for aerial deployables) launch and landing areas. To the extent such areas require new construction, noise and dust could be generated temporarily, and traffic could be disrupted. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

In general, the impacts from the abovementioned activities would be short-term and could potentially involve objectionable dust, noise, traffic, or other localized impacts due to construction activities. In some cases, these effects and aesthetic effects could potentially impact property values, particularly for new towers. These impacts are expected to be less than significant, but are problematic from an environmental justice perspective if they occur disproportionately in environmental justice communities. Since environmental justice impacts occur at the site-specific level, analyses of individual proposed projects would help determine potential impacts to specific environmental justice communities. 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 to Have No Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of primarily of routine maintenance and inspection of fixed infrastructure. It is anticipated that such activities would not result in environmental justice impacts, as the intensity of these activities would be low (low potential for objectionable effects such as noise and dust) and their duration would be very short. Routine maintenance and inspection would not adversely affect property values, for the same reasons.

Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment activities that involve construction. Impacts are expected to be less than significant. 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.

8.2.10.5. 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 minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to environmental justice communities resulting from implementation of this alternative could be as described below.

Deployment Impacts

As explained above, deployable technologies such as COWs, COLTs, and SOWs, along with aerial deployable technologies, could require storage, staging, and launch/landing areas. To the extent such areas require new construction, noise and dust could be generated temporarily, and traffic could be disrupted. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts. Impacts are expected to be less than significant 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 temporarily generate noise, and operational activities may generate traffic. These effects may be adverse in themselves, and may impact property values. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts. Impacts are expected to be less than significant. 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. As a result, there would be no impacts to environmental justice as a result of deployment and operation of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 8.1.10, Environmental Justice.

8.2.11. Cultural Resources

8.2.11.1. Introduction

This section describes potential impacts to cultural resources in Massachusetts 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.

8.2.11.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on cultural resources were evaluated using the significance criteria presented in Table 8.2.11-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to cultural resources addressed in this section are presented as a range of possible impacts.

Table 8.2.11-1: Impact Significance Rating Criteria for Cultural Resources

Type of Effect	Effect Characteristics	Impact Level			
		Adverse Effect	Mitigated Adverse Effect[1]	Effect, but Not Adverse	No Effect
Physical damage to and/or destruction of historic properties[2]	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties	Adverse effect that has been procedurally mitigated through Section 106 process	Effects to a non-contributing portion of a single or many historic properties	No direct effects to historic properties
	Geographic Extent	Direct effects on Area of Potential Effect (APE)		Direct effects on APE	Direct effects on APE
	Duration or Frequency	Permanent direct effects to a contributing portion of a single or many historic properties		Permanent direct effects to a non-contributing portion of a single or many historic properties	No direct effects to historic properties
Indirect effects to historic properties (i.e. visual, noise, vibration, atmospheric)	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties	Adverse effect that has been procedurally mitigated through Section 106 process	Effects to a contributing or non-contributing portion of a single or many historic properties	No indirect effects to historic properties
	Geographic Extent	Indirect effects on APE		Indirect effects on APE	Indirect effects on APE
	Duration or Frequency	Long-term or permanent indirect effects to a single or many historic properties		Infrequent, temporary, or short- or long-term or permanent indirect effects to a single or many historic properties	No indirect effects to historic properties
Loss of character defining attributes of historic properties	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties	Adverse effect that has been procedurally mitigated through Section 106 process	Effects to a non-contributing portion of a single or many historic properties	No direct or indirect effects to historic properties
	Geographic Extent	Direct and/or indirect effects on APE		Direct and/or indirect effects on APE	Direct and/or indirect effects on APE

Type of Effect	Effect Characteristics	Impact Level			
		Adverse Effect	**Mitigated Adverse Effect**[1]	**Effect, but Not Adverse**	**No Effect**
	Duration or Frequency	Long-term or permanent loss of character defining attributes of a single or many historic properties		Infrequent, temporary, or short-term changes to character defining attributes of a single or many historic properties	No direct or indirect effects to historic properties
Loss of access to historic properties	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties	Adverse effect that has been procedurally mitigated through Section 106 process	Effects to a non-contributing portion of a single or many historic properties	No segregation or loss of access to historic properties
	Geographic Extent	Any area surrounding historic properties that would cause segregation or loss of access to a single or many historic properties		Any area surrounding historic properties that could cause segregation or loss of access to a single or many historic properties	No segregation or loss of access to historic properties
	Duration or Frequency	Long-term or permanent segregation or loss of access to a single or many historic properties		Infrequent, temporary, or short-term changes in access to a single or many historic properties	No segregation or loss of access to historic properties

NA = not applicable

[1] Whereas mitigation measures for other resources discussed in this PEIS may be developed to achieve an impact that is "Less than Significant with Mitigation Incorporated," historic properties are considered to be "non-renewable resources," given their very nature. As such, any and all unavoidable adverse effects to historic properties, per Section 106 of the NHPA (as codified in 36 CFR Part 800.6), would require FirstNet to consult with the SHPO/Tribal Historic Preservation Office (THPO) and other consulting parties, including Indian Tribes and Native Hawaiian Organizations, to develop appropriate mitigation.

[2] Per NHPA, a "historic property" is defined as any district, archaeological site, building, structure, or object that is either listed or eligible for listing in the NRHP. Cultural resources present within a project's APE are not historic properties if they do not meet the eligibility requirements for listing in the NRHP. Sites of religious and/or cultural significance refer to areas of concern to 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 Traditional Cultural Properties (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.

8.2.11.3. 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 8.2.11-1, direct deployment impacts could be potentially significant if FirstNet's deployment locations were in areas with moderate to high probabilities for archaeological deposits, within historic districts, or at historic properties. To the extent practicable, FirstNet would attempt to minimize activities in areas with archaeological deposits or within historic districts. However, given archaeological sites and historic properties are present throughout Massachusetts, some deployment activities may be in these areas, in which case BMPs (see Chapter 17) would help avoid or minimize the potential impacts.

Indirect Effects to Historic Properties (i.e., Visual, Noise, Vibration, Atmospheric)

The potential for indirect effects to historic properties would be present during deployment of the proposed facilities/infrastructure and during trenching, grading, and/or foundation excavation activities. Indirect effects include the introduction of visual, noise, atmospheric, and/or vibration effects that diminish a property's historic integrity. The greatest likelihood of potentially significant impacts from indirect effects would be from the deployment of equipment in areas that would cause adverse visual effects to historic properties. To the extent practicable, FirstNet would attempt to minimize activities in areas within or adjacent to historic districts or properties.

Loss of Character Defining Attributes of Historic Properties

Deployment of FirstNet equipment has the potential to cause the loss of character defining attributes of historic properties; such attributes are the features of historic properties that define their NRHP eligibility. Examples of such impacts would be the loss of integrity of archaeological sites through ground disturbing activities, and direct impacts to historic buildings from equipment deployment that adversely alter historic architectural features. Significant impacts such as these can be avoided or minimized through BMPs (see Chapter 17).

Loss of Access to Historic Properties

The deployment of equipment requiring a secure area has the potential to cause the loss of access to historic properties. The highest potential for this type of significant impact would be from the deployment of equipment in secure areas that impact the access to sites of cultural importance to Native Americans. It is anticipated that FirstNet would identify potential impacts to such areas through the NHPA consultation process, and would minimize deployment activities that would cause such loss of access.

8.2.11.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action 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 of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to cultural resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be no impacts to cultural resources since the activities that would be conducted at these small entry and exit points are not likely to produce impacts.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts to cultural. If required, and if done in existing huts with no ground disturbance, installation of new associated equipment would also have no impacts to cultural resources because there would be no ground disturbance and no perceptible visual changes.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact cultural resources because those activities would not require ground disturbance or create 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 impact cultural resources, it is anticipated that this activity would have no impact on cultural resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to cultural resources as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur as a result of ground disturbance activities, including destruction of cultural or historic artifacts. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to cultural resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, 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.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water could impact cultural resources, as coastal areas of Massachusetts where sea level was lower during glacial periods have the potential to contain archaeological sites. Impacts to cultural resources could also potentially occur as a result of the construction of landings and/or facilities on shore to accept submarine cable, which could result in the disturbance of archaeological sites (bodies of water tend to be located in areas with high probabilities for archaeological deposits and Massachusetts has maritime archaeological sites), and the associated structures could have visual effects on historic properties.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be no impacts to cultural resources. If installation of transmission equipment required grading or other ground disturbance to install small boxes or huts, or access roads, there could potentially be impacts to cultural resources. Ground disturbance could impact archaeological sites, and the associated structures could have visual effects on historic properties.
  - Collocation on Existing Aerial Fiber Optic Plant: Soil excavation and excavated material placement during the replacement of poles and structural hardening could result in direct and indirect effects to cultural resources, although any effects to access would be short-term. Heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in direct and indirect effects to cultural resources.

- Wireless Projects
    - New Wireless Communication Towers: Deployment of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to historic properties. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the deployment of new wireless towers and associated structures or access roads, could result in the disturbance of archaeological sites. The deployment of new wireless communication towers and their associated structures could result in visual impacts to historic properties or the loss of access to historic properties.
    - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower could result in impacts to historic properties. Ground disturbance activities could result in the disturbance of archaeological sites, and the deployment of collocated equipment could result in visual impacts or physical damage to historic properties, especially in urban areas, such as Boston, that have larger numbers of historic public buildings.
    - Deployable Technologies: Implementation of deployable technologies could result in potential impacts to cultural resources if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. In addition, impacts to historic properties could occur if the deployment is long-term, or if the deployment involves aerial technologies with the potential for visual or other indirect impacts.

In general, the abovementioned activities could potentially involve ground disturbance, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to cultural resources associated with deployment could include physical damage to or destruction of historic properties, indirect impacts including visual effects, the loss of access to historic properties, or the loss of character-defining features of historic properties. These activities could affect, but not adversely affect, cultural resources as the potential adverse effects would be temporary and limited to the area near individual Proposed Action deployment site. Additionally, some equipment proposed to be installed on or near properties that are listed or eligible for listing on the NRHP could potentially be removed. Additionally as appropriate, FirstNet would engage in consultation as required under Section 106 of the NHPA. 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 no effect to cultural resources associated with routine inspections of the Preferred Alternative. If usage of heavy equipment as part of routine maintenance or inspections occurs off established access roads or corridors, or if the acceptable load of the surface is exceeded, ground disturbance impacts on archaeological sites could result as explained above. These potential impacts would be associated with ground disturbance or modifications of properties, however, due to the small-scale of expected activities, these actions could affect but would not likely adversely affect, cultural resources. In the event that maintenance and inspection activities occur off existing roads, FirstNet would engage in consultation as required under Section 106 of the NHPA.

8.2.11.5. Alternatives Impact Assessment

The following section assesses potential impacts to cultural resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to cultural resources as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in impacts to cultural resources if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in impacts to archaeological sites. These activities could affect, but not adversely affect, cultural resources 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. 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 deployment impacts, it is anticipated that there would be effects, but no adverse effects to historic properties associated with implementation/running of the deployable technology. No adverse effects would be expected to either site access or viewsheds due to the temporary nature of expected activities. As with the Preferred Alternative, it is anticipated that there would be no effects to cultural resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off established access roads or corridors, impacts to archaeological sites could occur, however, in the event that this is required, FirstNet would engage in consultation as required under Section 106 of the NHPA.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no impacts to cultural resources as a result of deployment and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.11, Cultural Resources.

8.2.12. Air Quality

8.2.12.1. Introduction

This section describes potential impacts to Massachusetts' air quality from 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.

8.2.12.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on Massachusetts' air quality were evaluated using the significance criteria presented in Table 8.2.12-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to Massachusetts' air quality addressed in this section are presented as a range of possible impacts.

Table 8.2.12-1: Impact Significance Rating Criteria for Air Quality

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

8.2.12.3. 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 Massachusetts that are in maintenance or nonattainment for one or more criteria pollutants, particularly, ozone is a state-wide issue (see Section 8.1.12, Air Quality, and Figure 8.1.12-1). The majority of the counties in Massachusetts are designated as maintenance areas for one or more of the following pollutants: CO_2, PM, and ozone (Table 8.1.12-4); counties located in the central portion of the state are designated nonattainment or maintenance for two NAAQS pollutants (Figure 8.1.12-1).

Based on the significance criteria presented in Table 8.2.12-1, 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. Less than significant emissions could occur for any of the criteria pollutants within attainment areas in Massachusetts; however, NAAQS exceedances are not anticipated. Given that nonattainment areas are present throughout Massachusetts (Figure 8.1.12-1), FirstNet would try to minimize potential emissions where possible and would recommend the implementation of BMPs, where feasible and practicable, to avoid or minimize potential impacts.

8.2.12.4. 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

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to air quality under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Activities associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit. Gaining access to the conduit and installing the cable may result in minor disturbance at entry and exit points, however this activity would be temporary and infrequent, and is not expected to produce any perceptible changes in air emissions.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would require no construction and have no short- or long-term emissions to air quality because it would create no new sources of emissions.
- Satellites and Other Technologies
    - Satellite Enabled Devices and Equipment: The duration of construction activities associated with installing permanent equipment on existing structures would most likely be short-term. It is anticipated that insignificant concentrations of criteria pollutants would be emitted during installment of this equipment from the use of machinery. Deployment and operation of satellite-enabled devices and portable equipment are expected to have minimal to no impact on ambient air quality concentrations.
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact air quality resources, it is anticipated that this activity would have no impact on those resources.

Activities with the Potential to Impact Air Quality

Construction, deployment, and operation activities related to the Preferred Alternative could impact air quality by generating various quantities of criteria and air pollutant emissions. It is expected that such impacts would be less than significant due to the shorter duration and localized nature of the activities. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to air quality include the following:

- Wired Projects
    - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber as well as land/vegetation clearing, excavation activities, and

landscape grading could result in fugitive dust and products of combustion from the use of vehicles and heavy equipment.

- New Build – Aerial Fiber Optic Plant: The use of heavy equipment during the installation of new poles and hanging cables, as well as constructing access roads, POP huts, or other associated facilities to house plant equipment could result in products of combustion from the use of vehicles and machinery, as well as fugitive dust emissions from site preparation.
- Collocation on Existing Aerial Fiber Optic Plant: Excavation equipment used during pole replacement, and other heavy equipment used for structural hardening or reinforcement, could result in products of combustion from the use of vehicles and heavy equipment, as well as fugitive dust from site preparation.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water could generate products of combustion from vessels used to lay the cable. In addition, the construction of landings and/or facilities on shore 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 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 the additional power units, structural hardening, and physical security measures required grading or excavation, then exhaust and fugitive dust from heavy equipment used for these activities could also result in increased air emissions.
  - Deployable Technologies: The type of deployable technology used would dictate the types of air pollutants generated. For example, mobile equipment deployed via heavy trucks could generate products of combustion from the internal combustion engines associated with the vehicles and onboard generators. These units may also generate fugitive dust depending on the type of road traveled during deployment (i.e., paved

versus unpaved roads). Aerial platforms (e.g., UASs or other aircraft) would generate pollutants during all phases of flight.

In general, the pollutants of concern from the abovementioned activities would be products of combustion from burning fossil fuels in internal combustion engines and fugitive dust from site preparation activities and vehicles traveling on unpaved road surfaces. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the construction impacts. These impacts are anticipated to be less than significant 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 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 as they would still be limited in nature.

8.2.12.5. Alternatives Impact Assessment

The following section assesses potential impacts to air quality associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific equipment associated with the Deployable Technologies Alternative could include heavy trucks with onboard generators, aerial vehicles (e.g., UASs or other aircraft), and ground support vehicles and other equipment for aerial deployment. The stand-alone Deployable Technologies Alternative differs from the Preferred Alterative in the number of mobile and aerial vehicles likely to deploy, the distances traveled from storage locations, and the duration of deployment. The potential impacts to air quality are as follows.

Deployment and Operation Impacts to Air Quality

Implementing deployable technologies could result in products of combustion from mobile equipment deployed via heavy trucks using internal combustion engines associated with the vehicles and onboard generators. While a single deployable vehicle may have an insignificant impact, multiple vehicles operating for longer periods, in close proximity, may have a greater cumulative impact, although this is expected to be less than significant 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, 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 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.

8.2.13. Noise

8.2.13.1. Introduction

This section describes potential noise impacts from construction, deployment, and operation of the Proposed Action and alternatives in Massachusetts. 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.

8.2.13.2. Impact Assessment Methodology and Significance Criteria

The noise impacts of the Proposed Action were evaluated using the significance criteria presented in Table 8.2.13-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the

potential noise impacts to Massachusetts addressed in this section are presented as a range of possible impacts.

8.2.13.3. Description of Environmental Concerns

Increased Noise Levels

The Proposed Action has the potential to generate noise during construction and operation of various equipment used for deployment. These noise levels could be above what is typically generated in a given area and may alter the ambient acoustical environment. If significant, the noise could cause impacts on residential areas, or other facilities that are sensitive to noise, such as churches, hospitals, or schools. The construction activities for deploying some of the various equipment evaluated under the Proposed Action could cause short-term impacts to nearby populations. However, it is likely that there would be less long-term effects from operational use of the proposed equipment.

Based on the significance criteria presented in Table 8.2.13-1, noise impacts would likely be less than significant given the size and nature of the majority of the proposed deployment activities. The majority of FirstNet's deployment activities would not be located in sensitive areas nor would a large number of noise sources be deployed/operated long-term in the same area. Noise levels from deployment activities are not expected to exceed typical noise levels for short-term/temporary construction equipment or generators.

To the extent practicable, FirstNet would attempt to mitigate or minimize noise effects during construction or operation. BMPs and mitigation measures would be followed to limit impacts on nearby noise-sensitive receptors. However, given that much of the concentration and setup of equipment would often occur in populated areas, FirstNet operations would not be able to completely avoid noise impacts due to construction and operations at various receptors.

8.2.13.4. 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.

Table 8.2.13-1: Impact Significance Rating Criteria for Noise

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Increased noise levels	Magnitude or Intensity	Noise levels would exceed typical noise levels from construction equipment and generators. Noise levels at noise sensitive receptors (such as residences, hotels/motels/inns, hospitals, and recreational areas) would exceed 55 dBA or specific state noise limits. Noise levels plus baseline noise levels would exceeds 10 dBA increase from baseline noise levels (i.e., louder). Project noise levels near noise receptors at National Parks would exceed 65 dBA.	Effect that is potentially significant, but with mitigation is less than significant	Noise levels resulting from project activities would exceed natural sounds, but would not exceed typical noise levels from construction equipment or generators.	Natural sounds would prevail. Noise generated by the action (whether it be construction or operation) would be infrequent or absent, mostly immeasurable.
	Geographic Extent/Context	County or local		County or local	County or local
	Duration or Frequency	Permanent or long-term		Short term	Temporary

NA = not applicable

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementing the Preferred Alternative could result in deploying various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential noise impacts and while others would not.

In addition, the same type of Proposed Action Infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no noise impacts under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Noise generated by equipment required to install fiber would be infrequent and of short duration, and is not expected to create perceptible impacts.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would require no construction or installation activities, and therefore would have no noise impacts.
- Satellites and Other Technologies
    - Satellite Enabled Devices and Equipment: The duration of construction activities associated with installing permanent equipment on existing structures would most likely be short-term. It is anticipated that insignificant levels of noise would be emitted during installment of this equipment. Noise caused by these construction and installation activities would be similar to other construction activities in the area, such as the installation of cell phone towers or other communication equipment. Deployment and operation of satellite-enabled devices and equipment are expected to have minimal to no impact on the noise environment.
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact noise resources, it is anticipated that this activity would have no impact on those resources.

Activities with the Potential for Noise Impacts

Construction, deployment, and operation activities related to the Preferred Alternative could create noise impacts from either the deployment or operation of the infrastructure. The types of

infrastructure deployment scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to air quality include the following:

- Wired Projects
    - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber as well as land/vegetation clearing, excavation activities, and landscape grading could result in high noise levels from the use of heavy equipment and machinery.
    - New Build – Aerial Fiber Optic Plant: The use of heavy equipment during the installation of new poles and hanging cables, as well as constructing access roads, POP huts, or other associated facilities to house plant equipment would be short-term and could result in increased noise levels from the use of vehicles and machinery.
    - Collocation on Existing Aerial Fiber Optic Plant: Excavation equipment used during potential pole replacement, and other heavy equipment used for structural hardening or reinforcement, could result in temporary increases in noise levels from the use of heavy equipment and machinery.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Installation of new associated huts or equipment, if required, could result in short term and temporarily higher noise levels if the activity required the use of heavy equipment for grading or other purposes.
    - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water could generate noise if vessels are used to lay the cable. In addition, the construction of landings and/or facilities on shore to accept submarine cable could result in short term and temporarily increased noise levels to local residents and other noise sensitive receptors from heavy equipment used for grading, foundation excavation, or other ground disturbing activities.
    - Installation of Optical Transmission or Centralized Transmission Equipment: Noise associated with the installation of optical transmission or centralized transmission equipment would be limited to the short-term, temporary use of vehicle and construction equipment. Long-term impacts are unlikely, as the noise emissions from optical networks are relatively low. Heavy equipment used to grade and construct access roads could generate increased levels of noise over baseline levels temporarily.
- Wireless Projects
    - New Wireless Communication Towers: Activities associated with installing new wireless towers and associated structures (e.g., generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in localized construction noise. Operating vehicles, other heavy equipment, and generators would be used on a short-term basis and could increase noise levels.

- Collocation on Existing Wireless Tower, Structure, or Building: Vehicles and equipment used to mount or install equipment, or to grade or excavate additional land on sites for installation of equipment, such as antennas or microwave dishes on an existing tower, could impact the local noise environment temporarily.
- Deployable Technologies: The type of deployable technology used would dictate the types of noise generated. For example, mobile equipment deployed via heavy trucks could generate noise from the internal combustion engines associated with the vehicles and onboard generators. With the exception of balloons, aerial platforms (e.g., UASs or other aircraft, except balloons) generate noise during all phases of flight, including takeoff, landing, and flight operations over necessary areas that could impact the local noise environment.

In general, noise from the abovementioned activities would be products of site preparation, installation, and construction activities, as well as additional construction vehicles traveling on nearby roads and localized generator use. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the construction impacts. These impacts are expected to be less than significant due to the temporary duration of deployment activities. Additionally, pre-existing noise levels achieved after some months (typically less than a year but could be a few hours for linear activities such as pole construction). 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 similar to several of the deployment activities related to routine maintenance and inspection of the facilities because of the temporary nature of the activities which would not create new permanent sources of noise. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that potential noise impacts would be similar to or less than those described for the deployment activities. If usage of vehicles or heavy equipment as part of routine maintenance or inspections or onsite generator use occurs, potential noise impacts could result as explained above.

8.2.13.5. Alternatives Impact Assessment

The following section assesses potential noise impacts associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred

Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific equipment associated with the Deployable Technologies Alternative would be heavy trucks with onboard generators, aerial vehicles (e.g., UASs or other aircraft), and ground support vehicles and equipment for aerial deployment. The Deployable Technologies Alternative differs from the Preferred Alterative in the number of mobile and aerial vehicles likely to deploy, the distances traveled from storage locations and the duration of deployment. The potential noise impacts are as follows:

Deployment Noise Impacts

Implementing deployable technologies could result in noise from mobile equipment deployed via heavy trucks, including not only onboard generators, but also the vehicles themselves. While a single deployable vehicle may have an insignificant impact, multiple vehicles operating for longer periods, in close proximity, may increase localized noise levels. Several vehicles traveling together could also create short-term noise impacts on residences or other noise-sensitive receptors as they pass by. With the exception of balloons, the deployment of aerial technology is anticipated to generate noise during all phases of flight. Aerial technologies would have the highest level of noise impact if they are required to fly above residential areas, areas with a high concentration of noise-sensitive receptors (i.e., schools or churches), or over national parks or other areas where there is an expectation of quiet and serenity on their way to their final destinations. Residences near deployment areas for aerial technologies (i.e., airports or smaller airfields) could also be affected during takeoff and landing operations. Additionally, routine maintenance and inspections of the deployable technologies are anticipated to be less than significant, given that these activities are of low-intensity and short duration. 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 in the area. However, deployable technologies could be deployed to areas with few existing facilities, so noise impacts could be minimal in those areas. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that potential noise impacts would be the same as those described for the deployment activities. If usage of vehicles or heavy equipment as part of routine maintenance or inspections occurs, potential noise impacts could result as explained above.

Operational impacts from aerial technologies would include repeated flyovers by UAS vehicles while they are needed in the area. This could generate less than significant, short-term impacts on any residential areas or other noise-sensitive receptors under the flight path of these vehicles. However, once these operations cease, noise levels would quickly return to baseline levels. 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. By not deploying the NPSBN, FirstNet would avoid generating noise from construction, installation, or operation of wired, wireless, deployable infrastructure or satellites and other technologies.

8.2.14. Climate Change

8.2.14.1. Introduction

This section describes potential impacts to climate and climate change-vulnerable FirstNet installations and infrastructure 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.

8.2.14.2. 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 8.2.14-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to climate and climate change-vulnerable resources addressed in this section are presented as a range of possible impacts.

CEQ requires the consideration of climate change from two perspectives. The first is the potential for impacts on climate change through GHG emissions resulting from the Proposed Action or alternatives. The second is related to the implications and possible effects of climate change on the environmental consequences of the Proposed Action or alternatives. This extends to the impacts of climate change on facilities and infrastructure that would be part of the Proposed Action or alternatives (CEQ, 2014).

CEQ has established the significance criteria for GHG emissions at 25,000 MT CO_2e on an annual basis, with the requirement that if projected emissions exceed this threshold, a GHG emissions quantitative analysis is warranted (CEQ, 2014). Although 25,000 MT is a very small fraction (one 266,920th) of the total U.S. emissions of 6,673 MMT in 2013 (USEPA, 2015l), the sum of additional emissions as a consequence of the deployment of FirstNet, combined with

multiple new sources of CO_2 and other GHGs from other projects and human activities, could be significant.

CEQ guidance for the consideration of effects of climate change on the environmental consequences of the Proposed Action is more general. In addition to the consideration of climate change's effects on environmental consequences, it also includes the impact that climate change may have on the projects themselves (CEQ, 2014). Projects located in areas that are vulnerable to the effects of climate change (e.g., sea level rise) may be at risk. Analysis of these risks through the NEPA process can provide useful information to the project planning to ensure these projects are resilient to the impacts of climate change.

8.2.14.3. 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) is also expected to increase, with the most intense heat waves occurring under higher emissions scenarios. Increases in temperature would also impact precipitation events, sea level rise, and ocean water acidity (USGCRP, 2014a).

Air Temperature

Figure 8.2.14-1 and Figure 8.2.14-2 below illustrate the anticipated temperature changes for low and high GHG emission scenarios for Massachusetts from a 1969 to1971 baseline.

Cfa – Figure 8.2.14-1 shows that by mid-century (2040 to 2059) temperatures in the entire state of Massachusetts 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 will increase by approximately 6 °F in the Cfa region (USGCRP, 2009).

Figure 8.2.14-2 shows that by mid-century (2040 to 2059) temperatures in the entire state of Massachusetts under a high emissions scenario will increase by approximately 5°F. By the end of the century (2080 to 2099) temperatures in the Cfa region of the state are expected to increase by approximately 8 °F (USGCRP, 2009).

Dfb – Temperatures in this region are expected to increase by mid-century (2040 to 2059) under a low emissions scenario at the same rate as the Cfa region. By the end of the century temperatures under a low emissions scenario will increase by 5 °F (USGCRP, 2009).

By mid-century (2040 to 2059), temperatures are expected to increase at the same rate as the Cfa region under a high emissions scenario. By the end of the century, (2080 to 2099) temperatures in the Dfb region are expected to increase by approximately 9 °F (USGCRP, 2009).

Table 8.2.14-1: Impact Significance Rating Criteria for Climate

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	Exceedance of 25,000 metric tons of CO_2e/year, and global level effects observed	Effect that is potentially significant, but with mitigation is less than significant	Only slight change observed	No increase in GHG emissions or related changes to the climate as a result of project activities
	Geographic Extent	Global impacts observed		Global impacts observed	NA
	Duration or Frequency	Long-term changes. Changes cannot be reversed in a short term		Changes occur on a longer time scale. Changes cannot be reversed in the short term	NA
Effect of climate change on FirstNet installations and infrastructure	Magnitude or Intensity	Climate change effects (such as sea level rise or temperature change) negatively impact FirstNet infrastructure	Effect that is potentially significant, but with mitigation is less than significant	Only slight change observed	No measurable impact of climate change on FirstNet installations or infrastructure
	Geographic Extent	Local and regional impacts observed		Local and regional impacts observed	NA
	Duration or Frequency	Long-term changes. Changes cannot be reversed in a short term		Changes occur on a longer time scale. Changes cannot be reversed in the short term	NA

NA = not applicable

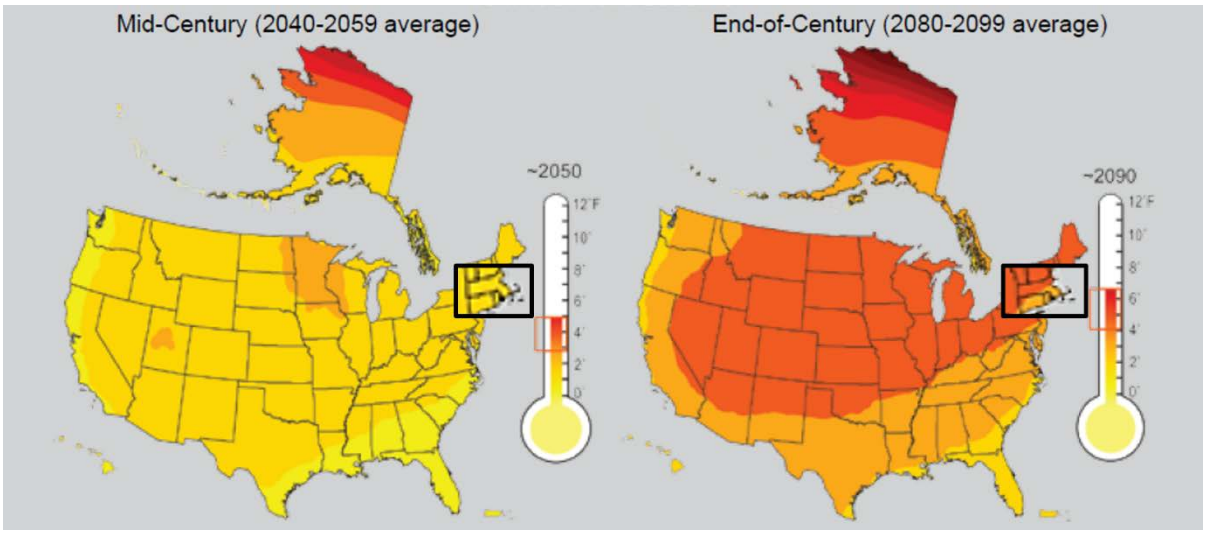


Figure 8.2.14-1: Massachusetts Low Emission Scenario Projected Temperature Change

Source: (USGCRP 2009)

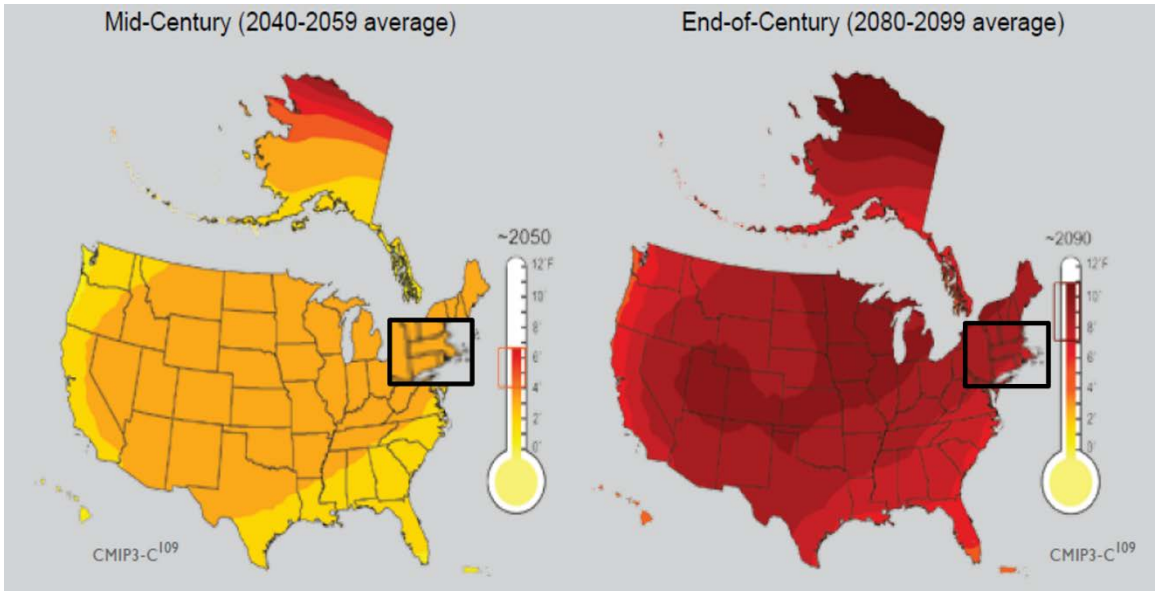


Figure 8.2.14-2: Massachusetts High Emission Scenario Projected Temperature Change

Source: (USGCRP 2009)

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 8.2.14-3 and Figure 8.2.14-4 show predicted seasonal precipitation change for an approximate 30-year period of 2071 to 2099 compared to a 1970 to 1999 approximate 30-year baseline. Figure 8.2.14-3 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 8.2.14-4 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 that 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 8.2.14-3 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 Massachusetts. However, there are no expected increases in precipitation in fall other than fluctuations due to natural variability (USGCRP, 2014b).

Figure 8.2.14-4 shows that if emissions continue to increase, winter and spring precipitation could increase as much as 20 percent over the period 2071 to 2099. In summer, precipitation in this scenario could increase as much as 10 percent. No significant change in fall precipitation is expected for the Cfa portion of Massachusetts (USGCRP, 2014b).

Dfb – Precipitation changes for the Dfb region are consistent with projected changes for the Cfa region with the exception of fall in a high emissions scenario in which precipitation could increase up to 20 percent over the period 2071 to 2099 (USGCRP, 2014b).

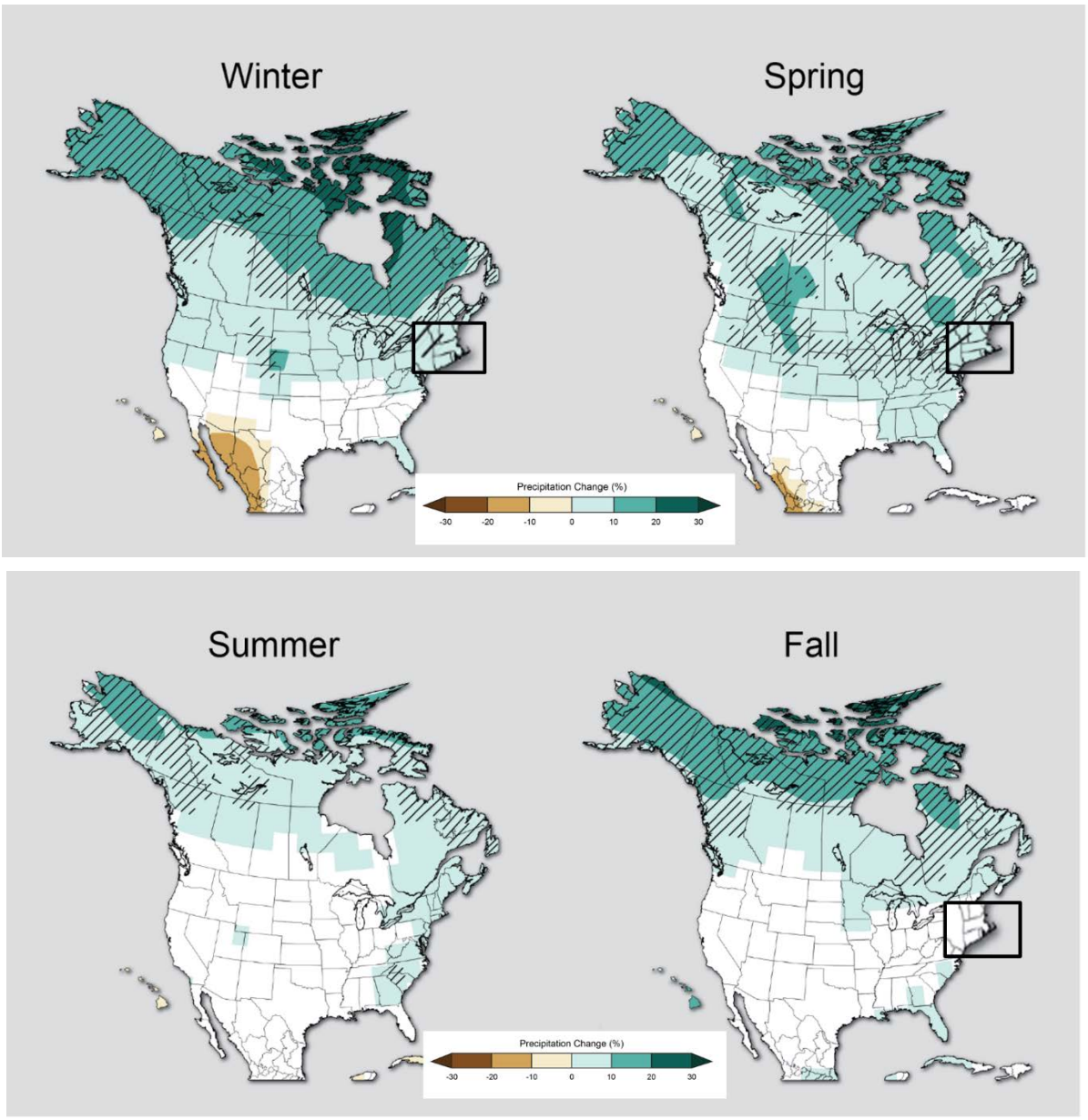


Figure 8.2.14-3: Predicted Seasonal Precipitation Change for 2071 to 2099 Compared to 1970 to 1999 Baseline in a Low Emissions Scenario

Source: (USGCRP, 2014b)

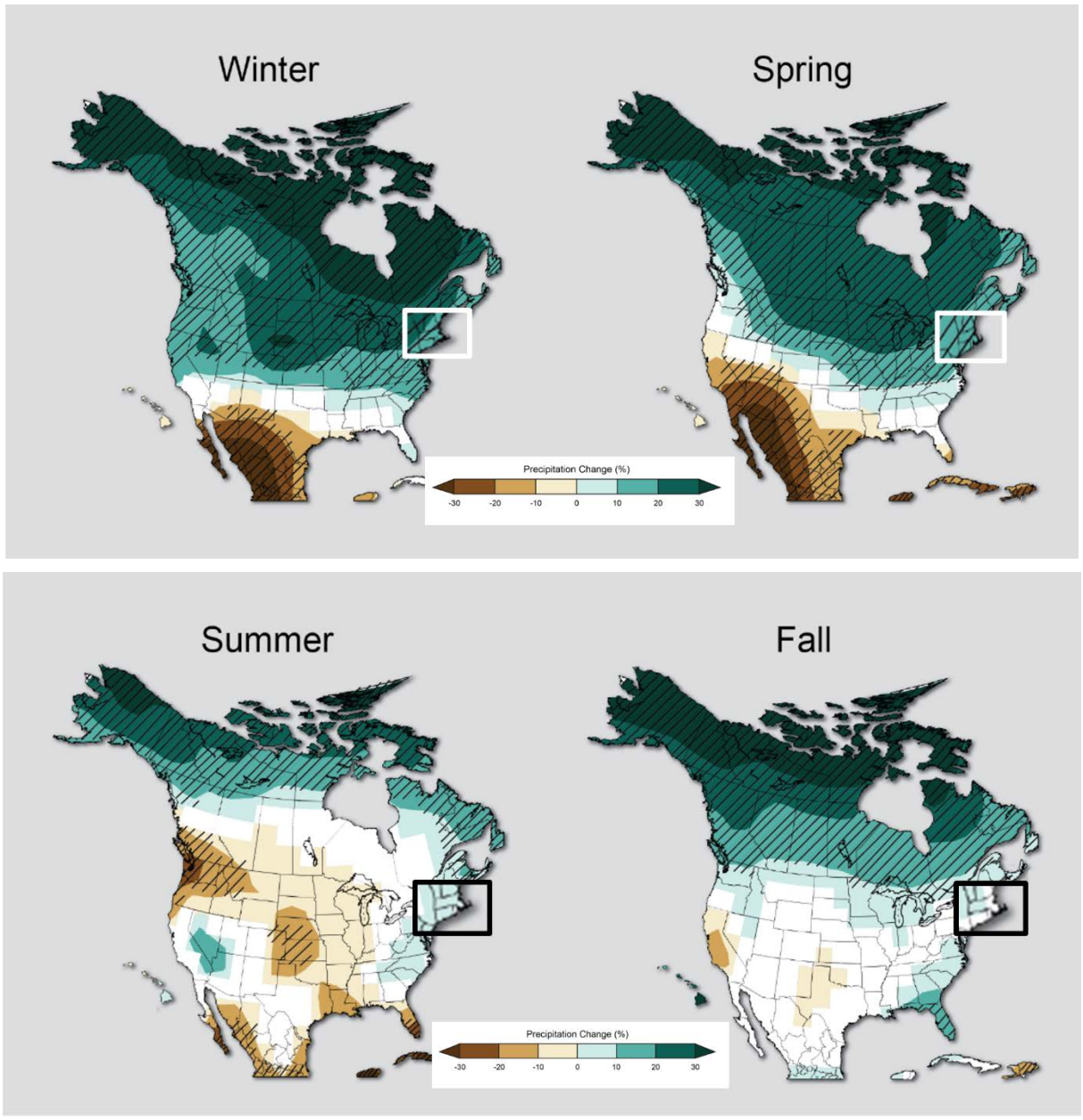


Figure 8.2.14-4: Predicted Seasonal Precipitation Change for 2071 to 2099 Compared to 1970 to 1999 Baseline in a High Emissions Scenario

Source: (USGCRP, 2014b)

Sea Level

Several factors would continue to affect sea level rise in the future. Glacier melt adds water to the ocean, and increasing ocean temperatures result in thermal expansion. Worldwide, "glaciers have generally shrunk since the 1960s, and the rate at which glaciers are melting has accelerated over the last decade. The loss of ice from glaciers has contributed to the observed rise in sea level" (USEPA, 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). Sea level and currents can be influenced by the amount of heat stored in the ocean (USEPA, 2012e).

The amount of sea level rise would vary in the future along different stretches of the U.S. coastline and under different absolute global sea level rise scenarios. Variation in sea level rise along different stretches of coast is mostly due to varying rates of land subsidence (also known as relative sea level rise). In the National Climate Assessment (NCA), potential sea level rise scenarios were reported. These scenarios were developed based on varying degrees of ocean warming and ice sheet loss as estimated by organizations like IPCC (NOAA, USGS, SERDP, USACE, 2012). Figure 8.2.14-5 and Figure 8.2.14-6 show feet of sea level above 1992 levels at different tide gauge stations. Figure 8.2.14-5 shows an 8 inch global sea level rise above 1992 levels by 2050 and Figure 8.2.14-6 shows a 1.24 foot global sea level rise above 1992 levels by 2050 (USGCRP, 2014c).

Cfa – Figure 8.2.14-5 presents an 8-inch global average sea level rise above 1992 levels resulting in a .7 to 1 foot sea level rise in 2050 on the coast of Massachusetts. Figure 8.2.14-6 indicates that a 1.24-foot sea level rise above 1992 level would result in a 1.3 to 1.7 foot sea level rise in 2050 along the coast of Massachusetts.

Dfb – The Dfb region is not affected by sea level rise.

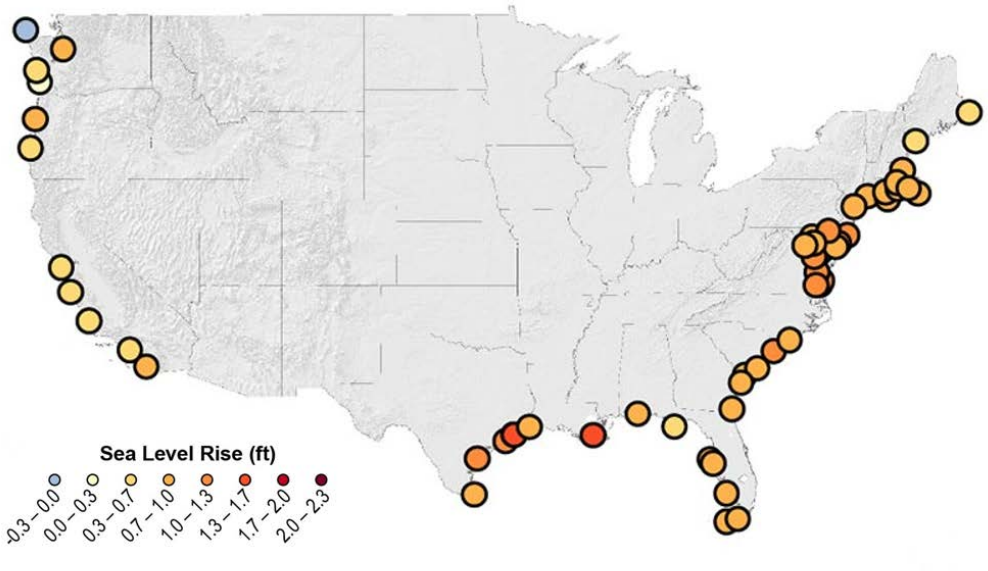


Figure 8.2.14-5: 8-inch Sea Level Rise Above 1992 Levels by 2050

Source: (USGCRP, 2014c)

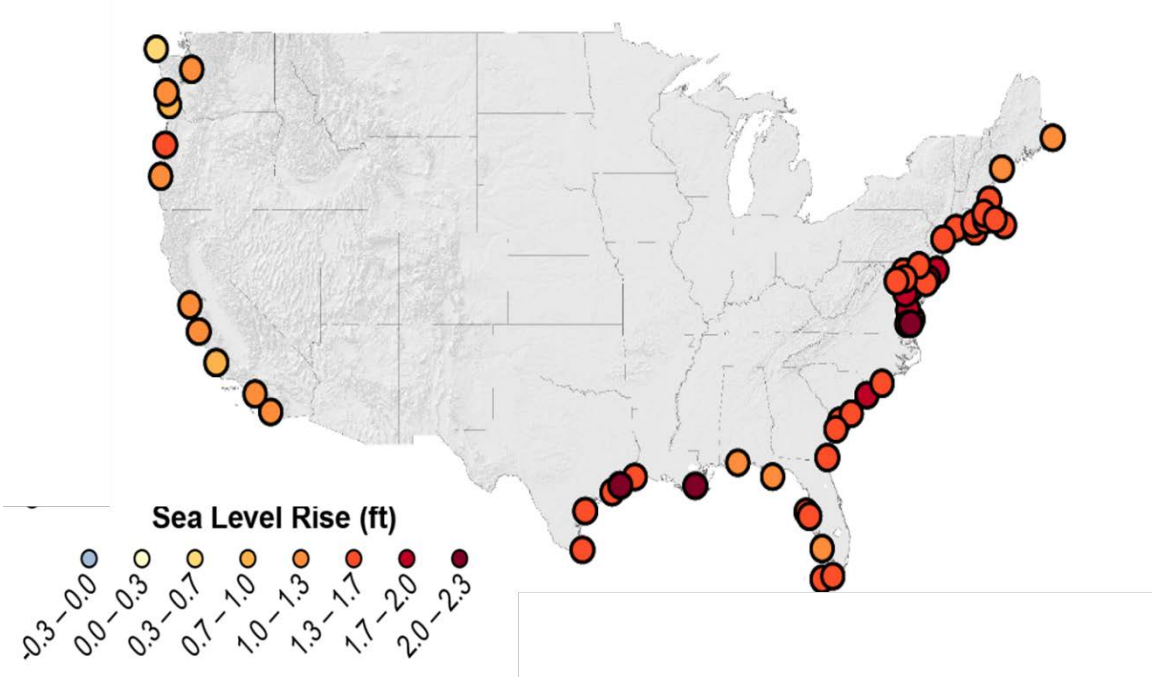


Figure 8.2.14-6: 1.24-foot Sea Level Rise Above 1992 Levels by 2050

Source: (USGCRP, 2014c)

Severe Weather Events

It is difficult to forecast the impact of climate change on severe weather events such as thunderstorms and hurricanes. Trends in thunderstorms and hurricanes are subject to greater uncertainties than trends in temperature and associated variables directly related to temperature such as sea level rise. Climate scientists are studying the influences of climate change on severe storms such as hurricanes. Recent research has yielded insights into the connections between warming and factors that cause severe storms. For example, atmospheric instability and increases in wind speed with altitude link warming with tornadoes and thunderstorms. Additionally, research has found a link between warming and conditions favorable for severe thunderstorms. However, more research is required to make definitive links between severe weather events and climate change (USGCRP, 2014d).

United States coastal waters are expected to experience more intense hurricanes with related increases in wind, rain, and storm surges (but not necessarily an increase in the number of storms that make landfall) (USGCRP, 2014d). Changes in hurricane intensity are difficult to project because there are contradictory effects at work. Warmer oceans increase storm strength with higher winds and increased precipitation. However, changes in wind speed and direction with height are also projected to increase in some regions; this tends 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).

8.2.14.4. 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 8.2.14-1, climate change impacts as a result of GHG emissions could be significant and require a quantitative analysis if FirstNet's deployment of technology was responsible for increased emissions of 25,000 MT/year or more. The GHG emissions resulting from FirstNet activities fall into two categories: short-term and long-term. Short-term emissions could be associated with deployment activities (vehicles and other motorized construction equipment) and would have no long-term or permanent impact on GHG emissions or climate change. Long-term (both temporary and permanent) emission increases could result from operations, including the use of grid-provided electricity by FirstNet equipment such as transmitters and optical fiber, and from the temporary use of portable or onsite electric generators (a less efficient, more carbon-intensive source of electricity), during emergency situations when the electric grid was down, for example after a hurricane.

A single large cell tower would typically require 20-60kW of power to operate (Balshe, 2011). The CO_2 emissions associated with the operation of the tower would depend on whether it was supplied by a stand-alone power source, such as a generator, or from the grid, and whether it was operating at full power on a continuous basis. A standard 60kW 3-phase diesel generator consumes approximately 5.0 gallons of diesel per hour (Multiquip, 2015). Diesel fuel combustion emits 22.38 lbs. of CO_2 per gallon (EIA, 2015g). A 60kW transmitter running on a generator would therefore be responsible for 1,221 kg of CO_2/day. Running continuously, the tower would cause the emission of 446 MT of CO_2 per year.

However, grid-provided electricity is less carbon-intensive, and would generate approximately 240 MT of CO_2 per year for the same equipment, depending on the region of the U.S. where the electricity was generated (USEPA, 2014e). Furthermore, the components of the system would not necessarily all be this large, running all the time, or at full power. Some may even run on low/no-emissions renewable energy. Therefore, this scenario is a "worst-case" for GHG emissions. If the system deployment resulted in the operation of more than 50 60 kW towers operating at maximum power in remote locations on diesel generators on a continuous basis, the 25,000 MT/year threshold may be exceeded and a quantitative analysis required. By comparison optical fiber is considerably more energy efficient and consumes considerably less power than transmitters (Willem Vereecken, 2011), and would not impact GHG emissions in such a way as to require a quantitative analysis.

Impact of Climate Change on Project-Related Resource Effects

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 resource availability, and recreation. These effects would vary from state to state depending on the resources in question and their relationship to climate change. 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.

Climate change-related sea level rise is already affecting Massachusetts and is anticipated to have multiple negative impacts including beach erosion, damage to infrastructure and housing, and repercussions throughout the economy (EEA, 2011) (USGCRP, 2014e). Climate change is expected to increase the frequency and intensity of heavy downpours as the 21st century progresses (USGCRP, 2014f). This will have consequences for both natural and built environments. For natural ecosystems, it would result in increased nutrient and sediment inputs to already stressed receiving waters, and negative impacts on both aquatic flora and fauna (USGCRP, 2014e). Average summer temperatures, the number of heating degree days, and the intensity and duration of summer heat waves in Massachusetts are expected to increase, with negative consequences for public health, air quality, and water quality, putting pressure on public health infrastructure and institutions (EEA, 2011) (USGCRP, 2014f).

Impact of Climate Change on FirstNet Installations and Infrastructure

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.

Coastal Massachusetts is at risk for stronger hurricanes as a result of climate change (USGCRP, 2014g). Sea level rise would increase the height, areal extent, and persistence of coastal flooding during these events. Stronger storms may also increase the potential for damage from high winds and wind-borne debris. Inland areas of Massachusetts at risk of increased flooding, as climate change is projected to increase the frequency and severity of torrential downpours which in turn may increase the potential for flash flooding (USGCRP, 2014f). Rising summer temperatures and the increased intensity and duration of heat waves will raise electricity demand for air conditioning and may strain electrical grid operations (DOE, 2015) while sustained high temperatures may overwhelm the capacity on-site equipment needed to keep microwave and other transmitters cool.

8.2.14.5. Potential Impacts of the Preferred Alternative

Greenhouse Gas Emissions

The following section assesses potential GHG emission impacts associated with implementation of the Preferred Alternative in Massachusetts, including deployment and operation activities.

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment and operation of various types of facilities or

infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to GHG emissions, climate impacts in other resource areas, and FirstNet infrastructure and operations, and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result in a range of no impacts to less than significant impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to climate change under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: There would be no short-term emissions associated with construction, as construction would not take place. The equipment required to blow or pull fiber through existing conduit would be used temporarily and infrequently, resulting in no perceptible generation of GHG emissions.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would require no construction and have no short- or long-term emissions. This would create no perceptible change in GHG emissions.
- Satellites and Other Technologies
    - Satellite Enabled Devices and Equipment: The installation of satellite-enabled equipment on existing structures, or the use of portable satellite-enabled devices would not create any perceptible changes in GHG emissions because they would not create any new emissions sources.
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. Therefore, it is anticipated that there would be no GHG emissions or any climate change effects on the project because of these activities.

Potential to Have Impacts

The deployment and use of energy-consuming equipment as a result of the implementation of the Preferred Alternative would result in GHG emissions whose significance would vary depending on their power requirements, duration and intensity of use, and number. The types of infrastructure deployment scenarios that could be part of the Preferred Alternative and result in potential impacts to GHG emissions and climate change include the following:

- Wireless 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 backup), 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 backup), 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 in excess of 25,000 MT if operated in large numbers over the long-term. However, this would be highly dependent on their size, number, and the frequency and duration of their use. Emissions associated with the deployment and maintenance of a complete network solution of this type may be significant if large numbers of piloted or unmanned aircraft were used for a sustained period of time (i.e. months to years). Emissions would depend on the type of platforms used, their energy consumption, and the duration of the network's operation.

Potential climate change impacts associated with deployment activities as a result of implementation of the Preferred Alternative include increased GHG emissions. GHG emissions would arise from the combustion of fuel used by equipment during construction and changes in land use. Emissions occurring as a result of soil disturbance and loss of vegetation are expected to be less than significant 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 partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Climate Change Impacts on FirstNet Infrastructure or Operations

Climate change effects on the Preferred Alternative could be potentially significant to less than significant with BMPs and mitigation measures incorporated because climate change may potentially impact FirstNet installations or infrastructure during periods of extreme heat, severe storms, and other weather events. FirstNet installations should be evaluated in the design and planning phase through tiering to this analysis, in the context of their local geography and anticipated climate hazards to ensure they are properly hardened or there is sufficient redundancy to continue operations in a climate-affected environment. Mitigation measures could minimize or reduce the severity or magnitude of a potential impact resulting to the project, including adaptation, which refers to anticipating adverse effects of climate change and taking appropriate action to prevent and minimize the damage climate change effects could cause.

Climate change's anticipated impact on extreme weather events such as hurricanes or heat waves may increase the severity of the emergencies to which first responders are responding in vulnerable areas, and thus the extent and duration of their dependence on FirstNet resources. FirstNet would likely prepare to sustain these operations in areas experiencing climate and weather extremes through the design and planning process for individual locations and operations.

8.2.14.6. 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 minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration.

Potential 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 based on the defined significance criteria, since activities would be temporary and short-term.

Potential Operations Impacts

Implementing land-based deployable technologies (COW, COLT, SOW) could result in emissions from mobile equipment on heavy trucks using internal combustion engines associated with the vehicles and onboard generators. While a single deployable vehicle may have an insignificant impact, multiple vehicles operating for longer periods, in close proximity, may have a cumulative impact, although this impact is expected to be less than significant. 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

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 few GHG emissions associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Emissions would arise from use of power generators as the main power source. Emissions from the use of one fossil-fuel-powered generator would not be significant based on the defined significance criteria, since activities would be temporary and short-term. These potential impacts could be further reduced through implementation of the

required BMPs and mitigation measures. These projects may also consist of deploying aerial vehicles including, but not limited to, drones, balloons, blimps, and piloted aircraft, which could involve fossil fuel combustion. Climate change effects have the most noticeable impacts over a long period of time. Climate change effects such as temperature, precipitation changes, and extreme weather during operations would be expected but could have little to no impact on the deployed technology 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.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure, or satellites and other technologies. As a result, there would be no impacts to GHG emissions or climate as a result of deployment and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.14, Climate Change.

8.2.15. Human Health and Safety

8.2.15.1. Introduction

This section describes potential impacts to human health and safety in Massachusetts associated with deployment 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.

8.2.15.2. 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 8.2.15-1. As described in Section 8.2, Environmental Consequences, the categories of impacts are defined as potentially significant, less than significant with mitigation incorporated, less than significant, or no impact. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to human health and safety addressed in this section are presented as a range of possible impacts.

Table 8.2.15-1: Impact Significance Rating Criteria for Human Health and Safety

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with 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, Toxic Substances Control Act (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

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 Occupational Hazards as a Result of Natural And Manmade Disasters	Magnitude or Intensity	Exposure to concentrations of chemicals above regulatory limits, or USEPA chemical screening levels protective of the general public. Site contamination conditions could preclude development of sites for the proposed use. Physical and biologic hazards. Loss of medical, travel, and utility infrastructure.	Effect is potentially significant, but with mitigation is less than significant.	No exposure to chemicals above health-protective screening levels. Hazardous or toxic materials or wastes could be safely and adequately managed in accordance with all applicable regulations and policies, with limited exposures or risks. No exposure to unsafe conditions. No loss of medical, travel, or utility infrastructure.	No exposure to chemicals, unsafe conditions, or other safety and exposure hazards.
	Geographic Extent	Regional impacts observed ("regional" assumed to be at least a county or county-equivalent geographical extent, could extend to state/territory)		Impacts only at a local/neighborhood level.	NA
	Duration or Frequency	Occasional frequency during the life of the project.		Rare event	NA

NA = not applicable

8.2.15.3. 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 8.2.15-1, 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 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, 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 Massachusetts Executive Office of Labor and Workforce Development (EOLWD) is not authorized by OSHA to administer a state program for public or private sector employers. Therefore, EOLWD defers all regulatory authority and enforcement for occupational safety relating to FirstNet site work to the leadership and interpretation of OSHA.

Hazardous Materials, Hazardous Waste, and Mine Lands

The presence of environmental contamination and mine lands at FirstNet deployment sites has the potential to negatively impact health and safety of workers and the general public. 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 8.2.15-1, human health impacts could be significant if FirstNet deployment sites are near contaminated properties or abandoned 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 MassDEP, 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. If sites containing known environmental contamination (or mine lands) are selected for proposed FirstNet deployment activities it may be necessary to implement additional controls (e.g., engineering, work practice, administrative, and/or PPE) to ensure workers, and the general public, are not unnecessarily exposed to the associated hazards. Additionally, for any proposed FirstNet deployment site, it is possible undocumented environmental contamination is present.

During 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. Proposed FirstNet deployment would attempt to avoid known contaminated sites. However, in the event that FirstNet is unable to avoid a contaminated site, then site analysis and remediation would be required under RCRA, 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 MassDEP 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

FirstNet is intended to improve connectivity among public safety entities during disasters, thereby improving their ability to respond more safely and effectively during such events. The addition of towers, structures, facilities, equipment, and other deployment activities is expected to allow for expedited responses during 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. Telecommunications, including public safety communications, can be knocked out (temporarily or permanently) during disaster events.

Based on the impact significance criteria presented in Table 8.2.15-1, 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 partner(s) would develop disaster response plans that outline specific steps employees should take in the event of a natural or manmade disaster.

8.2.15.4. 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

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to human health and safety under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: the pulling or blowing of fiber optic cable would be performed through existing conduit. Use of mechanical equipment would be limited to pulley systems and blowers. Some locations with no existing power supply may require the use of electrical generators. Hazardous materials needed for this work would include fiber optical cable lubricants, mechanical oil/grease, and fuel for electrical generators although these materials are expected to be used infrequently and in small quantities. These activities are not likely to result in serious injury or chemical exposure, or surface disturbances since work would be limited to existing entry and exit points, would be temporary, and intermittent. It is anticipated that there would be no impacts to human health and safety.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts 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 on those resources.

Activities with the Potential to Have Impacts

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no impacts to human health and safety under the conditions described below:

- Wired Projects
    - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber would require the use of heavy equipment and hazardous materials. The additional noise and activity at the site would require workers to demonstrate a high level of situational awareness. Failure to follow OSHA and industry controls could result in injuries. Excavation of soil at proposed sites known to contain environmental contamination has the potential to expose workers to harmful chemicals or releases that could impact the general public in the immediate vicinity. Additionally, some of this work would likely be performed along road ROWs, increasing the potential for vehicle traffic to collide with site workers or equipment. If a proposed deployment

activity involves the operation of heavy equipment, managing hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.

- New Build – Aerial Fiber Optic Plant: Installation of new poles and fiber optic lines would require excavation activities, working from heights, use of hazardous materials, and site locations in ROWs. Hazards associated with the site work include injury from heavy equipment, fall hazards, chemical hazards, and the potential for vehicle traffic to collide with site workers or equipment. Excavation of soil at proposed sites known to contain environmental contamination has the potential to expose workers to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.
- Collocation on Existing Aerial Fiber Optic Plant: Installation of overhead fiber optic lines would require work from height. In some instances, new poles would be installed requiring excavation activities with heavy equipment. Hazards associated with the site work include injury from heavy equipment, fall hazards, chemical hazards, and the potential for vehicle traffic to collide with site workers or equipment. Excavation of soil at proposed sites known to contain environmental contamination has the potential to expose workers to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.
- New Build – Submarine Fiber Optic Plant: The installation of fiber optic cables in limited nearshore and inland bodies of water requires workers to operate over aquatic and/or marine environments, which presents opportunities for drowning. When working over water exposure to sun, high or low temperatures, wind, and moisture could impact worker safety. Construction of landings and/or facilities on shore to accept submarine cable would require site preparation, construction, and management of hazardous materials and hazardous waste. Excavation of soils or sediments at proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.
- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of transmission equipment would require site preparation, construction activities, and management of hazardous materials and hazardous waste. Excavation of soils at proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of

heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads would require site preparation, construction activities, and management of hazardous materials and hazardous waste. Communication towers would be erected, requiring workers to perform their duties from heights sufficient to result in serious injury or death in the event of falling. Working from heights may also result in additional overhead hazards and falling objects. Excavation of soils at proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower. This would require workers to perform their duties from heights sufficient to result in serious injury or death in the event of falling not result in impacts to soils. Working from heights may also result in additional overhead hazards and falling objects. Excavation of soils at proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider. For a discussion of radio frequency emissions, 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 could potentially impact human health; and vehicles and heavy equipment present the risk of workplace and road traffic accidents that could result in injury. Set-up of a cellular base station contained in a trailer with a large expandable antenna mast is not expected to result in impacts to human health and safety. However, due to the larger size of the deployable technology, site preparation or trailer stabilization may be required to ensure the self-contained unit is situated safely at the site. Additionally, the presence of a dedicated electrical generator would produce fumes and noise. The possibility of site work and the operation of a

dedicated electrical generator have the potential for impacts to human health and safety. For a discussion of 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 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, and release of historic contamination to the surrounding environment. It is anticipated that potential health impacts associated with human exposure to environmental hazardous materials in air, water, or soil, the risk of road traffic, workplace accidents and injuries, noise exposure, and risk of infectious disease transmission would be less than significant 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 could be necessary to adequately protect workers. If usage of heavy equipment is part of routine maintenance, the potential for impacts to human health and safety would also increase. It is anticipated that potential health impacts associated with human exposure to environmental hazardous materials in air, water, or soil, the risk of road traffic, workplace accidents and injuries, noise exposure, and risk of infectious disease transmission would be less than significant 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.

8.2.15.5. Alternatives Impact Assessment

The following section assesses potential impacts to human health and safety associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable land-based infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to human health and safety as a result of implementation of this alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in less than significant impacts to human health and safety. The largest of the land-based deployable technologies may require site preparation work or stabilization work to ensure the self-contained trailers are stable. Heavy equipment may be necessary to complete the site preparation work. However, in general, the deployable technologies are small mobile units that could be transported as needed. While in operation, the units are parked and operate off electrical generators or existing electrical power sources. Connecting deployable technology to a power supply may present increased electrocution risk during the process of connecting power. If the power source is an electrical generator, then there would also likely be a need to manage hazardous materials (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 exposure, and risk of infectious disease transmission would be less than significant 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 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 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 to human health and safety as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 8.1.15, Human Health and Safety.

MA APPENDIX A – WATER RESOURCES

Table A-1: Characteristics of Massachusetts's Watersheds, as Defined by MassDEP

Watershed/Size Land Area within MA (square miles)	Major Surface Waterbodies	Major Water Quality Concerns
Blackstone River (382)	Blackstone River Lake Quinsigamond Manchaug Pond Mill River Mumford River Peters River Quinsigamond River West River	• Illicit connections/hook-ups to storm sewers, • Discharges from municipal separate storm sewer systems (MS4), and • Urban stormwater
Boston Harbor (293)	Back River Boston Harbor Dorchester Bay Fore River Hingham Bay Hull Bay Mystic River Neponset River Pleasure Bay Quincy Bay Weir River Winthrop Bay	• Stormwater discharge, • Combined sewer overflow, and • Municipal separate storm sewer systems
Buzzards Bay (432)	Acushnet River Agawam River Allens Pond Atwood Bog Copicut Reservoir Lake Noquochoke New Bedford Reservoir Paskamansett River Sampson Pond Sippican River Snell Creek Turners Pond Wareham River Westport River Weweantic River	• Non-point source pollution, • Excess nitrogen, • PCB contamination, and • Non-native plant species
Cape Cod (440)	Long Pond Mashpee Pond Wakeby Pond Wequaquet Lake	• Excess nitrogen from onsite septic systems, municipal wastewater treatment plants, irrigation, or road runoff.
Charles River (308)	Charles River Echo Lake Mill River Mine Brook Muddy River Populatic Pond Stony Brook	• Municipal wastewater discharges, • Combined sewer overflows, and • Urban stormwater

Watershed/Size Land Area within MA (square miles)	Major Surface Waterbodies	Major Water Quality Concerns
Chicopee River (720)	Chicopee River Quabbin Reservoir Quabog River Swift River Ware River	• Stormwater runoff, • Failing sewage disposal systems, and • Agricultural runoff
Connecticut River (660)	Chicopee River Connecticut River Deerfield River Millers River Westfield	• Stormwater runoff from developed areas, • Combined sewer overflows, • Riverbank erosion and sedimentation, • Runoff of pesticides and fertilizers from lawns, • Industrial wastes
Deerfield River (347)	Chickley River Clesson Brook Cold River Deerfield River Green River Mill Brook North River Pelham Brook Pelham Lake Plainfield Pond South River	• Localized illegal dumping, • Acid mine drainage, • Stormwater runoff, • Failing septic systems, and • Agricultural activities
Farmington River (156)	Benton Brook Big Pond Buck River Clam River Cone Brook Dimmock Brook Fall River Hubbard Brook Otis Reservoir Sandy Brook Shales Brook Silver Brook Thomas Brook Valley Brook West Branch Farmington River	• Aboveground/underground storage tanks, • Failed septic systems, • Landfills leachate, and • Storage, spreading, and handling of road salt
French and Quinebaug Rivers (251)	East Brimfield Reservoir French River Hamilton Reservoir Lower Quinebaug Upper Quinebaug Webster Lake	• Legacy industrial discharges, • Septic leachate, • Non-native plant species, and • Municipal wastewater treatment
Housatonic River (504)	Green River Hubbard Brook Konkapot River Williams River	• Industrial discharges (PCBs), and • Invasive plant species
Hudson River (240)	Berry Pond Bash Bish Brook Hoosic River Hudson River Kinderhoook Creek	• Urban development, • Legacy industrial discharges, and • Agricultural runoff

Watershed/Size Land Area within MA (square miles)	Major Surface Waterbodies	Major Water Quality Concerns
Ipswich River (155)	Boston Brook Emerson Brook Fish Brook Howlett Brook Lubbers Brook Maple Meadow Brook Martins Brook Miles River Norris Brook Plum Island Sound	• Agricultural runoff, • Hazardous waste contamination in municipal wells, and • Urban development runoff
Martha's Vineyard Island (89)	Chilmark Pond Edgartown Great Pond Katama Bay Lagoon Pond Menemsha Pond Oyster Pond Sengekontacket Pond Tashmoo Pond Tisbury Great Pond	• On-site residential septic systems, and • Industrial/agricultural plants pollution
Merrimack River (275)	Beaver Brook Little River Powow River Salmon Brook Spicket River Stony Brook	• Combined sewer overflows, • Urban runoff, and • Excessive nutrients due to urban development
Millers River (320)	Gales Brook Lake Rohunta Lawrence Brook Millers River Moss Brook Otter River Priest Brook Tarbell Brook Tully River West Brook Whetstone Brook	• Industrial and municipal wastewater treatment plant discharges, • Untreated road runoff, illegal dumping, and road salt
Mount Hope/Narragansett Bay (112)	Cole River Kickamuit River Lees River Mount Hope Bay Narragansett Bay North Wattupa Quequechan River Palmer River Runnins River South Wattupa	• Discharges from sewer overflows, • Agricultural/Industrial pollution, • Low dissolved oxygen levels/excess nutrients, and • Pathogens
Nantucket Island (49)	Folgers Marsh Hummock Pond Long Pond/Hither Creek Milacomet Pond Sesachacha Pond	• Excessive nutrients from point/nonpoint source pollution, and • Discharges from sewage treatment facilities

Watershed/Size Land Area within MA (square miles)	Major Surface Waterbodies	Major Water Quality Concerns
Nashua River (454)	Bowers Brook James Brook Mulpus Brook Nashua River Philips Brook Squannacook River Wachusett Reservoir Whitman River	• Pollution from agriculture, municipal development, and stormwater runoff
North Coastal (168)	Annisquam River Chebacco Lake Danvers River Essex River Lake Quannapowitt North River Pines River Saugus River	• Urban runoff, • Discharges from sewage treatment facilities, • Excessive nutrients/low dissolved oxygen, and • Invasive species
Parker River (82)	Bachelder Brook Beaver Brook Jackman Brook Little River Mill River Ox Pasture Brook Penn Brook Plum Island Sound Rowley River Wheeler Brook	• Discharges from wastewater treatment facilities • Nonpoint source pollution resulting in excessive nutrients/low dissolved oxygen
Shawsheen River (78)	Content Brook Elm Brook Fosters Pond Heath Brook Shawsheen River Spring Brook Strong Water Brook Vine Brook	• Failing septic systems, • Non-native plant species, • Pathogens, and • Stormwater runoff
South Coastal (241)	Eel River Gulf/Bound Brook Jones River North River Silver Lake South River	• Failing septic systems, and • Stormwater runoff containing industrial/agricultural waste
Sudbury-Assabet-Concord (377)	Assabet River Concord River Lake Cochituate Sudbury Reservoir Sudbury River Whitehall Reservoir	• Invasive aquatic species, • Stormwater runoff, and • Wastewater treatment plant discharges

Watershed/Size Land Area within MA (square miles)	Major Surface Waterbodies	Major Water Quality Concerns
Taunton River (562)	Assawompset Pond Assonet River Great Quittacas Pond Long Pond Matfield River Mill River Nemasket River Taunton River Threemile River Town River	• Pathogens, • Urban development pollution, • Industrial operations pollution, • Non-native plant species, and • Minimal storm water detention or other treatment
Ten Mile River (54)	Bungay River Coles Brook Fourmile Brook Greenwood Lake Manchester Pond Reservoir Scott's Brook Sevenmile River Speedway Brook Ten Mile River	• Urban development pollution, • Industrial operations pollution, • Discharges from storm sewer systems, • Non-native plant species
Westfield River (517)	Bear Hole Reservoir Borden Brook Cobble Mountain Reservoir Granville Reservoir McLean Reservoir Westfield River	• Non-native plant species, • Municipal wastewater treatment plants discharges, and • Urban development pollution

Source: (Pioneer Valley Planning Commission, 2001), (Millers River Watershed Advisory Committee, 2004), (Commonwealth of Massachusetts, 2015e), (MassDEP, 2015aa), (MassDEP, 2002b), (MassDEP, 2015bb), (MassDEP, 2004a), (MassDEP, 2002c), (MassDEP, 2015cc), (MassDEP, 2003b), (MassDEP, 2015dd), (USEPA, 2014b), (MassDEP, 2006a), (MassDEP, 2015j), (MassDEP, 2001), (MassDEP, 2015ee), (MassDEP, 2006b), (MassDEP, 2006c), (MassDEP, 2005a), (MassDEP, 2004b), (MassDEP, 2002d), (MassDEP, 2015ff) (Martha's Vineyard Commission, 2006), (MassDEP, 2003c), (MassDEP, 2003d), (MassDEP, 2015gg), (MassDEP, 2003e), (MassDEP, 1999), (MassDEP, 2015l) (MassDEP, 2005b), (USEPA, 2007), (Buzzards Bay NEP, 2013), (MassDEP, 2003f), (MassDEP, 2015hh), (MassDEP, 2004c), (MassDEP, 2008), (MassDOT, 2010), (MassDEP, 2010b), (MassDEP, 2015ii)

MA APPENDIX B – COMMUNITIES OF CONCERN

Table B-1: S1-Ranked Terrestrial Communities of Concern in Massachusetts

Vegetative Community Type	EPA Ecoregion(s)	Description	Distribution
Calcareous Forest Seep	Northeastern Highlands	Northern hardwood forests on slopes, with small springs and calcareous seeps where containing water with dissolved calcium from the ground intersects with the top of the water table	Primarily in Connecticut Valley and Western New England Marble Valleys
Yellow Oak Dry Calcareous Forest		Dry, open, oak-sugar maple forest with rich understory on shallow rock	Abundant in the southern parts of the state in Berkshire County and in Western New England Marble Valleys
High Elevation Spruce – Fire Forest/Woodland		Forest or woodland with dwarfed trees from wind on the tops of exposed mountains dominated with conifers, balsam fir, and red spruce vegetation	Worcester/Monadnock Plateau and Green Mountains and Berkshire Highlands
Scrub Oak Scrubland	Atlantic Coastal Pine Barrens and Northeastern Coastal Zone	Shrubland dominated by scrub oak with essentially no pitch pine; however within pitch pine – scrub oak habitat	Cape Cod, Narragansett and Bristol Lowland, Gulf of Maine Coastal Lowland and Plain, Southern New England Coastal Plains and Hills
Maritime Juniper Woodland/Shrubland		Evergreen and woodland shrubland within the coastal salt spray zones where trees tend to be short and scattered and sculpted by the wind and salt spray	Gulf of Maine Coastal Plain, Narragansett and Bristol Lowland, Cape Cod, Martha's Vineyard, Nantucket Island
Maritime Pitch Pine Dune		Maritime woods and scattered pitch pines on stable and active dunes and back-barrier sand flats that can have salt spray during storms and strong winds	Limited to Cape Cod, Martha's Vineyard, and Nantucket Island
Sandplain Grassland		Open community visually dominated by grasses on flat outwash plains with droughty, low nutrient soils. Most occurrences are near the ocean, although sandplains in other parts of the state support the grassland community	Gulf of Maine Coastal Plain, Boston Basin, Narragansett and Bristol Lowland, and Cape Cod
Sandplain – Heathland		Open, dwarf shrub dominated, primarily coastal community with sparse clusters of plants or lichen cover often occurring on acidic, nutrient poor soils	Connecticut Valley, Gulf of Maine Coastal Plain, Boston Basin, Narragansett and Bristol Lowland, and Cape Cod

Vegetative Community Type	EPA Ecoregion(s)	Description	Distribution
Oak – Tulip Tree Forest	Northeastern Coastal Zone	Forest community on gentle, moist fairly concave slopes or on well-drained flats at the base of slopes	Occurs in gradually sloped ravines in Robinson State Park and Agawam and Douglas State Forests in Connecticut Valley and portions of Southern New England Coastal Plains
Sassafras – Hackberry Maritime Cove Forest		A closed to semi-open forest/woodland in the salt spray zone that is composed of patches of single tree species and a dense understory of shrubs	The one known occurrence is located on the north side of Boston Harbor. It extends along the shoreline and steep slope immediately above the shoreline
Serpentine Outcrop	Northeastern Highlands and Northeastern Coastal Zone	Open, sparse, herbaceous vegetation with little tree or shrub growth often different than vegetation occurring in surrounding areas; woody species growing on serpentine or ultramafic[159] soils are often stunted	Gulf of Maine Coastal Lowland and Plain, Southern New England Coastal Plains and Hills, Green Mountains and Berkshire Highlands, and Berkshire Transition
Dry Riverside Bluff		Erosional high cliffs and bluffs of gravel and sand next to rivers or river floodplains supporting species of dry habitats	Primarily in Gulf of Main Coastal Plain, Coastal Lowland, and Southern New England

Source: (Griffith, et al., 2009) (Kearsley & Swain, 2001) (MDFW, 2013)

[159] Ultramafic – Igneous rocks with high percentages of magnesium, often accompanied by iron, chromium, and nickel. (Kearsley & Swain, 2001)

ACRONYMS

Acronym	Definition
AARC	Average Annual Rate of Change
ACEC	Areas of Critical Environmental Concern
ACHP	Advisory Council On Historic Preservation
ACK	Nantucket Memorial Airport Code
ACS	American Community Survey
AGL	Above Ground Level
AIM	Aeronautical Information Manual
AIS	Aquatic Invasive Species
APCO	Association of Public-Safety Communications Officials
APE	Areas 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
BAPERN	Boston Area Police Emergency Radio Network
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
BMP	Best Management Practice
BOS	Boston Logan International Airport Code
BTOP	Broadband Technologies Opportunity Program
BTS	Bureau of Transportation Statistics
CAA	Clean Air Act
CAI	Community Anchor Institution
CCMP	Comprehensive Conservation and Management Plan
CEQ	Council On Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFA	Controlled Firing Area
CFOI	Census of Fatal Occupational Injuries
CFR	Code of Federal Regulations
CGP	Construction General Permit
CH_4	Methane
CIMC	Cleanups In My Community
CIO	U.S. Chief Information Officer
CMED	Coordinated Medical Direction
CMR	Code of Massachusetts Regulations
CO	Carbon Monoxide

Acronym	Definition
CO_2	Carbon Dioxide
COLT	Cell on Light Truck
COW	Cell on Wheels
CRS	Community Rating System
CSO	Combined Sewer Overflows
CWA	Clean Water Act
CWCS	Comprehensive Wildlife Conservation Strategy
CZM	Massachusetts Coastal Zone Management
DCR	Department of Conservation and Recreation
DEDIC	Deerfield Economic Development & Industrial Corporation
DEP	Department of Environmental Protection
DOC	Department of Commerce
DoD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
DOT	Department of Transportation
DPU	Department of Public Utilities
E.O.	Executive Order
EEA	Massachusetts Executive Office of Energy and Environmental Affairs
EFH	Essential Fish Habitat
EIA	U.S. Energy Information Administration
EJSCREEN	Environmental Justice Screening and Mapping Tool
EMS	Emergency Medical Services
EOLWD	Executive Office of Labor and Workforce Development
EOPSS	Massachusetts Executive Office of Public Safety
EPCRA	Emergency Planning and Community Right To Know Act
ERP	Environmental Results Program
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FAQ	Frequently Asked Question
FAR	Federal Acquisition Regulation
FCC	Federal Communication Commission
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
FHWA	Federal Highway Administration
FLM	Federal Land Manager
FOA	The Fiber Optic Association, Inc.
FR	Federal Register
FRA	Federal Railway Administration
FSDO	Flight Standards District Offices

Acronym	Definition
FSS	Flight Service Station
FTA	Federal Transit Administration
GAO	Government Accounting Office
GHG	Greenhouse Gas
GPC	Greater Boston Police Council, Inc.
GPO	Government Printing Office
GWSA	Global Warming Solutions Act
HAP	Hazardous Air Pollutants
HASP	Health and Safety Plans
HHRA	Human Health Risk Assessment
HOA	Homeowner Associations
HSEMA	D.C. Homeland Security and Emergency Management Agency
HYA	Municipal-Boardman/Polando Field Airport Code
IBA	Important Bird Area
IFC	International Finance Corporation
IFR	Instrument Flight Rules
IP	Internet Protocol
IPCC	Intergovernmental Panel On Climate Change
LBS	Locations-Based Services
LCCS	Land Cover Classification System
LRFD	Load and Resistance Factor Design
LRR	Land Resource Regions
LTE	Long-Term Evolution
MassDCR	Massachusetts Department of Conservation and Recreation
MassDEP	Massachusetts Department of Environmental Protection
MassDFG	Massachusetts Department of Fish & Game
MassDPH	Massachusetts Department of Public Health
MassDOT	Massachusetts Department of Transportation
MassGIS	Massachusetts Office of Geographic Information
MassParks	Massachusetts State Parks
Massport	Massachusetts Port Authority
MBTA	Massachusetts Bay Transportation Authority
MBTA	Migratory Bird Treaty Act
MCZM	Massachusetts Office of Coastal Zone Management
MDAR	Massachusetts Department of Agricultural Resources
MDFW	Massachusetts Division of Fisheries and Wildlife
MEPA	Massachusetts Environmental Policy Act
MESA	Massachusetts Endangered Species Act
MGL	Massachusetts General Laws
MHC	Massachusetts Historical Commission

Acronym	Definition
MHI	Median Household Income
MIPAG	Massachusetts Invasive Plant Advisory Group
MLRA	Major Land Resource Areas
MMPA	Marine Mammal Protection Act
MMT	Million Metric Tons
MOA	Military Operation Areas
MPDES	Massachusetts Pollutant Discharge Elimination System
MRCT	Massachusetts Central Rail Transit
MS4	Municipal Separate Storm Sewer Systems
MSFCMA	Magnuson Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
MT	Metric Tons
MVY	Martha's Vineyard Airport Code
MW	Megawatt
MWRA	Massachusetts Water Resources 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
NCDC	National Climatic Data Center
NCED	National Conservation Easement Database
NCSL	National Conference of State Legislatures
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NERR	National Estuarine Research Reserve
NFIP	National Flood Insurance Program
NHA	National Heritage Area
NHESP	Natural Heritage and Endangered Species Program
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NIH	National Institutes of Health
NIST	National Institute of Standards and Technology
NM	Nautical Miles
NNL	National Natural Landmark
NOAA	National Oceanic and Atmospheric Administration

Acronym	Definition
NOTAM	Disseminated Via Notices To Airmen
NOX	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
NST	National Scenic Trail
NTFI	National Task Force On Interoperability
NTIA	National Telecommunications & Information Administration
NWF	National Wildlife Foundation
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
NWS	National Weather Service
OE/AAA	Obstruction Evaluation and Airport Airspace Analysis
ORH	Worcester Regional Airport Code
OSH	Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
OTR	Ozone Transport Region
PAB	Palustrine Aquatic Bed
PCB	Polychlorinated Biphenyl
PEIS	Programmatic Environmental Impact Statement
PEM	Palustrine Emergent Wetlands
PFO	Palustrine Forested Wetlands
PGA	Peak Ground Acceleration
PM	Particulate Matter
POP	Points of Presence
PPE	Personal Protective Equipment
PSAP	Public Safety Answering Points
PSCR	Public Safety Communications Research Program
PSD	Prevention of Significant Deterioration
PSS	Palustrine Scrub-Shrub Wetlands
PUB	Palustrine Unconsolidated Bottom
RCRA	Resource Conservation and Recovery Act
RF	Radio Frequency
RGGI	Regional Greenhouse Gas Initiative

Acronym	Definition
ROW	Right of Way
SAA	Sense and Avoid
SAIPE	Small Area Income and Poverty Estimates
SASP	State Aviation System Plan
SCEC	State Climate Extremes Committee
SCIP	Statewide Communications Interoperability Plan
SDS	Safety Data Sheets
SF_6	Sulfur Hexafluoride
SGCN	Species of Greatest Conservation Need
SHPO	State Historic Preservation Office
SHPO	State Historical Preservation Office
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SOC	Standard Occupational Classification
SOP	Standard Operating Procedures
SOW	Satellite on Wheels
SOX	Oxides of Sulfur
SPL	Sound Pressure Level
SSA	Sole Source Aquifer
STATSGO2	Digital General Soil Map of the United States developed by the National Cooperative Soil Survey
SUA	Special Use Airspace
SWAP	Source Water Assessment and Protection
SWPPP	Storm Water Pollution Prevention Plan
T/E	Threatened/Endangered
THPO	Tribal Historic Preservation Office
TMDL	Total Maximum Daily Load
TOXMAP	Tool that visually explores data from the USEPA's TRI and Superfund Program
TPY	Tons Per Year
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average
U.S.C.	United States Code
UA	Unmanned Aircraft
UAS	Unmanned Aircraft Systems
UHF	Ultra High Frequency
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency

Acronym	Definition
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
VFR	Visual Flight Rules
VHF	Very High Frequency
VOC	Volatile Organic Compound
VoIP	Voice over Internet Protocol
WAP	Wildlife Action Plan
WCS	Wetlands Classification Standard
WPA	Wetlands Protection Act
WWF	World Wildlife Fund
WWI	World War I
WWII	World War II
YOY	Young of the Year

REFERENCES

The citations in this Draft PEIS reflect the most recent information on the referenced site at the time the document was being written. If the site was updated after that point, the more recent information will be incorporated, as feasible, into the final document.

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