2022 EPA Region 1 Climate Adaptation Plan

October 2022

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DEPUTY ADMINISTRATOR

Preface

Climate change is threatening communities across the nation. Millions of Americans feel the destructive effects of climate change each year when the power goes down, rivers and lakes go dry, homes are destroyed by wildfires and communities are flooded by hurricanes. Underserved communities are especially vulnerable to the climate crisis and are more likely to experience the negative health and environmental effects of extreme weather events.

The Biden-Harris Administration is actively confronting the climate crisis while also advancing environmental justice. As part of a whole-of-government approach, the U.S. Environmental Protection Agency is strongly committed to taking the actions necessary to protect human health and the environment and to increase the resilience of the entire nation, even as the climate changes.

The EPA's commitment to action is reflected in its FY 2022-2024 Strategic Plan and in the 2021 Climate Adaptation Action Plan. Both documents present priority actions the agency will take to ensure that its programs, policies and operations remain effective under future climate conditions while we work to support states, territories, tribes and communities in increasing their own adaptive capacity and resilience to climate change impacts.

From flooding at Superfund sites, to wildfires causing air pollution, to sea-level rise affecting water quality and infrastructure, the EPA will boldly address climate impacts in both its programs and the communities it serves. We recognize the importance of tribal, state and local government partnerships in efficient, effective and equitable implementation of climate change adaptation strategies. Our plans were informed and improved by input we received in listening sessions we held to engage these and other partners as we developed these plans.

To ensure we are addressing the climate crisis in a comprehensive way, each of our national program and regional offices has developed individual Climate Adaptation Implementation Plans that outline how the EPA will attain the agencywide goals described in the broader Climate Adaptation Action Plan. These plans describe how programs and regions will integrate climate adaptation into their programs, partnerships and operations. They also describe how they will help partners build their resilience and capacity to adapt, while delivering co-benefits, including curbing greenhouse-gas emissions and other pollution, and

promoting public health, economic growth and climate justice. Of course, the EPA has a major role to play on emissions reductions as well, though that is not the focus of these plans. Indeed, we must focus on both climate adaptation and mitigation to ensure our nation and communities thrive in an era of climate change.

As part of this effort, we will empower our staff and partners by increasing awareness of how climate change may affect our collective ability to implement effective and resilient programs. We will also provide them with the necessary training, tools, data, information and technical support to make informed decisions and integrate climate adaptation into our work.

The EPA will work to modernize its financial assistance programs to encourage climate-resilient investments across the nation. We will also focus on ensuring that investments funded by the Bipartisan Infrastructure Law, the Inflation Reduction Act and other government programs are resilient to the impacts of climate change. Finally, as our knowledge advances and as impacts continue to develop, our response will likewise evolve. We will work to share these developments to enhance the collective resilience of our nation.

The actions outlined in these implementation plans reflect the EPA's commitment to build every community's capacity to anticipate, prepare for, adapt to and recover from the increasingly destructive impacts of climate change. Together with our partners, we will work to create a healthy and prosperous nation that is resilient to the ever-increasing impacts of climate change — which is vital to the EPA's goal of protecting human health and the environment and to ensuring the long-term success of our nation.

Janet G. McCabe

Preface
Regional Administrator David Cash, EPA Region 1

Climate change represents a clear and present danger to New England, especially to its most overburdened and vulnerable communities, and an enormous opportunity. As a regional agency dedicated to protecting human health and the environment, we have a responsibility to act with urgency and to accelerate our efforts to adapt to climate change and secure climate justice.

Our staff-driven, consensus-based plan, the Region 1 Climate Adaptation Plan (RCAP), represents an updated roadmap for how we continue to prepare for, adapt to, and help recover from the effects of these extreme changes. Our plan identifies regional climate vulnerabilities, research needs, and transformational actions, incorporating feedback from Tribal and state partners and communities with environmental justice concerns.

From sea level rise to heat waves to extreme weather events, climate change is already affecting our region, threatening our air and water quality and exacerbating health concerns. These growing climate impacts translate into real community, economic, and public health consequences across the region. And while climate change increasingly affects us all, we know that threats posed by climate change can disproportionately harm communities in our region already disproportionately impacted by environmental injustices.

Additionally, as a result of the 2021 Bipartisan Infrastructure Law, the Biden-Harris Administration is leading a once-in-a-generation opportunity to invest in our country, with particular focus on ensuring at least 40% of the benefits of these investments benefit disadvantaged communities. The task is enormous. It is critical that we have an "all-hands-on-deck" approach to preparing for climate change – and our plan embraces that approach. We will continue to update our plan, as needed, to help us prioritize our work on climate adaptation.

I look forward to working together across each division of EPA Region 1 – and across each community in our region – to help build resilience and adapt to climate change. We stand ready to assist New England Tribes, states, and communities, as they continue to address the threats we face together.

David Cash
Regional Administrator, EPA Region 1
August 2022

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ABCA – Analysis of Brownfield Cleanup Alternatives

ACE – Army Corps of Engineers

AQI – Air Quality Index

ARD – Air and Radiation Division

ARP – Alternative Restoration Plan

BACT – Best Available Control Technology

BCT – Best Conventional Pollutant Control Technology

BIL – Bipartisan Infrastructure Law

BMP – Best Management Practices

CA – Corrective Action

CAA – Clean Air Act

CBEI – Consumption Based Emissions Inventory

CCMP – Comprehensive Conservation and Management Plans

CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act

CFR – Code of Federal Regulations

COOP – Continuity of Operations Plan

CT – Connecticut

CT DEEP – Connecticut Department of Energy and Environmental Protection

CWA – Clean Water Act

CWSRF – Clean Water State Revolving Fund

DOJ – Department of Justice

DWSRF – Drinking Water State Revolving Fund

ECAD – Enforcement and Compliance Assurance Division

EGU – Electric Generating Units

EIS – Environmental Impact Statements

EJ – Environmental Justice

EO – Executive Order

EPA – Environmental Protection Agency

FEDCA – Federal Food, Drug and Cosmetic Act

FEMA – Federal Emergency Management Agency

FIFRA – Federal Insecticide, Fungicide and Rodenticide Act

FRP – Facility Response Plans

FTE – Full Time Equivalent

GDC – General Duty Clause

GHGs – Greenhouse Gases

GI – Green Infrastructure

GIS – Geographic Information System

GoM – Gulf of Maine

HABs – Harmful Algal Blooms

HASP – Health and Safety Plans

HVAC – Heating, Ventilation and Air Conditioning

ILF – In Lieu Fee

IMT – Incident Management Team

IPCC – Intergovernmental Panel on Climate Change

IUP – Intended Use Plans

LAER – Lowest Achievable Emission Rate

LCBP – Lake Champlain Basin Program

LCRD – Land, Chemicals and Redevelopment Division

LiDAR – Light Detection and Ranging (a remote sensing method used to examine the surface of the Earth)

LISS – Long Island Sound Study

LQG – Large Quantity Generator

LSASD – Laboratory Services and Applied Science Division

LTPGs – Long-term Performance Goals

LTS – Long Term Stewardship

LUST – Leaking Underground Storage Tank

MA – Massachusetts

ME – Maine

MPRSA – Marine Protection, Research, and Sanctuaries Act

MS4 – Municipal Separate Storm System

MSD – Mission Support Division

NAAQS – National Ambient Air Quality Standards

NARS – National Aquatic Resource Surveys

NECIA – Northeast Climate Impacts Assessment

NEON – National Ecological Observatory Network

NEP – National Estuary Program

NEPA – National Environmental Policy Act

NEWMOA – Northeast Waste Management Officials Association

NH – New Hampshire

NJ – New Jersey

NOAA – National Oceanic and Atmospheric Administration

NOx – Nitrogen Oxides

NPDES – National Pollutant Discharge Elimination System

NPDWR – National Primary Drinking Water Regulations

NPL – National Priorities List

NPM – National Program Manager

NPS – Nonpoint Source

NSR – New Source Review

NY – New York

O3 - Tropospheric Ozone

OA – Ocean Acidification

OAQPS – Office of Air Quality Planning and Standards

OECA – Office of Enforcement and Compliance Assurance

OGC – Office of General Counsel

OPA – Office of Public Affairs

ORA – Office of the Regional Administrator

ORC – Office of Regional Counsel

ORD – Office of Research and Development

ORIA – Office of Radiation and Indoor Air

OUST – Office of Underground Storage Tanks

P and C - Priorities and Commitments

P2 – Pollution Prevention

PCBs – Polychlorinated biphenyl

PM – Particulate Matter

$PM_{2.5}$ – Particles less than 2.5 micrometers in diameter

POCH – Post Office and Courthouse – EPA R1 office

PPA – Performance Partnership Agreement

PPG – Performance Partnership Grants

PSD – Prevention of Significant Deterioration

R1 – Region 1

R2 – Region 2

RAINE – Resilience and Adaptation in New England

RARE – Regional Applied Research Effort

RCAP – Regional Climate Adaptation Plan

RCN – Region 1 Climate Network

RCP – Representative Concentration Pathway

RCRA – Resource Conservation and Recovery Act

RFA – Request for Applications

RI – Rhode Island

RMN – Regional Monitoring Networks

RMP – Risk Management Plan

ROD – Record of Decision

RPR – Repair and Painting Rule

SDWA – Safe Drinking Water Act

SEMD – Superfund and Emergency Management Division

SMM – Sustainable Material Management

SNEP – Southeast New England Program

SO_2 – Sulfur dioxide

SRF – State Revolving Fund

SRR – Sustainable Resilient Remediation

SST – Sea Surface Temperatures

TEK – Traditional Ecological Knowledge

TMDL – Total Maximum Daily Load

TSCA – Toxic Substances Control Act

TSDFs – Treatment, Storage, and Disposal Facilities

USACE – U.S. Army Corps of Engineers

USDA – U.S. Department of Agriculture

USEEIO – US Environmentally-Extended Input-Output

USG – Unhealthy for Sensitive Groups

USGS – U.S. Geological Survey

USGCRP – U.S. Global Change Research Program

UST – Underground Storage Tanks

UVM – University of Vermont

VOC – Volatile Organic Compounds

VT – Vermont

WD – Water Division

WPDG – Wetland Program Development Grants

WQS – Water Quality Standards

WWTF – Wastewater Treatment Facility

7Q10 – Seven-day, consecutive low-flow with a ten-year return frequency

Section 1. Introduction

I. Executive Summary

Climate change and its associated impacts to air, water, and waste systems are challenging EPA's mission to protect human health and the environment. New England has and will continue to experience a range of impacts from climate change including increases in air and water temperature, increases in precipitation, sea level rise (SLR), more intense weather events and flooding, and seasonal shifts. The impacts of climate change are already affecting the lives and livelihoods of New Englanders, degrading air quality, threatening public health, and damaging infrastructure, ecosystems, and social systems in communities across the region.

To respond to climate impacts, President Biden's Executive Order (EO) 14008, Tackling the Climate Crisis at Home and Abroad, required every federal agency to develop Climate Action Plans. In response, the EPA created an agency-wide Climate Adaptation Action Plan in October 2021. This agency-wide plan recognizes that climate change poses important challenges to EPA's ability to fulfill its mission. This plan also included a Policy Statement on Climate Change Adaptation, which directs every program and regional office within the EPA to update their 2014 Adaptation Plans and/or develop an Implementation Plan to:

1. Integrate climate adaptation planning into EPA programs, policies, and rulemaking processes.
2. Consult and partner with Tribes, states, territories, local governments, environmental justice organizations, community groups, businesses, and other federal agencies to strengthen adaptive capacity and increase the resilience of the nation, with a particular focus on advancing environmental justice.
3. Implement measures to protect the agency's workforce, facilities, critical infrastructure. supply chains, and procurement processes from the risks posed by climate change.
4. Modernize EPA financial assistance programs to encourage climate-resilient investments across the nation.

These plans describe each Office's programmatic vulnerabilities to climate impacts and propose actions needed to adapt our programs and increase resilience in response to each vulnerability. EPA Region 1 (R1) covers Connecticut (CT), Rhode Island (RI), Massachusetts (MA), New Hampshire (NH), Vermont (VT), Maine (ME), and ten federally recognized Tribes. R1 released its first RCAP in 2014 and developed an addendum to the 2014 RCAP in 2016. The 2022 RCAP builds from those previous plans. The updated RCAP provides an overview of climate impacts in the Northeast, identifies R1 programmatic vulnerabilities in relation to those climate impacts, provides a list of 95 Priority Actions to respond to those programmatic vulnerabilities, and establishes regional climate science needs and a training plan. It is important to note that this plan only covers climate change adaptation and not climate change mitigation. Climate change adaptation is defined as taking action to prepare for and adjust to both the current and projected impacts of climate change.* Climate change mitigation refers to actions limiting the

* Adaptive capacity is the ability of a human or natural system to adjust to climate change (including climate variability and extremes) by moderating potential damages, taking advantage of opportunities, or coping with the consequences. Climate resilience can be generally defined as the capacity of a system to maintain function in the face of stresses imposed by climate change and to adapt the system to be better prepared for future climate impacts.

magnitude and rate of future climate change by reducing greenhouse gas emissions and/or advancing nature-based solutions.

Goal 2 of the EPA-wide FY 2022-2026 EPA Strategic Plan focuses on taking action to advance environmental justice (EJ). R1 is committed to advancing our understanding of how overburdened and underserved communities and individuals are particularly vulnerable to climate change impacts including low-income communities, those that are linguistically isolated, communities of color, children, the elderly, Tribes, and Indigenous people. Tribes are particularly vulnerable to the impacts of climate change due to the integral nature of their traditional lifeways and culture with the environment. It is also important to understand how these impacts will be magnified in communities already facing ongoing EJ issues. Funds appropriated to EPA under the 2021 Bipartisan Infrastructure Law (BIL) are either required or strongly encouraged to be used to support climate resilient infrastructure or other environmental restoration and protection programs and projects, with a focus on serving historically disadvantaged or underserved communities. Some of that work is highlighted in the Priority Actions listed in this plan.

II. R1 Divisional Climate Workgroup

To facilitate easier operations with local and state governments, as well as with other federal agencies, EPA created ten regional offices. Each Regional office is organized into divisions that correspond to EPA's national program offices. The corresponding regional divisions report back to and act in response to national office requests. EPA's regional programs assist Tribes and states in implementing programs, providing oversight, enforcing environmental statutes, and partnering with their state and tribal environmental office counterparts.

To identify EPA R1's programmatic vulnerabilities to climate impacts and to develop cross-divisional Priority Actions to respond to those vulnerabilities, as well as establish climate science needs, R1 formed the **R1 Divisional Climate Representative Workgroup.** The divisional workgroup consists of two divisional climate representatives from each of R1's nine divisions: Air and Radiation Division (**ARD**), Water Division (**WD**), Superfund and Emergency Management Division (**SEMD**), Land, Chemicals, and Redevelopment Division (**LCRD**), Mission Support Division (**MSD**), Enforcement and Compliance Assurance Division (**ECAD**), Laboratory Services and Applied Science Division (**LSASD**), Office of Regional Counsel (**ORC**), and Office of the Regional Administrator (**ORA**). The divisional workgroup was led by Emily Bolger from ARD and Charlotte Gray from ORA. ARD management support and supervision was provided by John Rogan, Branch Manager, Cynthia Greene, Deputy Director, and Lynne Hamjian, Director. The full **R1 Divisional Climate Representative Workgroup** is listed below, see **Table 1**. Each divisional representative worked with staff members across their respective divisions to ensure R1's programs were effectively covered within each part of this plan.

R1 Division	Divisional Climate Representatives on the Workgroup
ARD	Emily Bolger, Julianne Sammut, and John Moskal
WD	Anne Leiby and Mel Coté
SEMD	Christopher Smith and Andrew Robles
LCRD	Jessica Dominguez and Liz McCarthy
MSD	Mike Ottariano and Alex Dichter
LSASD	Bob Judge*, Anne McWilliams, and Tom Faber
ECAD	Mary Dever and Christine Sansevero

ORC	Greg Dain and Mark Stein
ORA	Emily Bender and Mikayla Rumph

Table 1. Region 1 Divisional Climate Representatives Workgroup

Representative Retired

III. Designated Climate Leader

Each Program and Regional Office must designate a Senior Leader on climate to oversee and ensure plan implementation and make resource decisions. R1 has designated the Deputy Director of ARD, Cynthia Greene, as the Senior Leader on climate.

Section 2. Vulnerability Assessment

I. Climate Change in New England

The impacts of climate change are already affecting the lives and livelihoods of New Englanders, damaging infrastructure, ecosystems, and social systems in communities across the region. New England is and will continue to be uniquely impacted by climate change due to its population distribution, geography, seasons, and weather patterns. The New England region is characterized by four distinct seasons, approximately 6,130 miles of coastline, some rocky and some with areas of subsidence, extensive beaches, lakes and rivers, hills and mountain ranges, and a mix of both urban and rural communities. In total, the New England region spans 71,991.8 square miles with three of the six New England states, ME, NH, and VT, bordering Canada (**Figure 1**).[1] The most densely populated areas in New England are on the coast, making them susceptible to sea level rise (SLR) and storm surge. The region's high density of built environment sites and facilities, large number of historic structures, and older housing and infrastructure compared to other regions suggest that urban centers in the Northeast are particularly vulnerable to climate shifts and extreme weather events. New England has and will continue to experience a range of impacts from climate change including increases in air and water temperature, increases in precipitation, SLR, more intense weather events and flooding, and seasonal shifts. The changing climate also has negative impacts on air quality and public health.[1] These climate impacts will not evenly affect populations in New England with some vulnerable populations feeling a greater burden. These vulnerabilities will be discussed in greater detail in the sections below.

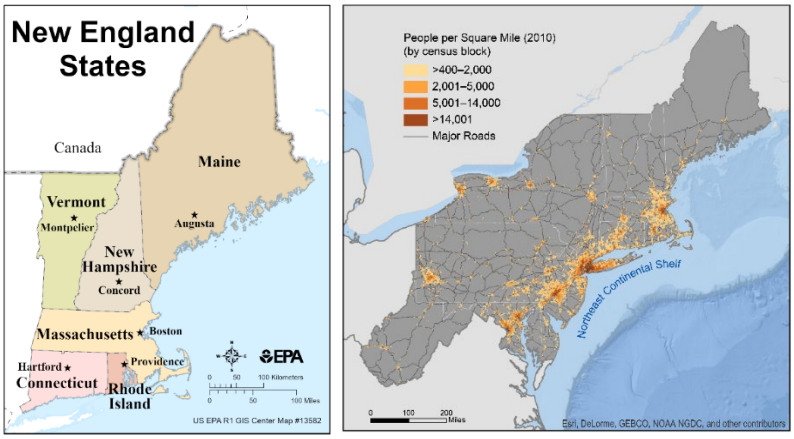

Figure 1. Map of New England States and Map showing Primary Roads and Population Density[1]

A. Increases in Air Temperature

Global average temperatures have increased by approximately 1.8°F (1°C) from 1901 to 2020. If temperatures continue to increase at the current rate, global warming is *likely* to reach 2.7°F (1.5°C) between 2030 and 2052. Observational evidence consistently points to human activities linked to human-induced emissions of Greenhouse Gases (GHGs) as the dominant cause for current and historical warming trends. Without significant reductions, annual average global temperatures could increase by 9°F (5°C) or more by the end of this century compared to preindustrial temperatures. With significant

reductions in emissions, the global temperature increase could be limited to 3.6°F (2°C) or less compared to preindustrial temperatures.[2]

New England appears to be warming at a faster rate than the global average. Scientists have attributed the warming in the Northeast to changes in atmospheric circulation as well as rising temperatures in coastal waters, such as the Gulf of Maine (GoM). Temperature data show that New England air temperature has already warmed past the 2.7°F (1.5°C) threshold set by the Intergovernmental Panel on Climate Change (IPCC) for the world. Between 1900 and 2020, New England warmed an average of 3.29°F (1.83°C). The most notable increases have been for the coldest days in winter. Overall, between 1900 and 2020, New England winters have warmed on average 4.86°F (2.75°C).[3] Consequently, Boston, MA, and Montpelier, VT, both experienced their warmest year on record in 2021.

By 2035, and under both lower and higher GHG emissions scenarios modeled by the IPCC [representative concentration pathway (RCP) 4.5 and RCP 8.5[a,4]], the Northeast is projected to be more than 3.6°F (2°C) warmer on average than during the preindustrial era.[1] This would be the largest increase in the contiguous United States and would occur as much as two decades before global average temperatures reach a similar milestone (**Figure 2**).[5] This significant rise in air temperature is the main driver impacting other climate indices in New England such as changes in precipitation, increases in water temperatures, more frequent and intense extreme weather events, seasonal shifts, and increased tropospheric ozone.[1]

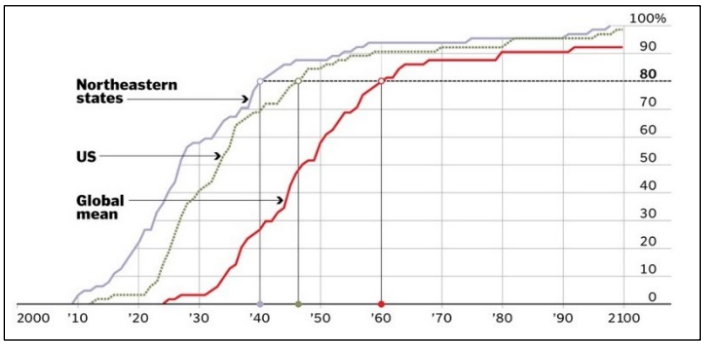

Figure 2. Timing when Northeastern States, U.S., and Global Average Temperatures Will Reach 3.6°F (2°C) of Warming based on Percentage of 32 Climate Models*[5]

80% is when the average of 32 climate models will reach 3.6°F (2°C)

B. Ocean Warming

Ocean and coastal temperatures along the Northeast Continental Shelf, which extends approximately 125 miles (200 kilometers) off the New England coast, have warmed by 0.06°F (0.033°C) per year over the period 1982–2016. This area is warming three times faster than the global average rate of 0.018°F (0.01°C) per year.[1] Through 2019, the Gulf of Maine has warmed faster than roughly 99 percent of the world's oceans. The GoM is rapidly changing because it is located at the meeting point of two opposing ocean currents — the Labrador Current that pulses cold water down from the Arctic, and the Gulf Stream that carries much warmer water up from the south. The dynamics of these two currents determine whether

[a]**Representative Concentration Pathways (RCPs)** are scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover. The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome.

the GoM receives cold, Arctic water or warmer water coming up from the south. As ice melts in the Arctic, the northern North Atlantic Ocean is becoming fresher. This causes the Gulf Stream to shift its path and allows more warm water to surge into the GoM where the Labrador Current once dominated.[6]

Figure 3 shows a schematic of the circulation in the Northwest Atlantic and Gulf of Maine.[7] While the temperature, circulation, and other physical aspects of the GoM are changing on decadal and longer time scales, the GoM also experiences shorter term fluctuations including marine heat waves. The GoM has experienced record sea surface temperatures (SSTs) during the last decade. For example, during the 2012 heat wave, the SSTs were on average 1.3 °C warmer than the long-term average and on par with some end-of-century climate projections. Observational analyses and model simulations indicate that the 2012 SST warming event was driven primarily by the atmosphere through anomalous air–sea heat fluxes. Relative to today's climate, marine heat waves are projected to increase in the future primarily through an overall warming of the ocean.[7]

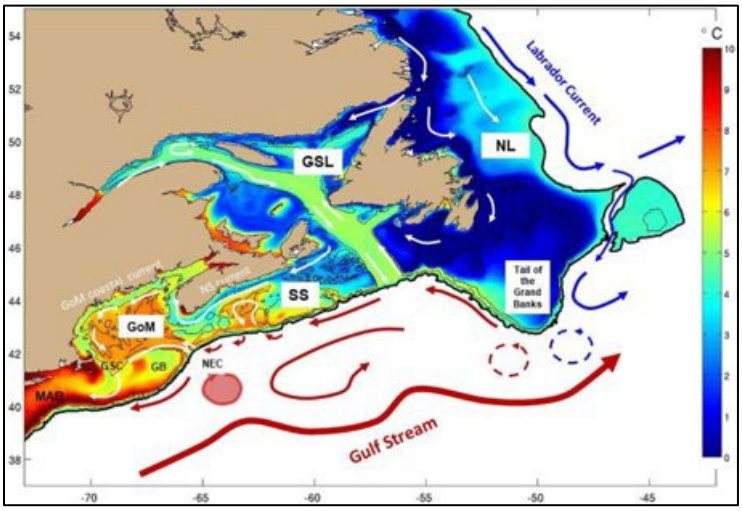

Figure 3. Schematic of the circulation in the Northwest Atlantic and Gulf of Maine (°C)[7]
The annual mean bottom temperature field is superimposed on the shelf region. Bottom temperature is from the Bedford Institute of Oceanography North Atlantic model. Arrows denote flow direction, with blue or red color indicating relative cold or warm temperature; onshelf arrows are white for visibility. The dashed circular arrows south of the Tail of the Grand Banks denote subsurface warm and cold eddies that are generated in that region. The solid red circle is a Gulf Stream ring which has a surface expression.

Increasingly, these warmer waters have brought warm-water-adapted species into the Northeast and GoM, changing local aquatic ecosystems and fisheries. Some fishermen now travel farther to catch certain species or target new species that are becoming more prevalent as waters warm. In the case of GoM cod, rising temperatures have been associated with changes in recruitment, growth, and mortality. Shifts in temperature and circulation will continue to generate more ecosystem changes. These changes have the potential to affect economic activity and social features of fishing communities, working waterfronts, travel and tourism, and other natural resource-dependent local economies. Proactive conservation and management measures can support climate resilience of fished species. For example, long-standing industry and management measures to protect female and large lobsters have supported the growth of the GoM's Georges Bank stock as waters warmed, but the lack of these measures in southern New England exacerbated declines in that stock as temperatures increased.[1]

C. Ocean and Coastal Acidification

As carbon dioxide (CO_2) in the atmosphere enters the ocean through surface water equilibration, it dissolves to form carbonic acid. Along coastlines, other inputs can add to this acidification, including acidic precipitation, river discharge, agricultural waste runoff, and other human materials that flow from the land into the ocean. Together, these factors contribute to coastal acidification. Increases in nutrient loading from increased runoff promotes algal growth, which drives up local CO_2 concentrations as those algal communities die and decay. Coastal acidification events are therefore more variable and episodic compared to global ocean acidification. The pH level of seawater has decreased significantly since 1750 (oceans are approximately 30% more acidic now) and is projected to drop more dramatically by the end of the century if CO_2 concentrations continue to increase and the oceans absorb more CO_2.[8]

The GoM waters are particularly sensitive to acidification effects due to the relatively cold and fresh nature of the water, poorly buffered (low alkaline) riverine inputs, and strong seasonal productivity.[9] Of particular concern in New England is the threat that acidification has on shellfish populations, especially soft-shelled clams. In more acidic waters, organisms such as shellfish and mollusks struggle to build and maintain shells and their growth rates may slow, and some may begin to lose their sense of smell and ability to find prey. These impacts to the species will translate to impacts to the New England economy, as commercial fishing and shellfishing comprises a large portion of the local economy. In 2020 alone, New England states landed over two million pounds of softshell clam, which is worth more than $23 million in sales.[10]

D. Changes in Precipitation

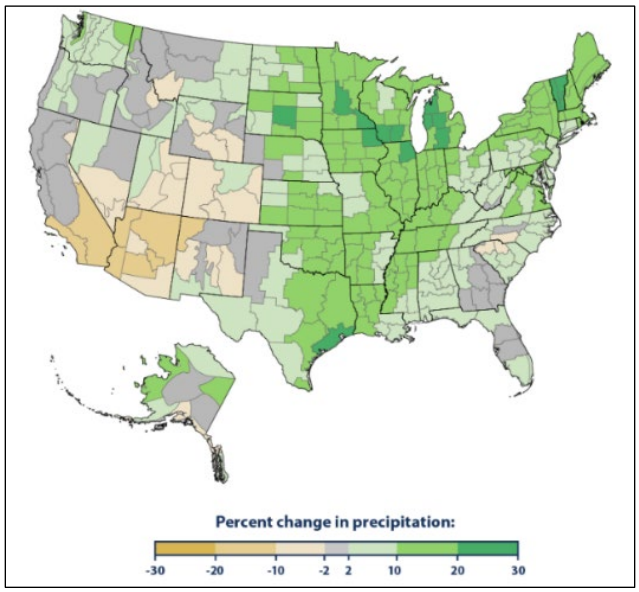

Figure 4. Rate of Change in Total Annual Precipitation in Different Parts of the United States since the 20th Century[11]

On average, U.S. precipitation has increased since 1900. While some areas in the southwestern U.S. have become drier, the Northeast among other areas have become wetter. **Figure 4** shows the rate of change in total annual precipitation in different parts of the United States since the early 20th century (since 1901 for the contiguous 48 states and 1925 for Alaska).[11] From 1901 to 2014, monitoring station records in the Northeast showed a significant 6.8% (0.6% per decade) increase in annual total precipitation and a much larger 41% (3.6% per decade) increase in annual extreme precipitation.[12] Under the RCP 8.5 scenario, a strong increase in precipitation amounts, intensity, and persistence is expected to occur in the Northeast, especially in the winter and spring seasons. Persistence refers to the continuation of current weather conditions. Therefore, an increase in persistence results in an increased likelihood of longer precipitation events, high-temperature events, or drought.[13] In the latter half of the twentieth century, an increase in both total and extreme precipitation events is projected in the Northeast.[14]

Between the winters of 2001 and 2017, New England lost an average of 6.2 days in which snow was not covering the ground, with CT losing the most, at 14.6 days. The lack of snowfall is contributing to the region's warming, as snow reflects the sun's energy back into space, and with less snow, more sunlight is absorbed by the ground. The reduction in seasonal snowfall and the transition to more rain events also influence rivers and streams during spring runoff.[15] A decrease in average snowfall in New England will also negatively impact the winter recreation and sports industries.[1]

E. Sea Level Rise

As the oceans warm with the rise in overall global temperatures, seawater expands and causes water levels to rise. Sea levels also rise when land-based ice, like glaciers and ice sheets, melt, adding water to the ocean. As a result of the increase in sea levels, coastal wetlands will continue to migrate landward causing a potential loss of total saltwater wetland area. According to NOAA's 2022 Sea Level Rise Technical Report, multiple lines of evidence provide increased confidence, regardless of the emissions pathway, in a narrower range of projected global, national, and regional sea level rise by 2050 than previously reported. By 2050, the expected relative sea level (RSL) will cause tide and storm surge heights to increase and will lead to a shift in U.S. coastal flood regimes, with major and moderate high tide flood events occurring as frequently as moderate and minor high tide flood events occur today. Without additional risk-reduction measures, U.S. coastal infrastructure, communities, and ecosystems will face significant consequences.[16]

Along the mid-Atlantic coast (from Cape Hatteras, NC, to Cape Cod, MA), several decades of tide gauge data through 2009 have shown that sea level rise rates were three to four times higher than the global average rate.[1] Additionally, from Cape Cod to NY, the coastline is subsiding (sinking)—largely due to vertical land movement related to the melting of glaciers from the last ice age—which exacerbates the impacts of sea level rise in those areas. Projections suggest that sea level rise in the Northeast will be greater than the global average of approximately 0.12 inches (3 mm) per year. A recent federal interagency report projects that by 2050 relative sea level rise in the northeast will be around 1.4 feet by 2050, underusing the intermediate greenhouse gas emissions scenario. By 2100 the more probable sea level rise scenarios project a sea level rise of 2 feet and 4.5 feet (0.6 m and 1.4 m) on average in the region.[17] However, the worst-case and lowest-probability scenarios project that sea levels in the region would rise upwards of 11 feet (3 m) on average by the end of the century.[18]

Changes to the coastal landscape could threaten the sustainability of communities and their livelihoods. Historical settlement patterns and ongoing development combine to increase the regional vulnerability of coastal communities. Saltwater intrusion from sea level rise into freshwater systems can also impact drinking water supplies, including the alteration of groundwater systems and wastewater infrastructure.[1] Natural and manmade features provide some protection from sea level rise. Infrastructure built along the coast, such as seawalls, bulkheads, and revetments, limit landward erosion caused by sea level rise and storm surge; jetties and groins interrupt alongshore sediment movement; and culverts and dams create tidal restrictions that can reduce habitat suitability for fish communities. Natural features such as coastal bluffs and dunes, while somewhat less vulnerable to these erosive forces than low lying features like beaches and salt marshes, are still no match for these storm surge forces, as we see on Cape Cod and other similar areas.[1]

F. Extreme Weather Events

An extreme event is a time and place in which weather, climate, or environmental conditions, such as temperature, precipitation, drought, or flooding, rank above a threshold value near the upper or lower ends of the range of historical measurements. Climate research has yet to show that any given event was caused solely by climate change, but research has demonstrated that climate change has made many extreme events more likely, more intense, longer lasting, or larger in scale than they would have been otherwise.[19]

Extreme Storms

The Atlantic hurricane season is from June 1 through November 30. These storms are anticipated to become more frequent and more intense in the future. Greater amounts of precipitation will cause inland river flooding and combined with storm surge flooding, will cause compound flood events that exacerbate coastal flooding and erosion. Additionally in New England, Nor'easters (named for the low-pressure systems typically impacting New England and the mid-Atlantic with strong northeasterly winds blowing from the ocean over coastal areas) typically occur between September and April, and when coupled with the Atlantic hurricane season, the region is susceptible to major storms and compound flooding nearly year-round.[1] In August 2011, Tropical Storm Irene dumped three to seven inches of rain throughout Vermont over two days. Extensive flooding caused millions of dollars of damage to infrastructure. Wells and public water systems were submerged and contaminated with chemicals and pathogens, degrading safe drinking water supplies.[20] Two months later in 2011, an unseasonably early October snowstorm dumped one to two and a half feet of snow, felled trees and resulted in significant power outages across the New England region. **Image 1**, taken on August 29, 2011, displays the erosion of VT Route 107 caused by the aftermath of Tropical Storm Irene in 2011. The cost of rebuilding infrastructure in VT was estimated to be up to $250M.[21] In August 2020, Tropical Storm Isaias hit CT with strong winds knocking out power in some areas for 9 days. Gusts of up to 61 mph resulted in significant tree damage throughout the state.[22] The storm also produced a tornado affecting the Westport area. It is considered the state's fourth worst weather event with damage comparable to Hurricane Sandy in 2012.[23]

Image 1. August 29, 2011, Stockbridge, VT Route 107
Photographer: Sacha Pealer

In March 2018, the region experienced a series of nor'easters that brought strong winds, heavy snow, and tremendous coastal flooding causing an estimated $52 million in damages.[24] Due to the combination of strong onshore winds and a slow-moving storm Boston, MA experienced its third highest water level on record. Winter snowstorms are common in New England, however the strength, including a bomb cyclone (a large, intense midlatitude storm that experiences pressure decreases at least 24 millibars in 24 hours [25]) and a blizzard, as well as the close timing of these massive storm systems made clean up and recovery difficult.[26]

Heat Waves

Unusually hot summer days and nights have become more common across the contiguous United States over the last few decades. A heat wave is a prolonged period of abnormally hot weather. Climate models predict an increase in the frequency, severity, and length of heat waves in coming decades. Extreme heat, whether in the form of rising long-term average temperatures or punctuated by heat waves, is a global health threat. Northeastern cities, with their abundance of concrete and asphalt and relative lack of vegetation, tend to have higher temperatures than surrounding regions due to the urban heat island effect. A recent study by the Nature Conservancy showed that in 92% of the urbanized areas surveyed across the US, low-income blocks have less tree cover than high-income blocks. The greatest difference between low- and high-income blocks was found in urbanized areas in the Northeast of the United States, where low-income blocks in some urbanized areas have 30% less tree cover and are 4.0ºC hotter.[27] The heat island effect can be reduced by planting trees and building green roofs. During extreme heat events, nighttime temperatures in the region's big cities are generally several degrees higher than surrounding regions, leading to higher risk of heat-related death.[1]

Neighborhoods in the U.S. and Canada where poverty rates are relatively high have been found to experience elevated temperature mortality impacts. Individuals without health insurance—a condition which may be more common among low-income populations—have also been found to experience higher rates of temperature mortality impacts. Studies have found higher temperature mortality rates among many minority populations, including Black and Hispanic populations. Older individuals have higher baseline mortality rates and are more susceptible to the negative health consequences of heat exposure, in part due to the exacerbation of heat stress on pre-existing cardiac conditions.[28]

Climate-driven changes in the frequency and intensity of extreme temperatures are also expected to result in disruptions in labor sectors where people work outdoors or in indoor environments without air conditioning. When temperatures are high, people are at risk of experiencing health and cognitive effects that prevent them from working at optimal levels. As a result, they may spend less time working on hot days, or may not be able to work at all. This results in a shift in the allocation of time to labor, with potentially significant economic implications. Workers with low-income levels may experience more hardship associated with reduced pay from lost labor hours. A lower income may also be associated with lack of access to insurance or healthcare, making these individuals more vulnerable to the potential health effects of heat exposure.[28]

Drought

In 2016 and 2020, New York and New England experienced historic drought conditions not seen since the 1960s. In September of 2020, the U.S. Department of Agriculture declared Aroostook County in Maine and Hillsborough and Merrimack Counties in New Hampshire as crop disaster areas. By the beginning of October, 166 community water systems and 5 municipalities in New Hampshire, more than 100 municipalities in Massachusetts, and several community water supplies in Connecticut, Maine, and Rhode Island had mandatory water restrictions in place.[29] The Northeast frequently experiences "flash" droughts which are short-term intense dry periods that can follow a period of normal to above-normal precipitation. While these flash droughts may last only 2–6 months, they can have profound impacts on a local region, resulting in shortages in public water supplies and very low streamflow which result in agriculture and economic impacts.[1] Green infrastructure can help replenish groundwater reserves, relieving stress on local water supplies and reducing the need to import potable water.[30]

Wildfire

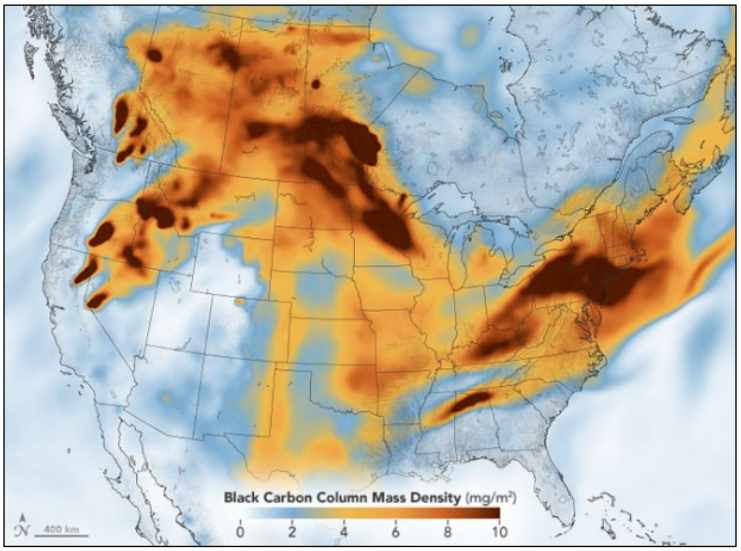

Figure 5. Black Carbon Column Mass Density from July 21, 2021, which Demonstrates Air Circulation Patterns Carrying Smoke from California and Canadian Wildfires to the Northeast[32]

Multiple studies have found that climate change has already led to an increase in wildfire season length, wildfire frequency, and burned areas. Climate change threatens to increase the frequency, extent, and severity of fires through increased temperatures and drought. Fires burn more land in the western U.S. and Canada than the eastern U.S., but parts of the Northeast may become at greater risk to wildfires due to increasing drought conditions.[31] Wildfire smoke from the western U.S. and Canada can also blow hundreds of miles toward the Northeast and cause local air quality problems, increasing human health impacts in the area. In the Summer of 2021 parts of the Northeast were engulfed in a blanket of smoke carried across the country from wildfires in the western U.S. and Canada (**Figure 5**). This event impacted visibility across the region and caused several of the New England states to issue air quality alerts during peak days.[32]

G. Coastal Flooding

Moderate to extreme flooding events are expected to become more frequent in most of the Northeast during the 21st century. Coastal flood risks are exacerbated by compound flooding, defined as storm surge and riverine flooding produce larger floodwaters at the coast that are longer in duration and more widespread than anticipated. These impacts can be amplified by sea level increases causing an increase in the number of flooding days across the Northeast coastal region. The National Oceanic and Atmospheric Administration (NOAA) defines high-tide flooding, also known as sunny-day flooding, as water rising about 2 feet above the typical daily high tide[34]. Boston, MA, could see as many as 18 high-tide flooding days in 2022-2023.[33] The record for such flooding was set in 2017, when high tides inundated parts of the city on 22 days, more than any other community on the east coast. On October 28, 2015, a King Tide event occurred, flooding parts of downtown Boston's waterfront (**Image 2**)[34]. A King Tide is a non-scientific term to describe exceptionally high tides and can be referenced as teachable moments for future flooding impacts from climate change.[34]

Coastal flooding can be exasperated when storms make landfall during high tides. On January 4, 2018, a bomb cyclone hit New England during an astronomical high tide causing significant flooding of Boston's downtown streets and a subway station. At 15.16 feet, it was the highest tide on record surpassing the previous high tide record set during the Blizzard of '78.[35, 36]

Climate change, including current and future SLR, is expected to exacerbate many long-standing inequities that affect socially and economically marginalized groups in the coastal zone. Devastating storms in recent years have provided stark examples of the impacts facing these vulnerable coastal residents, and the long-term consequences for these communities remain uncertain. Adaptive measures, such as seawalls, beach nourishment, and other protective measures including green infrastructure, have been shown to be effective in many instances. Residents of low-lying affordable housing in the coastal zone tend to be low-income individuals living in old and poor-quality structures, which are especially vulnerable to coastal floods. Low-income individuals are also more likely to be adversely affected as they have fewer financial resources to protect against and recover from flooding damage or loss of property.[28]

Image 2. October 28, 2015, King Tide Flooding in Downtown Boston
Photographer: Ken Moraff

H. Inland Flooding

As a result of a warming climate, heavy rainfall and extreme precipitation events will continue to increase during this century leading to more inland flooding. Predicted increases in the frequency of major hurricanes and stronger storms may also cause severe inland flooding events. Because New England was one of the first areas of the country to be developed, much of the historical industrial development occurred along rivers, canals, coasts, and other bodies of water for ease of hydropower and transportation. In New England these areas have industrial facilities, historically contaminated sites, waste management facilities, and petroleum storage facilities that are more vulnerable to flooding.[1] Flooding could increase the spread of contaminants into soils and waterways, resulting in increased risks to the health of nearby populations, ecosystems, and wildlife—a set of phenomena well documented following Superstorm Sandy and Tropical Storm Irene.[20] Inland flooding can be managed with green infrastructure, infiltration-based practices, floodplain management, and open space preservation to complement other measures to lower flood risk.[30]

In the U.S., minorities, those with low income, people with limited English proficiency, and certain immigrant communities are at increased risk of exposure to flooding given their higher likelihood of living in risk-prone areas and locations with poorly maintained infrastructure. In addition, low-income populations have been shown to be less likely to evacuate in response to warning systems. Nature-based infrastructure projects, such as those designed to protect against flooding, often exclude socially vulnerable groups and instead end up displacing lower income residents. Minorities may have limited access to information and resources designed to prevent or mitigate flooding risk due to language or cultural differences.[28] The Climate Change and Social Vulnerability in the United States: A Focus on Six Impact Sectors found that in the Northeast, minorities are 16% more likely than non-minorities to currently live in areas projected to have the worst flooding damages. Some evidence also indicates that those over 65 could see increased riverine flood frequency and magnitude by 2050 because of climate change.[28]

I. Seasonal Shift

The seasonality of the Northeast is central to the region's sense of place and is an important driver of rural economies. Seasonal differences in Northeast temperature have decreased in recent years as winters have warmed three times faster than summers. By 2050, winters are projected to be milder, with fewer cold extremes, particularly across inland and northern portions of the Northeast. This will likely result in a shorter and less pronounced cold season with fewer frost days and a longer transition out of winter into the growing season.[37] Forests are already responding to the ongoing shift to a warmer climate resulting in changes to the timing of leaf-out that affect plant productivity, plant–animal interactions, pollen production, and other essential ecosystem processes. Warmer late-winter and early-spring temperatures in the Northeast have resulted in trends toward earlier leaf-out and blooming, including changes of 1.6 and 1.2 days per decade, respectively, for lilac and honeysuckle. Warmer winters will likely contribute to earlier insect emergence and expansion in the geographic range and population size of important tree pests such as the hemlock woolly adelgid, emerald ash borer, and southern pine beetle. Increases in less desired herbivore populations are also likely, with nutria (exotic South American rodents) already being a major concern in different parts of the region. With changing seasons, there is also increased likelihood of climate change related public health problems in the Northeast.[1]

Shorter, milder winters will present a variety of challenges for rural industries such as logging, maple syrup harvesting, and the snow-related sports industry.[37] The outdoor recreation industry contributes nearly $150 billion in consumer spending to the Northeast economy and supports more than one million jobs across the region. Additionally, agriculture, fishing, forestry, and related industries together generate over $100 billion in economic activity annually, supporting more than half a million jobs in production and processing region wide. Projected changes in the Northeast's seasons will continue to affect terrestrial and aquatic ecosystems, forest productivity, agricultural land use, and other resource-based industries.[1]

J. Air Quality

Higher temperatures and changes in atmospheric circulation patterns can increase tropospheric ozone levels and change the length of the ozone season, which would expose more people in the Northeast to unhealthy levels of ozone. Additionally, more frequent, and severe wildfires and windblown dust from areas affected by drought may also diminish air quality regionally. Climate change increases the frequency of temperature inversions, which can trap particulate matter (PM) and thus increase PM concentrations.[38] The combination of patterns in the atmospheric deposition of sulfur, nitrogen, and mercury with climate change has implications for the health of ecosystems, shifts of species, the chemistry of surface waters, and the production of methylmercury and its bioaccumulation in food webs.[39] In New England, the increase in indoor moisture from increased precipitation, flooding events, and severe storms makes the older building stock more susceptible to mold conditions. Indoor conditions can also be affected by wildfire smoke, airborne allergens, and other particle pollution from outdoors which can infiltrate homes and buildings. Additionally, more frequent power outages and use of portable generators can increase the risk of carbon monoxide poisoning indoors.[40]

Recent studies have found that minorities, individuals with lower income, and individuals with lower educational attainment are at increased risk of ambient air pollution exposure and health effects related to that exposure. Neighborhoods with higher poverty rates have been found to have higher exposures to PM2.5 and ozone. Studies have found higher exposures to PM2.5 and ozone in neighborhoods with more racial minorities and higher incidence of childhood asthma. The EPA Social Vulnerability report found

that in the Northeast, minority children are 10% more likely than non-minority children to currently live in areas with the highest projected increases in childhood asthma diagnoses from climate-driven changes in PM2.5. Children in low-income households are 7% more likely than those with higher income to currently live in high-impact areas. Air pollution can also exacerbate chronic obstructive pulmonary disorder and increase the risk of heart attack in older adults, especially those who are also diabetic or obese.[28]

K. Public Health

Climate change can exacerbate existing health threats or create new public health challenges through a variety of pathways.[41] The health impacts from climate change in New England include:[42]

- **Temperature-Related Illness**: Heat-related illness and death remain significant public health problems in the Northeast. People living in urban areas, may experience higher ambient temperatures because of the additional heat associated with urban heat islands. Additionally, high heat days are correlated with high concentrations of urban air pollutants, such as ground-level ozone. The combination of heat stress and poor air quality can pose a major health risk to sensitive groups.
- **Vector-Borne Diseases**: Climate change is expected to alter the geographic range, seasonal distribution, and abundance of disease vectors, exposing more people in North America to ticks that carry Lyme disease or other bacterial and viral agents, and to mosquitoes that transmit West Nile, chikungunya, dengue, and Zika viruses. These diseases, specifically Lyme disease, have been linked to climate, particularly with abundant late-spring and early-summer moisture. By 2065–2080, under the higher scenario (RCP8.5) it is projected that the period of elevated risk of Lyme disease transmission in the Northeast will begin 0.9–2.8 weeks earlier between Maine and Pennsylvania, compared to 1992–2007. Similarly, a recent analysis estimates that there would be an additional 490 cases of West Nile neuroinvasive disease per year in the Northeast by 2090 under the higher scenario (RCP8.5) versus 210 additional cases per year under the lower scenario (RCP4.5).
- **Extreme Events**: More frequent and/or more intense extreme events, including drought, wildfires, heavy rainfall, floods, storms, and storm surge, are expected to adversely affect the health of the New England population. These events can exacerbate underlying medical conditions, increase stress, and lead to adverse mental health. Further, extreme weather and climate events can disrupt critical public health, healthcare, and related systems in ways that can adversely affect health long after the event.
- **Water-Related Illness**: Increasing water temperatures associated with climate change are projected to alter the seasonality of growth and the geographic range of harmful algae and coastal pathogens, and runoff from more frequent and intense rainfall is projected to increasingly compromise recreational waters and sources of drinking water through increased introductions of pathogens and toxic algal blooms.
- **Food Safety, Nutrition, and Distribution**: Climate change, including rising temperatures and changes in weather extremes, is projected to adversely affect food security by altering exposures to certain pathogens and toxins. In the Northeast, there will be increasing prevalence of shell disease in lobsters, and vibrio (a marine bacteria) and other pathogens in oysters associated with warming sea temperatures.
- **Unhealthy Indoor Air**: Changes in ambient humidity and more frequent heavy rainfalls and floods can increase moisture in buildings, leading to higher mold concentrations, dust mites,

bacteria, and other biological contaminants indoors. Damp indoor conditions and mold are both known to be associated with respiratory illnesses, including asthma symptoms and wheezing. Indoor air pollutants can cause immediate effects, such as irritation of the eyes, nose, and throat, headaches, dizziness, fatigue, and aggravated or worsened asthma symptoms among asthmatics. Long-term effects may include respiratory diseases, heart disease, and cancer.

- **Mental Health and Well-Being**: Mental health consequences, ranging from minimal stress and distress symptoms to clinical disorders, such as anxiety, depression, post-traumatic stress, and suicidality, can result from exposures to short-lived or prolonged climate- or weather-related events and their health consequences. These mental health impacts can interact with other health, social, and environmental stressors to diminish an individual's well-being. The concerns over the impacts of climate causing psychological effects are a growing concern among mental health experts.

While the health impacts listed above can affect anyone in the New England region, there are certain populations who are more vulnerable. Within public health, the term "susceptibility" often refers to factors related to physical predisposition (e.g., age), and "vulnerability" often refers to external factors (e.g., occupational exposure).[43] People that are more susceptible to the health effects of climate change are children, the elderly, and people with underlying health conditions. People who are more vulnerable to climate change include low-income communities, communities of color, Indigenous communities, the elderly, people without access to air conditioning, those living in older homes, the socially isolated, those who work outdoors, and those living in overburdened and vulnerable communities.[44]

L. Climate Migration

Climate migrants are people who leave their homes because of climate stressors. Climate stressors, such as wildfires, extreme storms, heavy flooding, and sea level rise, put pressure on people to leave their homes and livelihoods behind. [45] In New England, coastal and riverine communities are the most likely to be impacted. As sea levels rise or rivers experience extreme flooding and erosion, certain communities will become unhabitable and force communities to migrate away. For coastal impacts, **Figure 6** shows U.S. counties that would be impacted by six feet of sea level rise - shaded in blue. Inland counties are shaded in red according to how many migrants they would receive from coastal areas.[46] In New England climate refugees would be leaving the coast and heading farther inland, to counties in Vermont, New Hampshire, and Massachusetts.

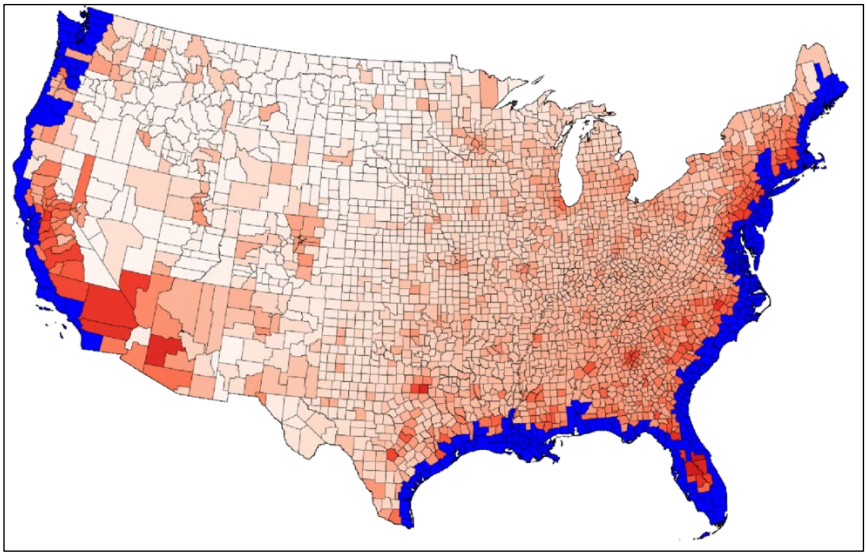

Figure 6. Modeled migration patterns due to sea level rise affecting counties in blue [47]

Other ways that climate change is causing migration relates to loss of jobs. Between 1996 to 2017 there was a 16% decline in fishing jobs in New England. This loss of jobs has been attributed largely to climate change affecting fishing stocks.[47] With a loss of economic opportunity, community members have had to migrate to other areas that provide more opportunities.

The 2014 Pioneer Valley Climate Adaptation Plan found that while sea level rise is not a direct concern for flooding in the Pioneer Valley, a region in Western MA about 100 miles inland, the region's economy and social systems are linked to coastal cities in other regions, especially Boston and New York City.[48] Therefore, severe weather impacts in these and other coastal areas will likely have secondary effects in the Pioneer Valley that could be a recipient of coastal migrants. Their plan stated that "storm surges and flooding, such as those seen during Superstorm Sandy in late October 2012, as well as other storms along the Atlantic coast have required mass evacuations. In the future, it is possible that an even larger mass evacuation in those areas would create demand for emergency sheltering in our region."

In fact, that is what happened in 2019. After Hurricane Maria hit Puerto Rico displaced Puerto Ricans migrated to the City of Holyoke in Massachusetts.[49] Even though the Pioneer Valley Adaptation Plan had anticipated this type of secondary effect, an assessment by the City of Holyoke determined that the city did not have the capability to respond to an influx of migrants driven by a climate change event and that it lacks the necessary financial resources to respond to the needs of a large influx of migrants who may arrive as a result of a climate-driven event.[49]

II. Vulnerable Populations

Certain individuals and communities—such as low-income communities, communities of color, federally recognized Tribes and indigenous peoples, children, the elderly, persons with underlying medical conditions and disabilities, those with limited access to information, those with language barriers—can be especially vulnerable to the impacts of a changing climate. As climate change exacerbates existing pollution problems and environmental stressors, overburdened and underserved communities and individuals are particularly vulnerable to these impacts. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas or living in isolated or segregated areas. EPA's September 2021 analysis, Climate Change and Social Vulnerability in the United States: A Focus on Six Impact Sectors, shows that the most severe harms from climate change fall disproportionately upon vulnerable populations, defined in the report based on income, educational attainment, race and ethnicity, and age. The report demonstrates how vulnerable populations are least able to prepare for, and recover from heat waves, poor air quality, flooding, and other impacts.[28]

A. Background and Demographics

New England has a population of over 14.8 million people across six states, with a large portion of the population located along the coastline that spans approximately 6,130 miles. The population density is nearly 235 people per square mile on average, which is significantly higher than the national population average of 79.56 people per square mile.[50] Rural and urban areas have distinct vulnerabilities, impacts, and adaptative responses to climate change. The urbanized parts of the Northeast are dependent on the neighboring rural areas' natural and recreational services, while the rural communities are dependent on the economic vitality and wealth-generating capacity of the region's major cities.[1] The three southern states of CT, RI, and MA are more densely populated and urbanized than the northern states with the most populated urban areas being situated along the eastern coastline. The three northern states,

NH, VT, and ME, have a much lower population density. ME and VT are considered among the most rural states in the country. **Table 2** shows the number of people within each state that live in urban versus rural areas in New England.[51]

State	Urban	Rural	Total
Connecticut	3,420,758	185,186	3,605,944
Rhode Island	1,097,379	0*	1,097,379
Massachusetts	6,924,033	105,884	7,029,917
New Hampshire	868,002	509,527	1,377,529
Vermont	225,562	417,515	643,077
Maine	815,078	547,281	1,362,359

Table 2. Number of People Living in Rural versus Urban Areas by New England State.[51]

Compared to a decade ago New England is more populated, older, and, in most places, more multicultural. Each state has varying demographics, shown in **Table 3**. [52]

State	% Under the Age of 18	% Over the Age of 65	% People of Color (POC)	% Language spoken at home other than English	Median Income	% Living in Poverty
Connecticut	20.4	17.7	34.1	22.3	$78,444	9.7
Rhode Island	19.3	17.7	28.6	22.4	$67,167	10.6
Massachusetts	19.6	17.0	28.9	23.8	$81,215	9.4
Vermont	18.3	20.0	7.4	8.0	$76,768	7.0
New Hampshire	18.8	18.7	10.2.	8	$76,768	7.0
Maine	18.5	21.2	7.0	6.1	$57,981	10.6

Table 3. **New England Demographics by State**[52]

B. Federally Recognized Tribes

EPA values its unique government-to-government relationship with federally recognized Tribes in planning and decision-making. This trust responsibility has been established over time and is further expressed in the 1984 EPA Policy for the Administration of Environmental Programs on Indian Reservations, 2011 Policy on Consultation and Coordination with Indian Tribes, and the January 2021 presidential memorandum entitled Tribal Consultation and Strengthening Nation-to-Nation Relationship. These policies recognize and support the sovereign decision-making authority of Tribal governments.

Under the Constitution, treaties with Tribes are part of the supreme law of the land, establishing unique sets of rights, benefits, and conditions for the treaty-making Tribes who were forced to cede millions of acres of their homelands to the United States, in return for recognition of property rights in land and resources as well as federal protections. Tribal treaty rights have the same legal force and effect as federal statutes, and they should be integrated into and given the fullest consideration throughout EPA's collective work. Reserved rights are the rights Tribes retain that were not expressly granted to the United

* The terms "rural" and "urban" here refer to data for nonmetro and metro areas, a county-level classification defined by the Office of Management and Budget. We use the February 2013 version of nonmetro and metro areas, unless otherwise noted, because it reflects conditions at the beginning of the decade. (USDA State Fact Sheets, https://data.ers.usda.gov/reports.aspx?StateFIPS=44&StateName=Rhode%20Island&ID=17854)

States by Tribes in treaties. Treaty and reserved rights, including but not limited to the rights to hunt, fish, and gather, may be found both on and off-reservation lands.

In September 2021, EPA joined 16 other federal agencies in signing a Memorandum of Understanding (MOU) that committed those parties to identifying and protecting Tribal treaty rights early in the decision-making and regulatory processes. Accordingly, EPA will consider and protect treaty and reserved rights in developing and implementing climate adaptation plans through strengthened consultation, additional staff training and annual reporting requirements. The EPA-wide FY 2022-2026 EPA Strategic Plan outlines cooperation and collaboration priorities with Tribes on climate change in Goal 1: Tackle the Climate Crisis. Goal 1 broadly entails cutting pollution that causes climate change and increasing the adaptive capacity of Tribes, states, territories, and communities. A key objective of this goal is to deliver targeted assistance to increase the resilience of Tribes, states, territories, and communities to the impacts of climate change (**Objective 1.2**). Specifically, through consultation and partnership, the Agency will assist federally recognized Tribes to take action to anticipate, prepare for, adapt to, or recover from the impacts of climate change.

There are 10 federally recognized Tribes in New England (**Figure 7**). The total population of tribal members from these federally recognized Tribes is approximately 18,500 members. The total acreage of tribal land holdings in New England is approximately 265,700 acres, and is comprised of a combination of reservation, trust, and fee lands. Compared with other Tribes throughout the nation, the Tribes in New England, while relatively smaller in both population and land holdings, are faced with a host of environmental, public health, and tribal sovereignty-related challenges. Additionally, climate change may disproportionately impact these Tribal communities compared to non-tribal communities.

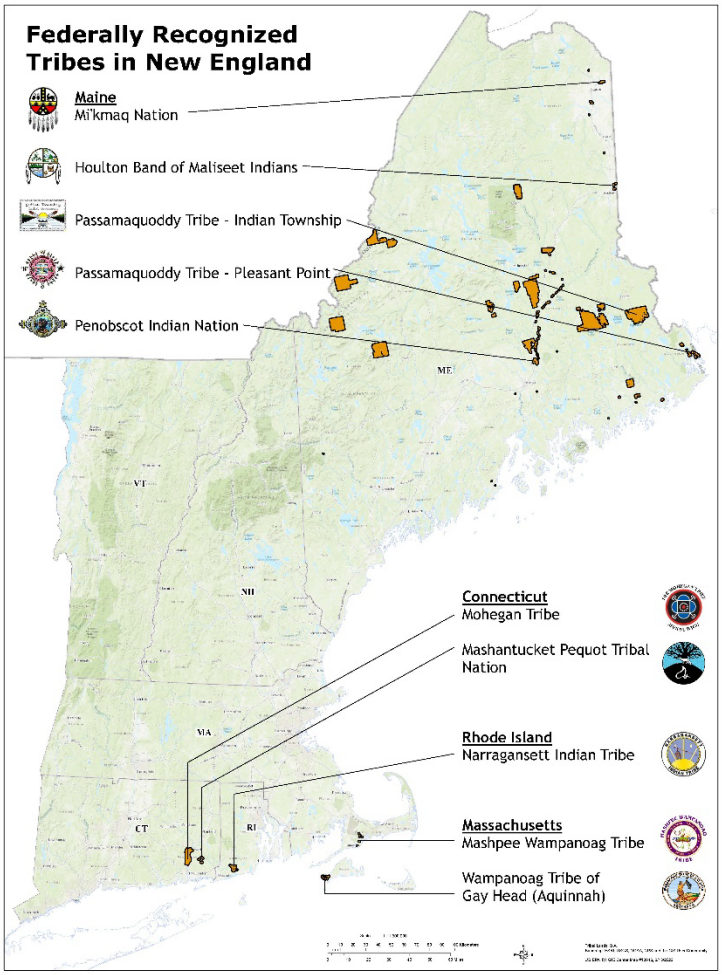

Figure 7. Map of the 10 Federally Recognized Tribes in New England

Tribes are particularly vulnerable to the impacts of climate change due to the integral nature of the environment within their traditional lifeways and culture. There is a strong need for Tribes to develop adaptation strategies that promote sustainability and reduce the impact of climate change. Observed and future impacts from climate change threaten indigenous communities' access to traditional foods, such as fish, game, wild, and cultivated crops. These resources have provided sustenance as well as cultural,

economic, medicinal, and community health for generations. To help adapt to the climate change impacts affecting Tribal food sovereignty, the Tribes and the New England Federal Partners, a group of 17 federal agencies working on environmental issues in the region, held a Tribal Climate Summit on April 13, 2022. Discussions from the Summit will inform future collaborations between the Tribes and the federal government to promote adaptation.

Image 3. October 29, 2012, Wampanoag Tribe of Gay Head (Aquinnah) Lobsterville Road Hurricane Sandy dune washout and road damage
Photographer: Bret Stearns

Beyond food resources, climate change impacts threaten sites, practices, and relationships with cultural, spiritual, or ceremonial importance that are foundational to Tribal cultural heritage, identity, and physical and mental health. For example, **Image 3** shows road damage and dune washout brought on by Hurricane Sandy in 2012, on Lobsterville Road within the Wampanoag Tribe of Gay Head (Aquinnah) Tribal lands. **Image 4**, taken in 2016**,** shows the eroding embankment at Passamaquoddy Tribe's Pleasant Point Wastewater Treatment Facility (WWTF) from sea level rise and flooding impacts.

Image 4. June 23, 2016, Passamaquoddy Tribe – Pleasant Point eroding embankment – Gene Francis, WWTF Operator and Ken Grant, Indian Health Service engineer
Photographer: Michael Stover

Traditional Ecological Knowledge (TEK) is the accumulated knowledge Tribes have about their environment. To ensure TEK is properly accounted for within the RCAP implementation process, R1 will work with the ten New England Tribes in an informal engagement process to review the background section on federally recognized Tribes, and the Tribal programmatic vulnerability, Priority Actions, and Regional Science Needs. Based on the engagement process, additional edits will be made to account for any TEK information gaps. R1 is committed to assisting Tribes in responding and adapting to climate change impacts.

C. Environmental Justice

Environmental justice is the 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. The EPA-wide FY 2022-2026 EPA Strategic Plan

prioritizes consideration of climate change and environmental justice in Goal 1: Tackle the Climate Crisis and Goal 2: Take Decisive Action to Advance EJ and Civil Rights. A key objective of Goal 1 is to deliver targeted assistance to increase the resilience of Tribes, states, territories, and communities to the impacts of climate change (**Objective 1.2**). Specifically, the Agency will assist states, territories, local governments, and communities with environmental justice concerns to take action to anticipate, prepare for, adapt to, or recover from the impacts of climate change. EPA's EJ program will be focused on taking decisive action to advance EJ, including building capacity and climate resilience and maximizing benefits to overburdened communities. EPA plans to increase support for community-led action by increasing investments and benefits directly to communities with environmental justice concerns and by integrating equity throughout Agency programs. R1's EJ Program is committed to supporting and assisting vulnerable populations and communities with environmental justice concerns in responding and adapting to climate impacts.

III. R1 Programmatic Climate Vulnerability Assessment

Climate change puts EPA's ability to implement its programs, created to protect human health and the environment, at risk. This section contains a preliminary assessment of EPA R1's programmatic vulnerabilities that identify how potential climate change impacts in New England (see Climate Change in New England) can potentially impact R1's programmatic work. The vulnerabilities were identified by the **R1 Divisional Climate Workgroup,** where each divisional representative worked with staff across their respective divisions to identify programmatic vulnerabilities. The vulnerabilities are broken down into seven programmatic areas, listed in blue throughout this plan, that cover EPA R1's programs: **1. Vulnerable Populations**, **2. Air Quality**, **3. Water Quality/Quantity**, **4. Contaminated Site Cleanup and Sustainable Development**, **5. Chemical Safety, Waste Management, and Pollution Prevention**, **6. Facilities and Operations**, and **7. Cross Sectional**. Under each programmatic area, vulnerabilities are numbered in red (ex. **2. Air Quality 2.1, 2.2, …, 2.5**). The **1. Vulnerable Populations** section identifies overarching vulnerabilities for Tribal communities and those living in communities with EJ concerns that have amplifying effects within each programmatic area following that section.

Under each programmatic vulnerability, R1 actions needed to address that vulnerability are described under five different categories, ***Regulatory***, ***Enforcement***, ***Monitoring/Lab Analysis***, ***Financial/Technical Assistance***, and ***Facilities/Operations***. ***Regulatory*** refers to actions R1 would take to set or apply EPA standards and regulations in non-enforcement contexts. ***Enforcement*** refers to actions R1 would take in response to noncompliance to enforce EPA standards and regulations. ***Monitoring/Lab Analysis*** are actions R1 would take to study the environmental issue through R1's laboratory analysis or increased monitoring capabilities done in partnership with states. ***Financial/Technical Assistance*** are actions R1 would take, consistent with federal law, to provide funding in the form of grants and cooperative agreements and/or support in the form of technical assistance to businesses, non-profit organizations, and Tribal, state, and local governments for a wide range of projects, from building or upgrading water pollution control and drinking water infrastructure, scientific studies, and community cleanups. Most grant funds are awarded to state agencies and municipal governments to help EPA implement programs to meet the goals of federal laws. ***Facilities/Operations*** are actions R1 would take to ensure R1's facilities are maintained and resilient. This is done in coordination with the building owner and the General Services Administration (GSA). There is an additional section under each vulnerability, ***Barriers to Address***, that describes any barriers that could prevent R1 from addressing the vulnerability. Resource, funding, and other restrictions as well as limits to our current knowledge can be overarching

barriers to addressing vulnerabilities in R1's programs. As our understanding of climate science evolves and our resources change, this assessment will be updated periodically to reflect those changes.

1. Vulnerable Populations

Climate change presents a great environmental challenge for everyone in New England, but especially those who live, work, and learn in overburdened and vulnerable communities. Tribal communities and those living in communities with EJ concerns have been historically underserved and may be overburdened by disproportionate impacts of climate change. R1 has identified and assessed specific vulnerabilities that these communities face in sections **1.1 – 1.2**, listed below, so that the region can ensure these communities' unique challenges will be taken into consideration when making decisions and will have equal opportunities to thrive. These overarching vulnerabilities have amplifying effects within each programmatic area following these sections. The amplifying effects vary, from each area, based on the type of climate impacts, locations, and populations that are most vulnerable.

1.1 Increased environmental risks/impacts from climate change will threaten the ability of R1 to serve and protect the 10 federally recognized Tribes within New England.

Regulatory: Disproportionate environmental risks/impacts from climate change on Tribal communities should be considered when either EPA directly implements permitting and regulatory programmatic functions in Tribal communities or when regulatory and permitting actions, in surrounding areas, may affect a Tribal community. The EPA Policy on Consultation and Coordination with Indian Tribes, the Memorandum of Understanding Regarding Interagency Coordination and Collaboration for the Protection of Tribal Treaty and Reserved Rights, as well as Region 1's Tribal Consultation Policy Implementation Guidance Document are useful resources to assist programs in the process of Tribal consultation. R1's programs should also consult the Legal Tools Development document, developed by EPA's Office of General Counsel, which provides an overview of several discretionary legal authorities that EPA may consider using to more fully ensure that its programs, policies, and activities fully protect human health and the environment in Tribal communities.

Monitoring/Lab Analysis: As the Tribes' natural resources are impacted by climate change, there will be an increased need for EPA to assist Tribes in monitoring changes in the environment and performing chemical and biological analyses. These changes include, but are not limited to, invasive species, changes in habitat, thermal impacts, and harmful algal blooms (HABs). EPA should also take into consideration TEK, the accumulated knowledge Tribes have about their environment, to ensure TEK is properly accounted for within EPA's programs. TEK can provide baseline data for evaluating change in the environment.

Enforcement: Consistent with EPA's trust responsibility to Tribes, Tribal concerns regarding impacts to Tribal lands and natural resources as a result of violations of environmental statutes, permits, or compliance requirements should be addressed in R1's compliance and enforcement work.

Financial/Technical Assistance: R1 provides annual funding to Tribes through Clean Water Act (CWA) 106 and 319, Clean Air Act (CAA) 103 and 105, and Brownfields programs, as well as the General Assistance Program. EPA also provides opportunities for Tribes to compete for other grant funding when appropriated. With increased climate-related environmental risks to Tribal communities, there may be an

increased need for funding to address these climate impacts. Where appropriate, R1 will integrate and review climate adaptation criteria in assistance agreement programs to ensure climate resilience.

Barriers to Address: Many of the Tribes lack the resources to competitively apply for funding to adequately address climate threats. EPA should take into consideration Tribes' administrative burden in applying for and managing grants, and where possible, provide funding from sources that can be included in performance partnership grants to ease the administrative burden.

1.2 Increased environmental risks/impacts from climate change will disproportionally affect communities with environmental justice concerns.

Regulatory: When considering the impacts of climate change, disproportionate impacts to communities with EJ concerns should be considered during permitting and regulatory programmatic work. R1 programs should consult the Legal Tools Development document, developed by EPA's Office of General Counsel, which provides an overview of several discretionary legal authorities that EPA may consider using to more fully ensure that its programs, policies, and activities fully protect human health and the environment in communities with EJ concerns.

Monitoring/Lab Analysis: When allocating monitoring and lab resources, communities with EJ concerns should be considered, especially where baseline data is limited or incomplete. EPA should also consider involving impacted communities, when appropriate, in our research through tools like citizen science and participatory research.

Enforcement: When addressing increased violations of environmental laws in R1's compliance and enforcement work, communities with EJ concerns should be considered.

Financial/Technical Assistance: EPA offers EJ grant opportunities to Tribal, state, local, and community-based organizations to address environmental and public health issues. With increased environmental risks to communities with EJ concerns, there may be an increased resource need for EJ grant programs.

Barriers to Address: Many community-based, non-profit organizations lack the resources to competitively apply for funding to adequately address climate threats. EPA should take into consideration the administrative burden for these organizations in applying for and managing grants, and where possible, provide funding from sources that may present fewer administrative burdens. There are many barriers to effectively reaching communities with EJ concerns, including language or cultural barriers. Increased R1 employee capacity is needed to better reach these communities as environmental concerns grow from climate change.

2. Air Quality

The CAA sets health-based air quality standards that EPA and the states implement. Climate change makes it more difficult to attain air quality standards and protect the quality of the air we breathe, especially in overburdened and vulnerable populations. Minorities, individuals with lower income, and individuals with lower educational attainment are at increased risk of ambient air pollution exposure and health effects related to that exposure (See Air Quality).[28] These changes are forcing EPA and the states to adapt and update air quality programs to meet requirements in an environment that is being altered by

climate change. As a result of climate change related air quality issues, R1 has identified specific vulnerabilities related to R1's ability to meet these requirements, **2.1-2.5**, listed below.

2.1 An increase in average temperatures will increase electricity demand and create a higher number of high electricity demand days. As a result, tropospheric ozone (O3) levels may increase, which threatens attainment of CAA National Ambient Air Quality Standards (NAAQS).

Regulatory: An increase in high ozone days will require R1 and states to send out more Air Quality Index (AQI) notifications and Ozone Alerts. If ozone levels increase such that the NAAQS are not being met, R1 will work with the states to develop control and attainment plans so that air quality does not exceed the ozone standards. Increases in ozone nonattainment areas will also require the Air Permitting Program to ensure Best Available Control Technology (BACT) or Lowest Achievable Emission Rate (LAER) for projects triggering major New Source Review (NSR), conduct air quality analyses to ensure no new or major sources violate NAAQS or Prevention of Significant Deterioration (PSD) increments, and review state programs where permit programs are delegated.

Monitoring/Lab Analysis: If ozone levels increase or elevated levels become more widespread, additional air monitors may need to be deployed throughout the region for CAA stationary and mobile source compliance. If so, air monitoring Annual Network Plans will need to be revised. In addition, higher electrical demand may require additional source emission testing and regional coordination of test protocols.

Financial/Technical Assistance: More air quality impacts will create a need for more air quality grant funding to be awarded to state and tribal air programs through CAA 103 and 105 grants.

Barriers to Address: Additional resources for more monitoring equipment may be needed. There is also additional transboundary pollution coming into the region from upwind states that are regulated outside of New England.

2.2 An increase in windblown/fugitive PM from drought and wildfires may increase PM concentrations, which threatens the attainment of CAA NAAQS.

Regulatory: An increase in particulate matter concentration and high concentration days will require more AQI notifications to be sent out. If PM concentrations increase such that the NAAQS are not being met, the region may have to review particulate matter attainment plans submitted by R1 states.

Monitoring/Lab Analysis: If PM levels increase or elevated levels become more widespread, additional air monitors may need to be deployed throughout the region for CAA stationary and mobile source compliance. If so, air monitoring Annual Network Plans will need to be revised.

Financial/Technical Assistance: More air quality impacts will create a need for more air quality grant funding to be awarded to state and tribal air programs through CAA Section 103 and 105 grants.

Barriers to Address: The Exceptional Events Rule limits R1's ability to mitigate PM pollution coming from outside of the region due to extreme weather events, such as wildfires. The amount of available air monitors is limited and will require more funding.

2.3 Potential changes in atmospheric patterns and the uncertainty surrounding air quality modeling limits EPA's ability to adequately predict, model, measure, and thus communicate future air quality trends, which threatens all Air Quality Planning activities and the CAA NAAQS.

Regulatory: To improve future air quality modeling, there is a need for EPA to work with states to ensure modeling inputs are appropriate and up to date for future modeling exercises used to make decisions on effective and efficient ways to implement the NAAQS and improve air quality.

Monitoring/Lab Analysis: If pollution levels increase, or elevated levels become more widespread, or dispersed into new areas, additional air monitors may need to be deployed throughout R1. If so, air monitoring Annual Network Plans will need to be revised.

Barriers to Address: The uncertainty related to future air quality impacts will remain until research and data can further R1's understanding.

2.4 An increase in extreme storm events and flooding will create more potential for an accidental release of an extremely hazardous substance to occur at a stationary source, which could impact the facility's chemical accident prevention program under Section 112(r) of the CAA - Accidental Release Prevention/Risk Management Plan (RMP) Rule.

Enforcement: To account for extreme storm event and flooding impacts, RMPs and chemical accident prevention programs may need to be revised and monitored then reviewed by R1. EPA HQ may choose to revise the RMP regulations to clarify that risks posed by climate change be anticipated and addressed.

Barriers to Address: There are resource constraints in addressing RMP and the General Duty Clause (GDC) compliance and a potential need for training on industry standards that address these risks.

2.5 Increased precipitation, flooding, and extreme events can lead to increases in mold, dust mites, bacteria, and other biological contaminants indoors. Prolonged power outages from these events could increase the use of backup generators and wood stoves, which lead to increases in carbon monoxide and indoor particulate matter.

Financial/Technical Assistance: With increased impacts on indoor air quality**,** state and Tribal air programs will need more technical assistance and funding to address these needs.

Barriers to Address: Resources are needed to address this.

3. Water Quality/Quantity

Climate change is already challenging the ability of R1's Water Division programs to restore and protect the integrity of New England's waters, including the multifaceted environmental, social, and economic benefits they confer to communities. Certain communities and populations are uniquely and disproportionally vulnerable to climate change impacts due to a variety of factors, including higher pollution burdens, greater exposure to environmental contaminants, lack of financial resources, limited access to quality health care, and other issues. Communities of color, low-income communities, children, persons with disabilities, the elderly, Tribes, and indigenous people often face unequal and often greater risks from climate change. These populations generally have fewer resources to prepare for or cope with

climate-related events – including those that impact the quality and quantity of their water resources – and are expected to experience greater hardships from climate change in the future.

Under the CWA, EPA, the states, and authorized Tribes are tasked with setting water quality standards (WQS) and controlling pollution through wastewater discharge permits and nonpoint source management to achieve the goal of attaining "water quality [that] provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water."[53] Under the Safe Drinking Water Act (SDWA), EPA promulgates national primary drinking water regulations applicable to public water systems to protect human health from contaminants. Under the Marine Protection, Research, and Sanctuaries Act (MPRSA), EPA works with the U.S. Army Corps of Engineers (USACE) to regulate, including setting standards governing, the transportation of material for the purpose of dumping it in ocean waters. Through the CWA, MPRSA, and SWDA, EPA Tribal, and state water programs protect and restore healthy aquatic ecosystems and safe drinking water supplies. But achieving water management goals has become more challenging and complex as climate change shifts hydrological patterns outside of historic norms. R1 programs are already confronting a variety of climate impacts, including warmer air and water temperatures, increased frequency of extreme weather events affecting water infrastructure operations and dredging needs, groundwater rise that may impact the performance and longevity of some water infrastructure, saltwater intrusion that places greater demands on drinking water treatment facilities to meet drinking water standards, and increased pollutant loading to waterbodies from changing precipitation patterns that hinder the attainment of water quality goals. The quantity and diversity of these impacts underscores the importance of climate adaptation to the water program's mission to protect, maintain, and restore the integrity of R1's waters, so that drinking water remains safe and aquatic ecosystems continue to function in as natural a manner as possible and provide their vital services. R1 staff have identified specific vulnerabilities to respond to R1's ability to meet these requirements, **3.1-3.11**, listed below.

3.1 An increase in air and water temperature, extreme precipitation, drought, ocean and coastal acidification, and sea level rise will create changing hydrologic conditions and other stressors that threaten the ability to effectively determine attainment of WQS.

Regulatory: Water temperature and the amount and circulation of water in a waterbody are important variables in both establishing and determining attainment of WQS. Extreme precipitation causes erosion and accelerates the delivery of sediment and other pollutants from the landscape, which also makes it more difficult to meet WQS. An increase in nonattainment of WQS will likely result in R1 encouraging states to conduct triennial WQS revisions on a more regular basis (ideally every three years as required by the CWA) to address changing conditions more effectively. It could also result in states including more water quality impairments (waterbody/pollutant combinations) in their biennial CWA Section 303(d) lists, which would increase the need for total maximum daily loads (TMDLs). Also, the designated uses for some waterbodies, and their associated criteria, may need to be removed or changed based on changing conditions (e.g., intermittent streams may be dry for longer periods of time in summer and no longer support certain aquatic life forms, warmer water may not assimilate nutrients as effectively), and hydrological changes may trigger a need for new "jurisdictional" determinations (e.g., deciding whether an intermittent stream is a "water of the U.S." regulated under the CWA), and all of these actions may trigger controversy and litigation.

Monitoring/Lab Analysis: Changing conditions will require more frequent monitoring in more locations to measure the impact on the affected waterbodies. The states are responsible for monitoring water quality

to determine attainment status and will need to invest more resources to address this need, but it also will require R1 to invest more resources to support state monitoring programs.

Financial/Technical Assistance: More water quality impacts will create a need for more resources to support state water monitoring programs through CWA Section 106 grants.

Barriers to Address: Barriers include: (1) uncertainty over scale and rate of localized change, and (2) resource constraints affecting the availability of adequate staffing and monitoring tools.

3.2 An increase in air and water temperature, extreme precipitation, drought, ocean and coastal acidification, and sea level rise will create changing hydrologic conditions and other stressors that may prevent attainment of existing TMDLs and Alternative Restoration Plans (ARPs) developed for impaired waters designated on state CWA Section 303(d) (impaired waters) lists. It also may be more difficult to identify the cause of the impairment that a new TMDL or ARP is developed to address.

Regulatory: Changing conditions and additional stressors will make it more difficult to determine the cause(s) of a particular waterbody impairment. TMDLs may need to be revised in the future if monitoring shows that nonattainment of TMDL targets is leading to unmet designated uses. Changing conditions will also likely lead to more controversy over water quality-based permit limits and TMDLs which, in turn, could lead to inaction or more litigation.

Monitoring/Lab Analysis: State monitoring programs may request additional support from R1 to help determine whether implementation of TMDLs and ARPs is leading to WQS attainment, and to determine the causes of any waterbody impairment in the face of changing conditions and increased stressors.

Financial/Technical Assistance: More water quality impacts will create a need for more resources to support state water quality planning programs through CWA Section 106 grants.

Barriers to Address: There is remaining uncertainty over the scale and rate of changes in waterbodies subject to a TMDL or ARP, and over which waterbodies require development of such a plan. Additionally, inadequate staffing and other resource constraints affect state water planning programs.

3.3 An increase in air and water temperature, extreme precipitation, drought, ocean and coastal acidification, and sea level rise will create changing hydrologic conditions and other stressors that may force permittees to confront different risks based upon factors (such as facility location and type of industry or municipal system) which should be reflected in additional National Pollutant Discharge Elimination System (NPDES) permit conditions, as would be consistent with the CWA.

Regulatory: Changing conditions and additional stressors will likely raise new and potentially challenging issues for assessing water quality, for state specification of WQS, for EPA and/or state determination of WQ-based permit limits, and for establishing a variety of other types of permit conditions and limits that may be associated with addressing changing local climatic conditions. For example, new flow requirements to prevent erosion and sedimentation, and new thermal discharge limits may be needed. Additionally, new permit limits for nutrient discharges may be needed to prevent violations of dissolved oxygen standards.

Monitoring/Lab Analysis: Changing conditions may require additional resources to support expanded monitoring for the permittees, states, and R1. Monitoring and analyses will be needed to assess both conditions in the receiving waters and the quality of pollutant discharges.

Enforcement: Changing climate conditions may cause greater non-compliance in the NPDES permit program which may also require R1 to work with states to ensure an effective enforcement response. For example, increased precipitation due to climate change could increase the number and volume of combined sewer overflows which contain stormwater and untreated sewage. As another example, situations could arise and need to be assessed where permittees might try to routinely use "by-pass" and "upset" permit conditions to justify ongoing changes to facility operations. Increases in temperature and extreme heat could lead to some large power plants requesting enforcement "forbearance" if rising water temperatures during heat waves threaten their ability to generate peak-level power while also meeting their permits' temperature limits.

Barriers to Address: Barriers to addressing climate impacts in the NPDES program include uncertainty about how localized impacts may affect municipal, industrial, and stormwater permittees, and how the corresponding permits can best address the risks raised by those changing conditions.

3.4 An increase in air and water temperature, extreme precipitation, drought, ocean and coastal acidification, and sea level rise will create changing hydrologic conditions and other stressors that will make it more challenging to effectively manage stormwater runoff from urban areas and industries covered under NPDES stormwater permits.

Regulatory: These changing climate conditions may require the development and implementation of stormwater best management practices (BMPs) that can provide necessary pollutant removal levels in the face of these changing conditions. Recreating natural hydrology will require the broader application of green infrastructure.

Monitoring/Lab Analysis: More challenging stormwater runoff management issues will require more R1 resources to support an increased demand for state and regional water quality monitoring.

Financial/Technical Assistance: States receive CWA Section 106 grants to support their NPDES programs, which usually are insufficient to cover all expenses and require supplemental state funding. Stormwater infrastructure is eligible for Clean Water State Revolving Funds (SRF), but often does not rank as highly on state Intended Use Plans (IUPs) as more traditional wastewater infrastructure projects.

Barriers to Address: There are resource constraints on funding to implement permit requirements for BMPs and other control technologies. Additional data is needed including the potential risk of a rise in groundwater for certain utilities.

3.5 An increase in air and water temperature, extreme precipitation, drought, ocean and coastal acidification, and sea level rise will create changing hydrologic conditions and other stressors that will make it more challenging to effectively manage stormwater runoff from urban areas not covered under NPDES stormwater permits, suburban and rural communities, and agricultural and forested lands covered by state and local nonpoint source (NPS) management programs.

Regulatory: These conditions will require the development and implementation of BMPs for various land uses that can provide necessary pollutant removal levels in the face of these changing conditions. EPA will work with state NPS programs to incorporate climate change considerations, including promoting green infrastructure, into updated and approved Nonpoint Source Management Program Plans required under CWA Section 319.

Monitoring/Lab Analysis: More challenging management of NPS runoff will require more R1 resources to support an increased demand for state and regional water quality monitoring.

Financial/Technical Assistance: More challenging management of NPS runoff will create an increased need for state and tribal CWA Section 319 grant funding. Structural stormwater BMPs may need to be sized and located differently, and cost more, to account for extreme precipitation, drought, rising groundwater table, and sea level rise. For example, road drainage design has traditionally been based on 100-year storms, but the frequency of that size storm is increasing.

Barriers to Address: Funding restrictions; additional baseline data, including the potential rise in groundwater, is needed to understand effectiveness and applicability of nature-based solutions.

3.6 Increased demand for septic system replacement as more systems fail due to increased precipitation, sea level rise, and rising groundwater tables. The impact of nutrient loading to waterbodies from septic systems may also be exacerbated by rising water temperatures.

Regulatory: Neither EPA nor states have generally required NPDES permits for discharges from septic systems, and in the select instances where NPDES permits have been required for discharges from a point source that reach jurisdictional surface waters via groundwater, they have been based on site-specific factors. However, if climate change causes increased septic system failures and those failures adversely affect surface waters, it may lead to increased public controversy and litigation over how those problems should be addressed.

Monitoring/Lab Analysis: Hydrologic changes that affect septic system performance may require additional resources to support expanded monitoring in the receiving waters for the municipalities, states, and R1.

Financial/Technical Assistance: More nutrient loading to waterbodies from septic systems will create an increased need for state and tribal CWA Section 319 grant funding. These grants could potentially be sought to address increased demand for septic system replacements as systems that are not rated or designed to handle increased precipitation and rising groundwater tables could fail and need replacement. Structural and non-structural BMPs for septic system design should be updated to identify changes in septic design or siting for areas prone to sea level rise, flooding, and/or rising groundwater levels. Infrastructure investment could also be used to support development of septic systems capable of functioning well under changed hydrologic conditions while also reducing nutrients to address additional NPS concerns.

Barriers to Address: Funding restrictions; resource limitations may affect the pace with which R1 is able to address septic system issues. There is also a need to better understand the effectiveness of innovative/alternative (I/A) wastewater systems in reducing nutrient loading and contaminants of emerging concern.

3.7 An increase in air and water temperature, extreme precipitation, drought, and sea level rise could create changes in wetland characteristics and shifting and/or disappearing wetland habitats that will increase the importance of avoiding or minimizing wetland losses and effectively mitigating unavoidable losses. There will be a greater need for blue carbon reserves (tidal wetlands and sea grasses), ocean and coastal acidification refuges, and living shorelines as mitigation sites.

Regulatory: Shifting and disappearing wetland habitats may require that more climate considerations be brought to bear during the review of 404 permits and National Environmental Policy Act (NEPA) documents to assure avoidance, minimization, and mitigation of impacts. R1 may also need to consider in its analyses the long-term climate-related implications of alternatives and whether they will achieve compliance within the 404(b)(1) guidelines. Jurisdictional determinations will become more complex due to landscape and watershed changes, including shifting and disappearing wetland habitats. There may also be a greater need for, and an expected increase in applications for resilience projects (e.g., beach nourishment, coastal shoreline erosion prevention and response, sea wall construction, dam removal, and flood mitigation projects) to provide mitigation of wetland impacts when avoidance or minimization of such impacts is not feasible.

Monitoring/Lab Analysis: Climate change impacts may require increased monitoring to determine wetland condition or blue carbon reserves. Monitoring may be needed to document the effectiveness of mitigation efforts. The monitoring may be done by states, R1, or others.

Enforcement: EPA will account for changing hydrologic conditions when evaluating whether wetlands may fall under federal jurisdiction and may be subject to EPA enforcement.

Financial/Technical Assistance: Increased funding through Wetland Program Development Grants (WPDG) may be needed to fund investigation and better understanding of the effects of climate change on wetlands and aquatic ecosystems. To the extent possible, priority could be considered for in-lieu fee (mitigation bank) projects that protect eelgrass and other blue carbon reserves.

Barriers to Address: Funding constraints; WPDG competitions give projects that address climate vulnerabilities a higher ranking, but R1 does not require applicants to address climate impacts. There is remaining uncertainty surrounding changes to wetland characteristics and marsh migration (lack of pathway, segmented ecosystems).

3.8 An increase in extreme precipitation and more frequent extreme storm events that cause more erosion and sedimentation may result in more frequent dredging projects that require ocean disposal or alternative placement methods. There also will be an increased demand to beneficially use dredged material to protect shorelines, beaches, dunes, and marshes from sea level rise.

Regulatory: There will be an increased demand to dredge earlier in the spring due to shorter winters and earlier snowmelts, potentially conflicting with fish migration. There will also be an increased demand to beneficially use dredged material for nourishing eroding beaches, coastal wetlands, and other shoreline areas. All of this may necessitate more EPA reviews pursuant to the MPRSA and CWA, which can pose difficult regulatory issues, and sometimes result in litigation, particularly arising out of decisions about where to dispose of, or use, the dredged material.

Permitting: There may be an increased need for emergency dredging permits to remove shoals formed by more extreme storms.

Monitoring/Lab Analysis: More dredging will require more monitoring and analysis of dredged material to characterize contaminant levels in the material and assess disposal and beneficial use options.

Barriers to Address: R1 is not responsible for sediment analyses, relying on the USACE and private permittees to collect and analyze sediment to determine suitability for ocean disposal or beneficial use. Staffing constraints may make it difficult to keep up with the demand for reviewing the results of these analyses to support suitability determinations.

3.9 An increase in air and water temperature, extreme precipitation, drought, ocean and coastal acidification, and sea level rise will create changing conditions that will make it harder to attain goals to restore and protect ecosystems in Geographic Programs, such as the National Estuary Programs (NEPs) (including the Long Island Sound Study [LISS]), Lake Champlain Basin Program (LCBP), and Southeast New England Program (SNEP).

Monitoring/Lab Analysis: Changing ecological conditions due to climate change will create an increased demand for monitoring by the geographic program, state, and/or R1.

Financial/Technical Assistance: Climate change impacts will create an increased demand on the geographic programs to provide funding to monitor and assess environmental conditions in their watersheds, and to develop and implement adaptation and resilience measures. This will place a greater burden on program and fiscal support staff and external partners in terms of grants administration, collaboration with partners, building consensus on priorities among competing needs, data support, monitoring, reporting on ecosystem changes, identification of innovative solutions, and providing technical assistance to state, regional, and local organizations/agencies.

Barriers to Address: There are funding restrictions, and not all geographic programs have conducted climate vulnerability assessments or developed adaptation strategies to guide implementation.

3.10 An increase in air and water temperature, extreme precipitation, drought, ocean and coastal acidification, and sea level rise will create changing conditions that threaten attainment of National Primary Drinking Water Regulations (NPDWR) under the SDWA.

Regulatory: The threat of increased nonattainment of national health-based standards for drinking water under the SDWA will create a need for EPA to work with state drinking water programs and water utilities to identify potential impacts of climate change on their systems, including how to prepare for, respond to, and recover from extreme storms, flooding, harmful algal blooms, and saltwater intrusion. These impacts could raise questions about the safety of surface water systems relying on watershed protection and disinfection methods to provide safe drinking water.

Monitoring/Lab Analysis: Increased nonattainment of NPDWR could necessitate additional monitoring and lab analysis to confirm such nonattainment, to determine the effectiveness of existing treatment, and to assess the causes of the nonattainment and ways to resolve it.

Enforcement: Increased nonattainment of NPDWR could necessitate additional federal and/or state enforcement actions to ensure the protection of public health.

Barriers to Address: There is remaining uncertainty over the scale and rate of changes in drinking waterbodies and resource constraints for additional monitoring and analysis needs.

3.11 An increase in air and water temperature, extreme precipitation, ocean and coastal acidification, flooding, and sea level rise may increase the likelihood of damage to drinking water, wastewater, and stormwater infrastructure resulting in an inability to effectively collect and treat wastewater and stormwater and protect and treat drinking water supplies. Warmer and more sediment-laden waters may foster algal and pathogen growth and decrease the capacity of surface water supplies.

Monitoring/Lab Analysis: Extreme events and damaged or failing water infrastructure may require additional monitoring and analyses by municipalities, states and/or R1 to assess human health and environmental impacts.

Financial/Technical Assistance: Impacts to drinking water, wastewater, and stormwater infrastructure will create a bigger resource need for the Drinking Water and Clean Water State Revolving Funds (CWSRF and DWSRF) capitalized with EPA grants and administered by the states. There will be increased demand for the SRF program to fund resilience projects that consider climate impacts to construct municipal wastewater facilities, control nonpoint source pollution, build decentralized wastewater treatment systems, implement green infrastructure projects, protect estuaries, and fund other water quality projects.

Barriers to Address: Funding restrictions.

4. Contaminated Site Cleanup and Sustainable Development

Accidents, spills, leaks, and past improper disposal and handling of hazardous materials and wastes have resulted in tens of thousands of sites across the country that have contaminated land, water (groundwater and surface water), and air (indoor and outdoor). EPA and its state and territorial partners have developed a variety of cleanup programs to assess and clean up these contaminated sites. Cleanups may be done by EPA, other federal agencies, states or municipalities, or the company or party responsible for the contamination. Climate-related risks, especially flooding in the Northeast, pose a threat to hazardous and toxic sites and nearby communities. Vulnerable populations within these communities are projected to experience a disproportionate amount of exposure to the negative impacts of these climate-related risks. In particular, the Brownfields Program is designed to provide grants and technical assistance to projects that affect vulnerable populations in low-income and disadvantaged communities. R1 staff have identified specific vulnerabilities climate change poses to cleanup programs so that these risks can be managed, **4.1**-**4.5**, listed below.

4.1 Increases in air and water temperature, precipitation, flooding, and periods of drought may result in altered fate and transport pathways and exposure assumptions, impaired aquatic habitats, dispersal of contaminants, damage to remediation related structures, and ultimately ineffective remedies at Removal and Remedial sites. At coastal sites, saltwater impacts made more likely by sea level rise may cause corrosion of remediation equipment and impair restoration efforts.

Increased frequency of extreme weather events is likely to require more frequent and robust emergency response actions at contaminated sites. These impacts threaten the work performed pursuant to CERCLA.

Regulatory: Removal and remedial (i.e., Superfund) sites determined to be significantly impacted by the risks described above may require an evaluation to determine steps that can be taken to mitigate the risks. At remedial and removal sites where remedies have not yet been selected, the assessment of remedial alternatives needs to consider the risks described above in order to choose remedies that are protective of human health and the environment. As part of this process, consideration of climate impacts will be required in drafting decision documents for remedial and removal sites, to ensure selected remedies are protective against climate impacts. At remedial sites where remedies have already been selected, consideration of climate impacts will be conducted as part of the CERCLA 5-Year Review process. In response to extreme weather events, R1 emergency response to Superfund sites may be increasingly required to ensure the protection of public and environmental health.

Monitoring/Lab Analysis: As a result of climate impacts, Superfund sites may require additional sampling and analyses of soil, sediment, groundwater, and air. The need for installation of microwells and vapor intrusion evaluations may increase with the rise in water table elevations.

Enforcement: Legal support will be required to negotiate enforcement documents that address climate change impacts to CERCLA remedies. At sites with existing remedies, legal support may be required in evaluating the ability to compel responsible parties to take actions which mitigate climate risks. At federal facility sites, R1 may need to negotiate/enforce compliance within the terms of federal facility agreements with federal parties to address climate change impacts. In response to extreme weather events, R1 may need to determine emergency enforcement actions that can take place at the federal level to mitigate immediate and substantial endangerment to human health and the environment and ensure emergency planning compliance.

Financial/Technical Assistance: Designing or modifying remedies to be protective of climate impacts will come with significant costs. The source of the funding depends on who is paying for the cleanup. Additional federal funding will be needed to design and build more robust remedies, or to modify existing remedies where changes are determined to be necessary for EPA-lead sites. At federal facilities, EPA will need to work with federal parties to identify additional funding needs required to address climate impacts for the facilities to receive adequate federal appropriations to address the identified impacts.

Barriers to Address: There are cost and engineering challenges in implementing remedies that consider climate impacts. For example, remedies that provide increased mitigation of flood risk are likely to be far more expensive than those that do not consider flooding (e.g., shipping waste off-site as opposed to capping waste in place on-site). There are also remaining uncertainties over rate and scale of localized impacts at Superfund sites. Programmatic and legal barriers also need to be identified and addressed, such as the additional program resources needed to modify existing remedies and legal resources needed to negotiate or renegotiate settlement agreements to incorporate measures to address climate change. R1 needs to work closely with the Department of Justice, and in many cases the states, to make such changes.

4.2 An increase in air and water temperature, extreme precipitation, sea level rise, and more frequent/intense extreme storm events may result in hazardous waste release, compromised

protective controls, and possible introduction of new exposure pathways at RCRA Corrective Action (CA) facilities.

Regulatory: Hazardous waste releases, compromised protective controls, and possible introduction of new exposure pathways may create a need for R1 to work with states to review facilities with vulnerable long-term remedies and to focus long term stewardship (LTS) resources on those sites with potential climate change vulnerabilities. In these efforts, legal review may also be needed when considering climate change impacts on the protectiveness of existing remedies. In response to extreme weather events, R1 emergency response to RCRA CA facilities may be needed to ensure the protection of public health and the environment.

Monitoring/Lab Analysis: Changing conditions may require additional resources to support expanded monitoring for the CA facilities. R1 monitoring and analyses may be needed to investigate potential risks as a result of a release.

Enforcement: In response to extreme weather events, R1 may need to work with states to determine emergency enforcement action that can take place at the federal and/or state level to mitigate imminent and substantial endangerment to human health and the environment and ensure emergency planning compliance.

Financial/Technical Assistance: There will be an increased resource need for RCRA CA LTS resources in conjunction with state programs and partners to address climate impacts at vulnerable RCRA CA facilities.

Barriers to Address: Funding restrictions are a constraint. There are remaining uncertainties over the rate and scale of localized impacts at RCRA CA facilities.

4.3 An increase in air and water temperature, extreme precipitation, sea level rise, and more frequent/intense extreme storm events may result in potential release from, erosion of cover/caps over, and/or compromised control and leak detection systems at underground storage tanks (USTs). This may result in increased action under CERCLA response and the Leaking Underground Storage Tank (LUST) programs.

Regulatory: Potential release from, erosion of cover/caps over, and compromised control and leak detection systems at USTs may require R1's UST and Superfund emergency response programs to work with states to respond to petroleum spills and leaks from USTs. R1 may also need to work with states to ensure all regulated USTs are inspected every three years to ensure proper control and leak detection systems are in place.

Monitoring/Lab Analysis: As a result of increased climate impacts, USTs may require additional sampling and analysis. R1 and state resources may be needed to support increased monitoring and analyses needs.

Financial/Technical Assistance: To address potential increases in petroleum releases from regulated USTs, there could be an increased demand on the LUST Trust Fund. Under the LUST program, R1 may also need to increase outreach to states and Tribes on the Office of Underground Storage Tanks (OUST)'s Flood Guide.

Barriers to Address: There are remaining uncertainties over the rate and scale of localized impacts at USTs and the resources needed to address these impacts.

4.4 An increase in air and water temperature, extreme precipitation, sea level rise, and more frequent/intense extreme storm events may result in the potential release of un-remediated contaminants, compromised engineered controls, or impacted design of site reuse and remedial alternatives at Brownfield sites. This creates a bigger resource need for the Brownfields program.

Regulatory: Potential release of un-remediated contaminants or compromised engineered controls at Brownfield sites may require R1's Brownfields and Superfund Emergency Response programs to work with states to prevent or mitigate releases. To the extent climate impacts result in the releases or threats of release of contamination significant enough that a CERCLA action is taken at a site, sites may be disqualified from receiving Brownfield funding.

Monitoring/Lab Analysis: As a result of increased climate impacts, Brownfield sites may require additional sampling and analysis. R1 and state resources may be required to support increased monitoring and analyses needs.

Financial/Technical Assistance: Potential release of un-remediated contaminants, compromised engineered controls, or impacted design of site reuse and remedial alternatives at Brownfield sites may create a bigger demand and higher costs for Brownfield grants. R1's Brownfields program may also need to increase outreach to Tribes, states, grantees, and contractors on best practices and tools for remediation and redevelopment resiliency, such as EPA's Climate Smart Brownfields Manual and the Sustainable and Resilient Remediation (SRR) guidelines.

Barriers to Address: There are remaining uncertainties over the rate and scale of localized impacts at Brownfield sites and the resources needed to address those impacts.

4.5 An increase in air and water temperature, extreme precipitation, sea level rise, and more frequent/intense extreme storm events may result in potential release of Toxic Substances Control Act (TSCA) regulated materials, polychlorinated biphenyls (PCBs) contaminated storm debris, and increased releases and demand on disposal sites which threatens TSCA.

Regulatory: Climate change impacts may become a more frequent factor in TSCA risk-based determinations in assessing whether cleanup and disposal actions will not present an unreasonable risk of injury to health or the environment. Extreme weather events (e.g., high winds, heavy precipitation events) may damage community infrastructure (e.g., schools and childcare facilities) and residential homes. As a result, there may be an increased risk of exposure to PCBs if buildings are renovated or demolished as part of the recovery efforts. Potential climate impacts at PCB disposal sites may create a need for R1 to increase familiarity, both internally and with state partners, of sustainable and resilient remediation guidance as it applies to PCB cleanups. R1 may also need to assist states in authorizing potential repairs of pre-1978 flood damaged residential properties and child occupied facilities under emergency provisions of EPA's Lead Renovation, Repair and Painting Rule (RRP).

Monitoring/Lab Analysis: As a result of increased climate impacts, PCB disposal sites may require additional sampling and analysis. R1 and state resources may be required to support increased monitoring and analyses needs.

Enforcement: There may be increased need to issue "debris letters" that address the regulatory status of PCB contaminated storm debris if requested as part of an enforcement consultation after an extreme weather event. TSCA enforcement actions may need to address potential climate impacts to proposed PCB cleanup and disposal plans and existing settlement agreements may need to be modified or renegotiated.

Barriers to Address: There are remaining uncertainties over the rate and scale of localized impacts at PCB disposal sites and the resources needed to address those impacts.

5. Waste Management, Pollution Prevention, and Chemical Safety

Beyond cleaning up hazardous waste sites, EPA's programs set forth a framework for the management of non-hazardous solid wastes, sustainable materials, pollution prevention, and chemical safety. The RCRA federal Hazardous and Solid Waste Amendments (HSWA) are focused on waste minimization and phasing out land disposal of hazardous waste as well as corrective action (CA) for releases. By examining how materials are used throughout their life cycle, a Sustainable Materials Management (SMM) approach seeks to: use materials in the most productive way with an emphasis on using less; reduce toxic chemicals and environmental impacts throughout the material life cycle; and assure sufficient resources are available to meet today's needs and those of the future. Pollution prevention (P2) is any practice that reduces, eliminates, or prevents pollution at its source. Reducing the amount of pollution produced means less waste to control, treat, or dispose.

Pesticides are regulated under the broad authority granted in two major statutes, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA). These laws have been amended by the Food Quality Protection Act and the Pesticide Registration Improvement Act. While these programs are varied in function, they are collectively impacted by increases in air and water temperature, extreme precipitation, sea level rise, and more frequent and/or extreme storm events. It is anticipated that these impacts will be largely geographical in nature which indicates that any possible susceptible population within such locales could be impacted and should be considered vulnerable. To address potential climate change impacts, R1 has identified programmatic vulnerabilities, **5.1-5.3**, listed below.

5.1 An increase in air and water temperature, extreme precipitation, sea level rise, and more frequent/intense extreme storm events may result in hazardous waste release, damaged equipment, and effects on emergency evacuation routes at treatment, storage, and disposal facilities (TSDFs), which impacts all sites that require RCRA permits.

Regulatory: A TSDF not only must comply with the standards of 40 CFR Part 264/265, but an owner or operator also needs to obtain a permit in Part 270 (or operate under interim status) to engage in hazardous waste management. Hazardous waste release, damaged equipment, and effects on emergency evacuation routes at TSDFs may create a need for R1 to review state TSDF RCRA permits for facilities that are vulnerable to climate impacts. Specifically, R1 may need to assist states in addressing any permitted

facility located within the 100-year floodplain (40 CFR Part 264.18(b) for floodplains) and encourage states to use the most up-to-date mapping tool to identify floodplains.

Monitoring/Lab Analysis: Changing conditions may require additional leak detection and repair monitoring at compromised RCRA TSD facilities. R1 and state resources may be required to support increased monitoring and analyses needs.

Enforcement: In response to extreme weather events, R1 may need to work with states to determine emergency enforcement action that can take place at the federal and/or state level to mitigate imminent and substantial endangerment to human health and the environment and to ensure emergency planning compliance. R1 may also have to work with permit writers to update the permit requirements for TSDFs located in floodplains to reflect these facilities' obligations concerning flood preparedness and prevention. For TSDFs with flood preparedness obligations, R1 and R1 states will have additional responsibilities associated with ensuring compliance with these permit parameters.

Financial/Technical Assistance: Long term planning resources for climate change impacts on closure/post-closure of TSD facilities, under 40 CFR Part 264/265, should be included in the financial assurance section of permits.

Barriers to Address: National guidance for addressing climate change in permits could be beneficial, and there is remaining uncertainty over rate and scale of localized impacts at TSD facilities.

5.2 An increase in air and water temperature, extreme precipitation, sea level rise, and more frequent/intense extreme storm events may result in damage to the built environment, increases in waste/debris, disruption of supply chains and transportation, and exacerbated pollution which may create a resource need for the SMM and P2 programs.

Financial/Technical Assistance: Damage to the built environment, increases in waste/debris, and disruption of supply chains and transportation could all impact R1's SMM program. R1 may need to provide technical assistance and outreach as well as resources to assist states in waste system vulnerability decisions, and to improve public awareness of the links between waste (particularly food waste) and climate change. P2 grant may need to be used to support states and state technical assistance programs to develop and adopt source reduction practices to respond to climate impacts.

Barriers to Address: There is limited program capacity in the SMM and P2 programs in R1, without climate considerations, and there is remaining uncertainty surrounding the scale of localized pollution impacts in the Northeast and the funding needed to address those impacts.

5.3 An increase in air and water temperature, extreme precipitation, sea level rise, and more frequent/intense extreme storm events may result in the alteration of ecosystems which could change the timing, area, and extent of pests and diseases. This may lead to increased pesticide usage which may lead to more non-compliance with the FIFRA and FFDCA. Increased application of pesticides will likely also result in more chemicals present in soil and water and increased risks of release from runoff and extreme weather events.

Regulatory: A potential increase in pesticide usage and application may require R1 to work more often with State Lead Agency (SLA) pesticide programs to address a greater risk of non-compliance. A greater

risk of non-compliance may require R1 to conduct more outreach and training, as well as increase partner engagement and coordination with state programs.

Financial/Technical Assistance: A potential increase in pesticide usage may create a resource need for the Pesticide Environmental Stewardship Program Grants to be awarded to states to mitigate the potential negative effects of increased pesticide application.

Barriers to Address: The extent of climate change impacts on pesticide usage are largely unknown.

6. Facilities and Operations

The R1 building footprint consists of three facilities, one regional office where the majority of R1's 500+ staff work, one regional laboratory where laboratory and field staff work, and one emergency response warehouse containing equipment to quickly respond to environmental emergencies. All three spaces are leased and therefore subject to relocation. The regional office, McCormack POCH at 5 Post Office Square in Boston, MA is a high-rise with 24 stories and is used primarily as an office building. EPA has space on the ground floor, floors 1–2, floors 4–7, and floor 15. Climate change impacts can cause disruptions to facility access and damage to vehicles and equipment. During drought and high temperatures, there may be an increased need to reduce water usage and increase the temperature range in buildings to conserve natural resources. These factors can have a negative impact on operations and can affect the ability of R1 staff to carry out the mission of the Agency. This is especially true for those employees and contractors who are required to perform essential duties at our Region 1 facilities and have pre-existing health conditions exacerbated by higher and lower temperatures. Staff have identified specific vulnerabilities to respond to R1's ability to meet these requirements, **6.1-6.7**, listed below.

6.1 Increased precipitation, flooding, and frequency and intensity of extreme storm events may threaten all things stored on the ground floor and below, such as the mail room, storage areas, security systems, and emergency response trucks and equipment, at McCormack POCH building in Boston, MA. This could lead to increased indoor dampness and humidity and increases in mold, dust mites, bacteria, and other biological contaminants. During an extreme storm event the building may become inaccessible and lose power which impacts all programs that need access to and have items stored at POCH.

Facilities/Operations: R1 may need to develop a plan to move equipment and vehicles from the ground level of POCH before and in response to flooding or an extreme event. R1 should consider moving storage and equipment (emergency response trucks and equipment, mail room, storage areas, security system) susceptible to water damage off the ground floor. During or after flooding events, in-person operations of all programs conducted at POCH may be impacted.

Barriers to Address: Regardless of precautions taken, future flooding events still would affect access to POCH and possibly damage building systems. There are also limited storage areas in POCH available above the ground floor. In responding to potential climate impacts through building retrofits, there are historical and operational restrictions in approving retrofits since POCH is a leased space and all adjustments must be coordinated between GSA and the building owner.

6.2 Increased precipitation, flooding, and frequency and intensity of extreme storm events may threaten all things stored at R1's single-floored, lab facility in North Chelmsford, MA. This could

lead to increased indoor dampness and humidity and increases in mold, dust mites, bacteria, and other biological contaminants. During an extreme storm event the building may become inaccessible and lose power which impacts all programs conducted at the lab.

Facilities/Operations: R1 may need to develop a plan to move and cover lab equipment before and in response to flooding or an extreme event. During or after flooding events, in-person operations of all R1 lab programs conducted at the North Chelmsford lab facility may be impacted.

Barriers to Address: Regardless of precautions taken, future flooding events still would affect access to the lab facility and possibly damage building systems. In responding to potential climate impacts through building retrofits, there are operational restrictions in approving retrofits since the lab facility is a leased space, and all adjustments must be coordinated between GSA and the building owner.

6.3 Increased precipitation, flooding, and frequency and intensity of extreme storm events may threaten all things stored at R1's Emergency Response Warehouse in Woburn, MA. This could lead to increased indoor dampness and humidity and increases in mold, dust mites, bacteria, and other biological contaminants. During an extreme storm event the building may become inaccessible and lose power which impacts the ability of the Emergency Response program to adequately respond to a situation such as an oil spill or release of hazardous chemicals.

Facilities/Operations: R1 may need to develop a plan to move equipment off the floor of R1's Emergency Response Warehouse in Woburn before and in response to flooding or an extreme event. This could impact SEMD's Emergency Response program that stores equipment in this warehouse, as well as the MSD managed closed circuit television security system.

Barriers to Address: Regardless of precautions taken, future flooding events still would affect access to R1's Emergency Response Warehouse and possibly damage building systems. In responding to potential climate impacts through building retrofits, there are operational restrictions in approving retrofits since the warehouse is a leased space, and all adjustments must be coordinated between GSA and the building owner.

6.4 Increased precipitation, flooding, and frequency and intensity of extreme storm events may lead to increased damage to R1's Government-Owned Vehicle (GOV) fleet. GOVs are currently parked on the 7th floor of a parking garage nearby POCH so immediate threats only exist to GOVs stored on the ground floor of POCH and the lab.

Facilities/Operations: R1 may need to develop plans to move equipment and vehicles from the ground floor of POCH and the lab to/from the 7th floor parking garage before and in response to flooding or an extreme event. This may impact access and usage of GOVs for all programmatic work that requires use of a GOV.

Barriers to Address: EPA doesn't own enough parking spaces for the full GOV fleet, so the safety of the GOV fleet is always dependent on private garage availability.

6.5 Increased number of days over 90°F (32.2°C) and 100°F (37.8°C), including more periods of consecutive days over these temperatures, will stress heating, ventilation, and air conditioning

(HVAC) systems in occupied facilities. When those days happen in succession, HVAC systems work harder for longer periods and will consume more energy doing so.

Facilities/Operations: R1 may need to work with GSA and building owners to ensure HVAC systems are being maintained in accordance with proper schedules, develop internal communication to R1 staff regarding efforts made to reduce energy consumption, and ensure federal mandates to reduce energy consumption and energy resilience are in accordance with building operations. During extreme heat days, all in-person operations needed for R1 programs may be impacted and all staff should be advised and properly accommodated.

Barriers to Address: HVAC system upgrades must be done in coordination with GSA and building owners.

6.6 High winds from extreme storm events may cause damage to building facades and windows, limit the use of outside storage at the lab, and increase the possibility of power outages at all facilities (POCH, R1 Lab, Emergency Response Warehouse).

Facilities/Operations: During extreme weather events with high wind impacts, R1 may need to develop plans to move equipment at all facilities to secure areas and discuss window ratings. All in-person operations will be affected during a high-wind event.

Barriers to Address: Retrofitting older buildings with new windows or building more secure wind proof storage at the lab is costly and time consuming. All building retrofits must be done in coordination with GSA and building owners.

6.7 Drought could lead to water usage limitations at all facilities (POCH, R1 Lab, Emergency Response Warehouse).

Facilities/Operations: During times of drought, R1 may need to develop plans and test building systems on limiting water usage.

Barriers to Address: All building retrofits must be done in coordination between GSA and building owners.

7. Cross Sectional

Certain EPA programs are cross sectional in that they touch on multiple programmatic areas. Considering the vulnerabilities above, there will be an overall increase in environmental risks/impacts from climate change that have amplifying effects when considering vulnerable populations. An increase in overall environmental risks will impact the National Environmental Policy Act (NEPA) process, R1's capacity to communicate to communities, and the scope of cross-media grant programs. Since climate, vulnerable populations, and EJ are cross sectional in nature, these topics should be considered within all of EPA's programs. The NEPA program is already committed to providing coordination and input to lead agencies on EJ concerns. When communicating climate risks and programmatic vulnerabilities to communities, focus is needed to communicate the disproportionate risks that vulnerable populations will be experiencing. The cross-media grant programs also require additional attention and focus on vulnerable populations. R1's Healthy Communities Grant Program already has vulnerable populations built into the

request for application (RFA) and targets resources to benefit communities at risk (areas needing to create community resilience, environmental justice areas of potential concern, sensitive populations [e.g., children, elderly, Tribes, urban and rural residents, and others at increased risk]). R1 staff have identified the cross-sectional climate vulnerabilities to highlight areas that affect multiple programs and divisions, **7.1-7.4**, listed below.

7.1 Increased environmental risks/impacts brought on by increases in flooding, extreme precipitation, the frequency and intensity of storm events, sea level rise, extreme heat, and high temperature days, and by the associated air and water quality vulnerabilities from these threats (see above) will need to be addressed during environmental reviews under the NEPA process.

Regulatory: Increased environmental risks/impacts from climate change may require R1's NEPA program to address climate impacts/adaptation recommendations in NEPA pre-project coordination, scoping comments, and draft and final Environmental Review comments. There may also be a need for R1 to coordinate with the lead agency for the Environmental Impact Statement (EIS) to ensure the EIS reflects climate change considerations consistent with EPA's policies and court rulings.

Barriers to Address: EPA only has an advisory role in the NEPA process and therefore can only make recommendations to, as opposed to mandating requirements for, the lead federal agency throughout the Environmental Review process.

7.2 Increased environmental risks/impacts from climate change will create a need for increased community awareness and communication on climate change within each R1 program.

Regulatory: Communication and outreach strategies should be considered in permitting and regulatory decisions made as a result of climate change impacts. R1 programs should consult with the Office of Public Affairs (OPA) on outreach strategy, communication, inter-governmental relations, and community coordination.

Monitoring/Lab Analysis: Increased monitoring and lab work from climate impacts should be included in OPA's outreach strategy for increased transparency.

Enforcement: R1's enforcement response to increased noncompliance associated with climate impacts may require increased outreach and communication coordination with OPA.

Financial/Technical Assistance: Increased need to address climate impacts within grant opportunities may require increased outreach and communication coordination with OPA.

Barriers to Address: There are funding and resource restrictions with increased communication and coordination needs from OPA.

7.3 Increased environmental risks/impacts from climate change will negatively impact human health of New England communities which will create a bigger resource need for State Performance Partnership Grants (PPG) to fund activities in Performance Partnership Agreements (PPA) in support of 19 environmental programs.

Financial/Grants: More environmental risks/impacts from climate change will create a need to reevaluate future PPA/PPG Priorities and Commitments (P and C) state program requirements to include more on climate change adaptation.

Barriers to Address Vulnerability: Additional resources may be needed to address these impacts.

7.4 Increased environmental risks/impacts from climate change will negatively impact human health of New England communities which will create a bigger resource need for Region 1's Healthy Communities Grant Program to fund projects under seven statutes.

Financial/Technical Assistance: More environmental risks/impacts from climate change will create a need for more Healthy Community grant funding to be awarded for community resilience and adaptation projects.

Barriers to Address Vulnerability: There are funding restrictions and/or inconsistent financial resources.

Section 3. Priority Actions

I. Introduction

As part of R1's response to EPA's Climate Adaptation Action Plan, staff created Priority Actions on climate adaptation to address the agency-wide priorities identified in the Action Plan and respond to programmatic vulnerabilities (***R1 Programmatic Climate Vulnerability Assessment).*** The agency-wide priorities on climate adaptation are detailed in **Table 4** and were created in accordance with the EPA-wide FY 2022-2026 EPA Strategic Plan. R1's Priority Actions were identified by ***R1's Divisional Climate Representatives Workgroup***, where each divisional representative worked with staff across their respective divisions to identify Priority Actions within the 2022-2026 timeframe. The vulnerabilities are broken down into seven programmatic areas, listed in blue throughout this plan, that cover EPA R1's programs: **1. Vulnerable Populations**, **2. Air Quality**, **3. Water Quality/Quantity**, **4. Contaminated Site Cleanup and Sustainable Development**, **5. Chemical Safety, Waste Management, and Pollution Prevention**, **6. Facilities and Operations,** and **7. Cross Sectional**. If the Priority Action addresses a programmatic vulnerability, then the vulnerability is linked as a red superscript after the Priority Action statement (**x**[#]). Certain actions are labeled as "**Aspirational**" meaning additional resources and/or leadership outside of R1 are needed for the action to be achievable and therefore do not have associated metrics.

1.	**Integrate climate adaptation into EPA programs, policies, rulemaking processes, and enforcement activities.**
2.	**Consult and partner with Tribes, states, territories, local governments, EJ organizations, community groups, businesses, and other federal agencies to strengthen adaptive capacity and increase the resilience of the nation, with a particular focus on advancing EJ.**
3.	**Implement measures to protect the agency's workforce, facilities, critical infrastructure, supply chains, and procurement processes from the risks posed by climate change.**
4.	**Measure and evaluate performance.**
5.	**Identify and address climate adaptation science needs.**

Table 4. EPA Climate Adaptation Priorities

APPENDIX A contains a table of all the Priority Actions and includes additional information on the corresponding Priority Action Number (#), Lead Division, Performance Metric, Fiscal Year (FY) Timeline, Agency Wide Priority (**Table 4**), Vulnerability Number (#), Co-benefits of the Action, and Resource Availability. The Performance Metric was created to evaluate the action's progress over the FY timeframe. Beyond the performance metric, internal FY 22 and 23 targets were created to track progress for all actions except those labeled as "***Aspirational***." Co-benefits refers to any added benefits from the action in the areas of mitigation of greenhouse gases and other pollution, public heath, economic growth and job creation, national security, and environmental justice. Resource Availability demonstrates if resources are available or partially available to address the action or if resources are needed. Many other potential actions were identified during the development of the plan that will be addressed if the necessary authorities and/or resources are attained in the upcoming months and years. Certain R1 divisions will be developing internal climate work plans that address additional actions not included in this plan. As

resource availability and knowledge on climate impacts in New England and its impacts on EPA programs evolves, the Priority Actions will be updated periodically to account for those changes.
In addition to quarterly tracking on progress for trackable Priority Actions, R1 will be tracking two Long-Term Performance Goals (LTPGs) on climate adaptation identified in the EPA-wide FY 2022-2026 EPA Strategic Plan:

- By September 30, 2026, assist at least 400 federally recognized Tribes to take action to anticipate, prepare for, adapt to, or recover from the impacts of climate change.
- By September 30, 2026, assist at least 450 states, territories, local governments, and communities, especially communities that are underserved and disproportionally at risk from climate change, to take action to anticipate, prepare for, adapt to, or recover from the impacts of climate change.

In coordination with National Program Managers (NPMs) and Program Offices, R1 identified relevant programs that fall under these LTPGs and created internal FY 22 and 23 targets to track quarterly progress in meeting these goals. These goals ensure that R1 will provide targeted assistance to Tribes and indigenous peoples, states, territories, local governments, communities, and businesses to transform their environmental programs, strengthen their adaptive capacity, and increase the resilience of the nation, with a particular focus on advancing environmental justice.

II. R1 Priority Actions

1. Vulnerable Populations

Tribal

Due to greater reliance on their natural resources for sustenance, cultural identity and lifeways, Tribes will be disproportionally at risk from climate change impacts. These impacts include threats to tribal food sovereignty in the form of freshwater and marine aquatic organisms, agricultural food sources, wild game, and forest food sources. Invasive species migration as a result of climate change threatens native plant and animal species upon which the Tribes depend. With the majority of New England Tribes being located on riverine and/or coastal areas, flooding, erosion, sea level rise and storm surge pose significant threats to tribal housing and infrastructure. Priority Actions **1-5** were created to assist the Tribes with resources, tools, and partnerships to address these climate threats. Climate discussions will be informed by and reflect local TEK, including oral stories and traditions, where appropriate and when shared by the Tribes. The region will discuss with the Tribes how TEK can be integrated into regional activities.

1. The **Tribal** program will continue to work with the Passamaquoddy Tribe – Pleasant Point and the US Army Corps of Engineers as well as other federal partners to continue to protect Passamaquoddy Pleasant Point facilities on the coast through supporting the protection of shoreline with an extension of a recently completed revetment.[1.1, 3.3]
2. The **Tribal** program will continue to work with the Passamaquoddy Tribe – Pleasant Point and federal partners to assist the Tribe in seeking funding to address sea level rise by constructing a barrier wall around or relocating the wastewater treatment plant.[1.1, 3.3]
3. The **Tribal** program will continue to work with US and Canadian federal agencies to assist the Houlton Band of Maliseet Indians with fish passage and habitat restoration improvements of the Wolastoq/St. John River watershed through continued collaboration with international partners.[1.1]

4. The **Tribal** program will work with University of Maine – Orono to assist New England's federally recognized Tribes in creating a GIS-based Tribal Climate Story Map that identifies the climate risks and resilience activities that Tribes will be undertaking in 2022-2023.[1.1]
5. The **Tribal** program will work with the New England Federal partners and the New England Tribes to coordinate and facilitate a Tribal Climate Summit in April 2022 to identify climate vulnerabilities and potential funding and technical assistance resources to help the Tribes address their vulnerabilities.[1.1]

Environmental Justice

Increased environmental risks/impacts from climate change will disproportionally affect communities with EJ concerns. EJ and equity are at the heart of EPA's work to tackle climate change, protect air and water, and keep the places children learn and play safe from environmental hazard and/or harm. R1's EJ program will be focused on taking decisive action to advance EJ, including building capacity and climate resilience, and maximizing benefits to overburdened and underserved communities. Priority Action **6** was created to build EJ considerations into all R1 actions on climate.

6. The **EJ** program will provide support to the various program offices for their Priority Actions, including research, analysis and outreach needed to help implement the program offices' Priority Actions in communities with EJ concerns. The EJ Program will work with **OPA** to provide support on community coordination and communication, including overall communication strategy for outreach and gathering input as needed for Priority Actions involving communities with EJ concerns.[1.2]

2. Air Quality

Climate change makes it more difficult to attain air quality standards and protect the quality of the air we breathe, especially in overburdened and vulnerable populations. For New England, the top air quality climate adaptation concerns are potential increases in tropospheric ozone (O3) and particulate matter (PM), uncertainty surrounding changes in atmospheric patterns, greater potential for accidental release of regulated toxic or flammable substances at CAA Section 112(r) facilities, and potential indoor air quality impacts. R1 remains committed to working with the New England States' Air Offices to meet NAAQS standards, expand air and community monitoring networks where needed, revise and update stationary source facilities' RMPs, and administer funding for Regional Indoor Environments grants. Priority Actions **7-15** were created to address the top climate adaptation concerns for air quality. Priority Action **13** is ***aspirational***, and dependent on New England State Air Office partnership and OAQPS support. Priority Action **14** is ***aspirational*** because it is difficult to predict the number and type of facilities that will be most affected by climate change impacts and predict the number of enforcement actions that will take place from increased climate impacts. Priority Action **15** is ***aspirational*** and requires funding increases from the Office of Radiation and Indoor Air (ORIA).

7. The **Air Quality Planning** branch will work with the Office of Public Affairs (**OPA)** to send out air quality alerts/air awareness notices that include energy conservation guidance and ENERGY STAR residential resources.[2.1]
8. **The Air Permitting** branch will ensure the Lowest Achievable Emissions Rate (LAER) and offsets on projects triggering major Nonattainment New Source Review (NNSR).[2.1]

9. The **Air Permitting** branch will review state programs where permits programs are delegated or EPA-approved to ensure they meet CAA requirements for ozone and ozone precursors.[2.1]
10. On the subset of air quality alerts/air awareness notices that reference wildfires, the **Air Quality Planning** branch will work with **OPA** to send out notices that include information on wildfire linkages to climate change, if appropriate.[2.2]
11. The **Air Monitoring** program will review and approve revised state monitoring plans. Depending on the initial review, the next steps will be to work to either increase the available funding, and/or identify cost saving measures and partner with R1 states to expand the ambient air monitoring network, as needed.[2.1, 2.2, 2.3]
12. The **Indoor Air** program will work with **OPA** to send out social media posts during extreme weather events in New England that include messaging on proper use of backup generators and wood stoves to advise on indoor air impacts. The program will also provide technical assistance on mold after extreme events.[2.5]
13. ***Aspirational*:** The **Air Quality Planning** branch will work with **OAQPS** to encourage state air offices to incorporate clean energy strategies into State Implementation Plans (SIPs) and distribute a clean energy resource sheet for states to provide to facilities.[2.1]
14. ***Aspirational*:** The **Air Enforcement** program will devote compliance monitoring and enforcement resources to help reduce the pollutants that contribute to climate change and hazards from the effects of climate change. The program will focus on facilities vulnerable to climate change impacts by conducting inspections and, in any enforcement actions, using all available authorities, injunctive relief, and mitigation tools.[2.1, 2.2, 2.4]
15. ***Aspirational*:** The **Indoor Air** program will work with **ORIA** to incorporate the addition of climate change impacts on indoor air in RFA for Indoor Air Grants. Once RFA has been revised, changes in RFA interest should be assessed and increases in funding for regional Indoor Air discretionary funding should be considered to account for any additional needs.[2.5]

3. Water Quality/Quantity

Climate change impacts such as warmer air and water temperatures, increased precipitation, extreme storms, drought, ocean and coastal acidification, and sea level rise are already creating conditions and additional stressors that will make it more difficult to meet the goals of the CWA, SDWA, and the MPRSA. The R1 Water Division (WD) will leverage its statutory authorities and financial assistance programs, utilize the most current science, and promote climate adaptation strategies to make New England, and all its residents, more resilient to the impacts of climate change. The WD's Priority Actions are broadly grouped and aligned with the National Water Program to achieve three key goals:

- Improve the Climate Resilience of America's Water Infrastructure
- Protect America's Waters from a Changing Climate
- Advance the Adaptive Capacity and Climate Knowledge of All Water Community Partners.

The following actions are organized by water program area following the statutory constructs of the CWA, MPRSA, and SDWA.

WQS, 303(d) Lists, and TMDLs

Climate change impacts will create changing conditions, such as changes in hydrology, and additional stressors that threaten the attainment of WQS, TMDLs, and ARPs that states develop for waterbodies listed as impaired on state CWA Section 303(d) lists. The development of numeric water quality criteria for WQS relies on data on the effect of different concentrations of a pollutant on aquatic life or human health, as well as the duration of the exposure to that pollutant, and on other variables such as temperature, salinity, and hardness that are subject to changes from a warming climate. The CWA requires states to review their WQS every three years and revise them if appropriate, which provides regular opportunities to determine whether the impacts of climate change necessitate a change in their WQS. Priority Actions **16-21** are intended to address this vulnerability. Priority Actions **20** and **21** are ***aspirational*** and depend heavily on buy-in from the states as well as significant additional staff and financial resources.

16. The **Water Monitoring** program will continue to develop regional lab cyanobacteria capability for toxin analyses and identification and support the regional cyanobacteria collaborative.[3.1]
17. The **Water Monitoring** program will prioritize projects with the states, WD, and the Office of Research and Development (ORD) that address climate change impacts for the regional lab's monitoring and analytical support and will add parameters, when possible, that can measure climate change impacts.[3.1]
18. The **Water Monitoring** program will maintain and increase monitoring resources for the Regional Monitoring Network (RMN), advocate for continued National EPA support for RMN, and continue to support National Aquatic Resource Surveys (NARS).[3.1]
19. The **TMDL** program will encourage states to consider and address climate impacts in new TMDLs, ARPs, and Protection Plans and increase technical assistance to state and local partners with stormwater, wastewater, and nonpoint source (NPS) management actions needed to achieve TMDL and ARP targets.[3.1]
20. ***Aspirational*:** The **WQS and Water Monitoring** programs will work with states to conduct water quality monitoring more frequently and in more locations to determine whether designated uses are attained and to document changes in climate conditions to inform WQS revisions and, if necessary, "Use Attainability Analyses" (UAAs).[3.1]
21. ***Aspirational*:** The **TMDL** program will encourage states to update TMDLs that are over 10 years old which did not account for warming water temperatures, more extreme high and low streamflow conditions, or other climate impacts.[3.2]

National Pollutant Discharge Elimination System (NPDES)

The NPDES program is impacted by increases in air and water temperature, extreme precipitation, drought, ocean and coastal acidification, and sea level rise. These changing conditions may cause permittees to confront different risks based upon factors, such as facility location and type of industry or municipal system, which should be reflected in additional NPDES permit conditions and permit limits, as allowable under the CWA. Understanding which risks permittees throughout New England face will be critical to understanding how permit limits and conditions could be modified to address these localized climate risks. R1 is committed to working with its state NPDES partners on these issues if resources are available at the federal and state level. Increases in precipitation may also lead to more frequent discharges of untreated sewage from municipal collection systems, and more stormwater discharges. In response, some Long-Term Control Plans and Stormwater Pollution Prevention Plans may need to be

updated to account for increased precipitation. To address these issues, Priority Actions **22-28** were created with Priority Actions 22 and 24 as the highest priority. Priority Actions **25-28** are ***aspirational***. Priority Actions **25** and **26** will require partnership and leadership from Office of Regional Counsel (ORC), Office of General Counsel (OGC), and Office of Water (OW). Priority Action **27** will require action by the Office of Water (OW). Priority Action **28** may require Department of Justice (DOJ) and Office of Enforcement and Compliance Assurance (OECA) buy-in and investment.

22. The **NPDES** program will work with the Geographic Information System (**GIS)** program to develop a GIS Mapping tool that: 1) incorporates existing NPDES maps and FEMA maps, NOAA "major events" and other non-EPA federal tools that permit writers can link to in order to better understand local climatic conditions for a particular permit; and 2) which will allow permit writers to identify, rank, and periodically evaluate (using a ranking system) all NPDES permittees by high, medium, and low risk for changing climate conditions (such as storm surge and increased precipitation) in order to include, as appropriate, additional permit conditions and limits.[3.3]
23. The **NPDES** program will develop a list of best management practices (BMPs) and associated permit language for the purpose of addressing changing conditions due to climate within NPDES permits, such as, for example, those BMPs related to retrofits to address flooding.[3.3]
24. The **NPDES** program will promote the use of Green Infrastructure (GI) through the development of tools (such as the Opti-Tool) that demonstrate to communities the benefits of GI and that allow the region to track the implementation of GI and its associated environmental benefits.[3.4]
25. ***Aspirational:*** The **NPDES** program will work with the ORC, OGC, and OW to consider the potential for developing permit conditions that would require certain high-risk permittees to conduct a climate change risk/vulnerability assessment.[3.3]
26. ***Aspirational:*** The **NPDES** program will encourage OW to update the Permit Writers' Manual to incorporate climate considerations.[3.3]
27. ***Aspirational:*** The **NPDES** program will work with ORC to consider the potential for developing MS4/stormwater permit conditions that would require reductions in impervious cover (not just pollutant controls) in order to reduce stormwater flows.[3.4]
28. ***Aspirational:*** The **Water Compliance and Enforcement** program will devote compliance monitoring and enforcement resources in response to extreme weather events and use available authorities, injunctive relief, and mitigation tools to address the impacts of climate change as appropriate. Focus will be put on facilities in the most vulnerable areas.[3.3]

Nonpoint Source (NPS) Management

Climate change impacts will create changing hydrologic conditions and additional stressors that will make it more challenging to effectively manage NPS pollution. Because of its diffuse nature, NPS pollution is more difficult to regulate than point sources like wastewater and stormwater discharges, and its severity is heavily influenced by variables including air and water temperature, the timing and intensity of precipitation, and land use management practices. R1's NPS Program worked closely with the New England states to update their NPS Program Plans to incorporate climate change considerations in FY19-20, but most of these plans could be improved based on more current scientific data and technical knowledge. Priority Actions **29-31** were created to address this vulnerability. Priority Actions **30-31** are ***aspirational*** and depend heavily on buy-in from the states as well as significant additional staff and financial resources.

29. The **NPS** program will work with states to strengthen climate change considerations in their Nonpoint Source Management Program Plans when they're updated in FY24-25 as required under CWA Section 319.[3.5]
30. ***Aspirational:*** The **NPS** program will support development of enhanced nitrogen-reducing innovative/alternative (I/A) septic systems and their use as upgrades or replacements in areas where centralized sewer systems are not feasible and nutrient impairment is an issue.[3.6]
31. ***Aspirational:*** The **NPS** program will identify changes in septic system design or siting for areas prone to sea level rise, flooding, and/or rising groundwater levels and review state septic system regulations to determine whether they need to incorporate updated design and siting standards.[3.6]

Wetlands

Warming air and water temperatures, extreme precipitation, drought, and sea level rise will create changes in wetland characteristics that in turn will cause shifting and/or disappearing wetland habitats. These changes will increase the importance of avoiding or minimizing wetland losses and effectively mitigating unavoidable losses**.** Changes in the timing and intensity of precipitation, and sea level rise will affect the hydrological conditions that determine the regulatory jurisdiction of the wetland as well as their resiliency to other stressors. R1's Wetlands Program already includes and will continue to include consideration of climate change as an important criterion in selecting projects for funding through the Wetlands Program Development Grants. R1 is also encouraging state In-Lieu Fee (mitigation bank) programs to expand the range of potential mitigation sites to coastal wetlands and eelgrass meadows (blue carbon). Priority Actions **32-35** were created to address this vulnerability with Priority Actions 32 and 33 as the highest priority. Priority Actions **34-35** are ***aspirational*** and depend heavily on buy-in from other federal and state agencies as well as additional staff and financial resources.

32. The **Wetlands** program will create internal best practices on climate resilience for permitting proposed coastal resilience projects (e.g., beach nourishment, coastal shoreline erosion, sea wall construction, dam removal, and flood mitigation projects) through the CWA Section 404 regulatory review process.[3.7]
33. The **Wetlands** and **Ocean and Coastal** programs will complete the Regional Blue Carbon Inventory to measure carbon sequestration capacity of existing tidal wetlands and seagrasses.[3.7]
34. ***Aspirational:*** The **Wetlands** program will encourage the U.S. Army Corps of Engineers (USACE) and states to use the best available scientific information on changes to wetlands ecosystems when making jurisdictional determinations.[3.7]
35. ***Aspirational:*** The **Wetlands** program will work with the USACE and the states to encourage the In-Lieu Fee programs to adopt climate adaptation priorities into the program instrument, requests for proposals, and/or competitive project scoring and recommend that In-Lieu Fee programs revise the individual Service Area priorities to include climate adaptation and resilient resource needs.[3.7]

Dredged Material Management

An increase in extreme precipitation and more frequent extreme storm events that cause more erosion and sedimentation may result in more frequent dredging projects that require ocean disposal or alternative methods of handling the dredged material. There also will be an increased demand to beneficially use dredged material to protect shorelines, beaches, dunes, and marshes from sea level rise. R1 works closely with the USACE and coastal states to regulate dredging projects and the disposition of dredged material

under CWA Section 404 and the MPRSA. Priority Action **36**, which has been under discussion with the USACE and state agencies for over a decade, is intended to help address this vulnerability.

36. The **Dredged Material Management** program will work with the USACE and coastal states to encourage more beneficial use of dredged material by developing a tracking system to track beneficial use.[3.8]

Geographic Programs

EPA's National Estuary Program (NEP) includes six programs or partnerships administered by the R1 WD (the Long Island Sound Study [LISS], Narraganset Bay Estuary Program, Buzzards Bay National Estuary Program, Massachusetts Bays National Estuary Partnership, Piscataqua Region Estuaries Partnership, and Casco Bay Estuary Partnership). The LISS, which is jointly administered with R2, also receives additional funding through a separate CWA designation as a "Geographic Program," as does the Lake Champlain Basin Program (LCBP) (also co-administered with R2) and the Southeast New England Program (SNEP). These Geographic Programs and the Urban Waters Federal Partnership (UWFP)/Mystic River Watershed Initiative are place-based partnership programs intended to facilitate and accelerate the attainment of CWA goals in a more efficient, transparent manner in highly impacted, priority watersheds. These programs provide collaborative convening, coordination, funding, technical assistance, and access to other CWA programs and resources to state agencies, other federal agencies, and nongovernmental organizations to support implementation of the NEPs' Comprehensive Conservation and Management Plans (CCMPs) and other management or strategic plans. These plans typically set short- and long-term goals for water quality and habitat restoration in their respective watersheds, develop annual workplans with actions to help meet those goals, and track progress with both programmatic outputs and environmental outcomes. Most of the geographic programs have conducted vulnerability assessments of both their watersheds and their plans, which have informed the development of climate resilient programs and projects. Priority Actions **37-44** were created to address this vulnerability with Priority Action 38 as the highest priority. Priority Actions **42-44** are ***aspirational*** and depend heavily on buy-in from the states and many other partners, as well as significant additional staff and financial resources. For Priority Action **43,** the Lake Champlain TMDL implementation timeframe is more than 20 years, and annual milestones have not yet been determined. Where appropriate, these priority actions will consider the impacts and needs of affected Tribes and communities with environmental justice concerns.

37. The **NEP** managers will work with the six NEPs to complete their programmatic vulnerability assessments and integrate climate-resilient goals and actions into their Comprehensive Conservation and Management Plans.[3.9]

38. The **NEPs, the LCBP, and the SNEP** will utilize their Bipartisan Infrastructure Law (BIL) appropriations, as appropriate, to accelerate implementation of climate resilient actions described in their CCMPs or other management plans and strategies.[3.9]

39. The **LISS** will support implementation of the Long Island Sound Sustainable and Resilient Communities initiative by providing financial and technical assistance to coastal communities in Connecticut and New York to develop local resilience plans.[3.9]

40. The **SNEP** will work with program partners to develop a stormwater practice flow duration curve through a SNEP applied research project that considers the latest climate projections and enables municipalities to site and design stormwater BMPs to restore hydrologic balance in watersheds.[3.9]

41. The **LCBP** will develop a mass balance model for Missisquoi Bay using alternative land use and climate scenarios to estimate future phosphorus loadings and develop a public-facing toolkit that allows comparison of effectiveness of BMPs.[3.9]
42. ***Aspirational:*** The **SNEP** will work with program partners to develop a municipal stormwater bylaw/ordinance model and conduct demonstration projects and training for municipalities and consultants on how to use next generation storm water flow duration curves at a watershed or site scale to address water quality, flooding, drought, and the projected impacts of climate change.[3.9]
43. ***Aspirational:*** The **LCBP** will work with the state of Vermont and other program partners to reduce phosphorus loading in Lake Champlain to achieve the 2016 phosphorus TMDL, which took climate impacts into consideration during its development.[3.2, 3.9]
44. ***Aspirational:*** The **LISS**, **SNEP**, and **LCBP** will collaborate and communicate with technical assistance programs (SNEP Network, LISS Sustainable and Resilient Communities initiative, University of Vermont Sea grant) to determine how Region 1 can best support climate resilience efforts.[3.9]

Drinking Water Quality

Changing conditions from climate change impacts may threaten attainment of NPDWR under the SDWA. Warmer water temperatures and increased precipitation may increase the prevalence of both pathogens and harmful algal blooms in surface water supplies. Prolonged drought, sedimentation of drinking water reservoirs, and saltwater intrusion all may reduce the availability and quality of both surface and groundwater drinking water supplies. More extreme storms and increased precipitation will cause erosion and sedimentation that could both reduce the capacity of surface water reservoirs and the quality of drinking water due to turbidity. The Drinking Water Program has been providing technical assistance and training workshops on climate resilience for water utilities and small systems for almost a decade, and Priority Action **45**, which is a divisional high priority, was created to continue this important work.

45. The **Drinking Water** program will conduct outreach through training workshops and exercises with states and water sector utilities on the impacts of climate change on their systems, including how to prepare for, respond to, and recover from climate impacts.[3.10]

Clean Water and Drinking Water Revolving State Fund (SRF)

Climate change impacts may increase the likelihood of damage to drinking water, wastewater, and stormwater infrastructure resulting in an inability to effectively collect and treat wastewater and stormwater and protect drinking water supplies. More extreme storms, increased precipitation and flooding, and sea level rise threaten water infrastructure and its operation on the coast and rivers, where many of these facilities are located. Increased precipitation and population growth are already overwhelming aging and often undersized wastewater and stormwater pipes and treatment facilities, and sea level rise will soon inundate some combined sewer overflow discharges on the coast. The EPA Clean Water and Drinking Water SRF Programs make annual grants to the New England states to capitalize their revolving loan programs, with which states provide below-market rate loans to municipalities and other eligible entities to fund new and upgraded water infrastructure. During the annual SRF program review with each state, R1 has already begun to discuss the importance of investing in resilient water infrastructure, and Priority Action **46**, which is a divisional high priority, was created to build on that work.

46. The **SRF** program will engage in discussions with state SRF programs to consider, where possible, the utilization of SRF funding, including BIL appropriations, to prioritize resiliency infrastructure projects on Drinking Water and Clean Water SRF Intended Use Plans (IUPs) during the annual SRF reviews.[3.11]

4. Contaminated Site Cleanup and Sustainable Development

Superfund Sites

The Superfund program is responsible for cleaning up some of the nation's most contaminated land and responding to environmental emergencies, oil spills, and natural disasters. The expected impacts of climate change pose risks to the contaminated sites managed under Superfund. Increases in air and water temperature, precipitation, flooding, and periods of drought may result in altered fate and transport pathways and exposure assumptions, dispersal of contaminants, and ultimately ineffective remedies. R1 Project Managers work to mitigate these risks at cleanup sites, identifying areas of risk (flooding, extreme-weather events, etc.), and employing practices which help to ensure these events will not result in damage to sites. To address the top climate adaptation concerns for Superfund, Priority Actions **47-53** were created. Priority Action **53** is ***aspirational*** and dependent on resource availability.

47. The **Superfund** program will incorporate flood/storm risk into the remedy decision making process and Five-Year Review process such that future floods/storms are less likely to impact selected remedies.[4.1]
48. The **Superfund** program will incorporate climate risk language into standard document templates (e.g., Proposed Plans, Records of Decision, Five-Year Reviews, Action Memorandums).[4.1]
49. The **Superfund** program will employ practices that minimize resource use, waste generation, energy use, and greenhouse gas emissions at NPL Sites.[4.1]
50. The **Superfund** program will evaluate impacts of increases in air and water temperature, drought, and increasingly common periods of low flow on new and existing site remedies.[4.1]
51. The **Superfund** program will continue coordination among program offices to plan for emergency response actions in response to extreme weather events.[4.1]
52. The **Superfund** program will assess current regional resources to determine if resource levels and existing plans would be sufficient to adequately respond to an extreme event, such as a wildfire, hurricane, or large storm.[4.1]
53. ***Aspirational:*** The **Superfund** program will evaluate and prioritize the steps that would be required to ensure flooding would not inundate/disperse uncontrolled contamination (may involve evaluation of remedy changes) at non-federal facility National Priorities List (NPL) sites with significant and/or increasing flooding risk and will work with federal agencies through the Federal Facility Agreement process at federal facility NPL sites to address flooding threats.[4.1]

Other Remedial Programs

In addition to Superfund, site cleanups are also funded or overseen by other programs, including RCRA Corrective Action (CA), TSCA, Underground Storage Tank (UST), and Brownfields programs. Like for all remedial work, climate change poses risks to the effectiveness of remedies and resiliency of site reuse. Increases in air and water temperature, precipitation, flooding, and periods of drought could potentially affect fate and transport pathways and exposure assumptions, dispersal of contaminants, and the integrity

of engineered controls. To ensure cleanups remain protective of human health and the environment, remedies and site redevelopments must be designed to mitigate these impacts. To address the top vulnerabilities, Priority Actions **54-60** and **79-82** (7. Cross Sectional) were created. Funds from the Bipartisan Infrastructure Law (BIL) may enable more opportunities for the Brownfields program to assist with resilient remedial design and site reuse in the region under Priority Actions **58-59**. Priority Action **60** is ***aspirational*** and dependent on resource availability.

54. The **RCRA Corrective Action (RCRA CA)** program will focus long-term stewardship (LTS) resources on incorporating climate vulnerability in further development of the LTS program and/or performing LTS inspections on vulnerable sites.[4.2]

55. The **RCRA CA** program will make flood and storm risk information available to consider during the remedy decision making process or other appropriate phases of a project to assist regulators and responsible parties in making decisions that minimize or eliminate flood and storm risk impacts on selected remedies at RCRA sites.[4.2]

56. The **Underground Storage Tank (UST)** program will, after an extreme storm event occurs, provide outreach to states and Tribes to address a potential release of contaminants from USTs because of flooding/severe storm impacts.[4.3]

57. The **UST** program will ensure that Tribes and states are aware of OUST's flood guide during annual meetings.[4.3]

58. The **Brownfields** program will work with state and tribal partners to help grantees identify vulnerabilities through site eligibility review and cleanup planning and will provide information to grantees with identified vulnerabilities on how to prioritize sites and design resilient remediation and site reuse.[4.3]

59. The **Brownfields** program will increase consideration of climate vulnerabilities in Analysis of Brownfield Cleanup Alternatives (ABCA) in complying with current Office of Brownfields and Land Revitalization (OBLR) policy.[4.4]

60. ***Aspirational:*** The **Toxic Substances Control Act (TSCA) Enforcement** programs will conduct additional outreach to targeted audiences on flood damaged residential properties and child occupied facilities under emergency provisions of the Renovation, Repair and Painting Program (RRP) and responses to emergency work needed for exemption, and record keeping.[4.5]

5. Waste Management, Pollution Prevention, and Chemical Safety

Hazardous Material Operations and Sustainable Materials Management (SMM)

Climate impacts may result in hazardous waste release, damaged equipment, and effects on emergency evacuation routes at TSDFs which impacts all sites that require RCRA Permits. Damage to the built environment, increases in waste/debris, disruption of supply chains and transportation, and exacerbated pollution may also impact R1's SMM and Pollution Prevention (P2) programs. To address these vulnerabilities, Priority Actions **61-63** and **80-82** (7. Cross Sectional) were created.

61. The **RCRA Waste Management** will encourage state permit writers to use publicly available mapping tools to identify floodplains during RCRA permit renewals. [5.1]

62. The **SMM** program will hold outreach events to improve public awareness on the links between waste (particularly food waste) and climate change to encourage lower impact practices in the regional food system.[5.2]

63. The **SMM** program will work with states to help develop a regional understanding of EPA's US Environmentally-Extended Input-Output (USEEIO) models, and Consumption Based Emissions

Inventory (CBEI) that can help better define consumption-related GHG emissions associated with individual state activities in the Northeast. [5.2]

6. Facilities and Operations

The Customer Service and Facilities Branch and Information Services Branch are the primary branches within the Mission Support Division (MSD) responsible for addressing Priority Actions related to facilities and operations. The top vulnerabilities are the effects of increased precipitation, flooding, and extreme weather events on facilities and how R1's operations are affected as a result. Prior to FY22, general information was added to the Regional Continuity of Operations (COOP) Plan to address recovery strategies. To further address these vulnerabilities, Priority Actions **64-68** were created.

64. The **Facilities** program will develop/codify storm event pre-deployment strategies for government-owned vehicles and equipment stored in the garage and ground floor of the McCormack building, the New England Regional Laboratory, the contracted parking garage for the government-owned vehicle fleet, and the Emergency Response Warehouse in R1's Continuity of Operations Plan (COOP).[6.1, 6.2, 6.3, 6.4, 6.6]

65. The **Facilities** program will work with EPA OMS and GSA to develop and encourage strategies for greater temperature resilience of employees, including solutions for those who may be differently impacted by higher summer building temperatures.[6.5]

66. The **Information Technology** (IT) program will work with EPA OMS/EI to test resilience of telework information technology resources and capacity during periods of high demand and over extended lengths of time.[6.6]

67. The **Facilities and IT** programs will ensure current plans are up to date for building/IT/security systems continuity if building damage occurs or power is lost at the McCormack building, the laboratory, and the warehouse.[6.6]

68. The **Facilities** program will work with EPA OMS and GSA to develop and encourage strategies for limiting water use during times of drought.[6.7]

7. Cross Sectional

Climate Mapping for Hazardous Waste Sites

Hazardous sites, such as RCRA CA sites, hazardous waste generators, and National Priorities List (NPL) sites, are at risk from the impacts from climate change. In response to these impacts and EPA R1's 2014 Regional Climate Adaptation Plan, R1 formed a **Climate Mapping** team to develop an internal pilot project, the NPL Climate Vulnerability Assessment Mapping tool. This tool was released in 2020 and utilized a GIS analysis that overlays and risk-ranks site boundaries with climatic and environmental justice concerns, considering facility/site size and proximity to other sites. Specifically, this tool considers demographic indicators, flooding, sea level rise, temperature, precipitation, and storm surge, with a focus on populations who may be more disproportionally impacted. The GIS methodology was then applied in two subsequent versions for RCRA CA, and RCRA TSDFs and LQG sites. Future iterations will look to integrate new and updated datasets from our Tribal, federal, and state partners as appropriate. With expanded use across programs, the team (in coordination with HQ and EPA program experts) will consider ways to standardize the mapping resources, guidance, and use of data sources. The Climate Mapping team created Priority Actions **69-78** to expand on prior efforts to create Version 2 of the climate

vulnerability assessment methodology and mapping tool for hazardous waste sites and create a replicable, and shareable GIS model. Priority Actions **75-78** are ***aspirational***. **75** will require regional program staff from the TSCA-PCB, UST, Brownfields, and RCRA CA programs to work with the GIS program or national GIS office to reach mapping goals. **76** requires regional program interest and support to champion this assessment in other programs. **77-78** will require national office support to make the tool public.

69. The **Climate Mapping** team will review data and update the methodology for the climate vulnerability assessment of hazardous waste sites for Version 2 of the mapping tool and will then create a GIS model that can be applied to other programs.[1.2, 4.1-4.3]
70. The **Climate Mapping** team will improve the screening ability of the GIS tool to determine potentially vulnerable hazardous waste sites and other sites of concern for emergency response and preparedness during extreme weather events.[1.2, 4.1, 4.2, 5.1]
71. The **Climate Mapping** team will train internal **Superfund**, **RCRA CA,** and **RCRA Enforcement** program staff, as well as other program staff who may leverage results from this GIS model, on Version 2 of the climate vulnerability mapping tool.[1.2, 4.1, 4.2, 5.1]
72. The **Superfund** program will work with the **Climate Mapping** team to utilize Version 2 of the climate vulnerability mapping tool to evaluate Removal/Remedial Superfund Sites for climate related risks.[1.2, 4.1]
73. The **RCRA CA** program will work with the **Climate Mapping** team to utilize Version 2 of the climate vulnerability mapping tool to evaluate RCRA CA Sites for climate-related risks.[1.2, 4.2]
74. The **RCRA Enforcement** program will work with the **Climate Mapping** team to utilize Version 2 of the climate vulnerability mapping tool to evaluate RCRA facilities for climate-related risks. In the enforcement work, R1 will use all available authorities, injunctive relief, and mitigation tools to address the impacts of climate change as appropriate on facilities in the most vulnerable areas.[1.2, 5.1]
75. ***Aspirational:*** **LCRD** will work with the **Climate Mapping** team to evaluate flood risk/extreme weather event impact for **TSCA-PCB**, **UST**, **Brownfields**, and **RCRA CA** sites using tools such as the Version 2 of the climate vulnerability mapping tool and other relevant mapping resources and tools.[1.2, 4.3-4.5]
76. ***Aspirational:*** The **Climate Mapping** team will apply the climate vulnerability assessment model to other R1 programs.
77. ***Aspirational:*** The **Climate Mapping** team will share Version 2 with the public.[1.2, 4.1, 4.2, 5.1]
78. ***Aspirational:*** The **Climate Mapping** team will train external partners on Version 2.[1.2, 4.1, 4.2, 5.1]

Internal and Partner Capacity Building for Land, Chemicals and Redevelopment Programs

LCRD is responsible for the goals, objectives, and priorities for a broad range of EPA programs including RCRA Waste Management, RCRA CA, UST/LUST, Brownfields, Pesticides, TSCA-PCB, SMM, and P2 programs. LCRD programs are collectively impacted by increases in air and water temperature, extreme precipitation, and sea level rise, and more frequent/intense extreme storm events. To address these vulnerabilities across the board through internal and partner capacity building, Priority Actions **79-83** were created. Priority Action **83** is ***aspirational*** and contingent upon staff time, resources, and availability of ORD support.

79. The **LUST, Brownfields, TSCA-PCB,** and **RCRA CA** programs will increase staff familiarity with climate adaptation informed remediation best practices, such as Sustainable Resilient

Remediation (SRR), to help staff in remedial programs become comfortable referencing and sharing one of the latest tools to maximize the efficiency and resiliency of remedial actions.[4.2-4.5]

80. **LCRD** will consolidate resources potentially useful for LCRD program decision-making into a central location.[4.2-4.5, 5.1-5.3]
81. **LCRD** will have regular communication with state and tribal partners on climate issues, tools, and data.[4.2-4.5, 5.1-5.3]
82. **LCRD** will host internal informational sessions on climate vulnerabilities and tools.[4.2-4.5, 5.1-5.3]
83. ***Aspirational:*** The **LUST, Brownfields, TSCA-PCB,** and **RCRA CA** programs will work with ORD to help pilot and identify site vulnerability indicators and tools for states, grantees, responsible parties, and project managers to apply.[4.2-4.5, 5.1-5.3]

Federal Partnerships

As climate change brings increased environmental impacts, federal agency partnerships are needed to combine resources and more effectively tackle these impacts. The New England Federal Partners (NEFP) is a group of 17 federal agencies formed to work together on some of these complex environmental issues, such as coastal and ocean planning, climate change mitigation and adaptation, and resiliency planning. The group was officially recognized as a partnership by all participating agencies through a Statement of Common Purpose in 2010, which established a framework for communication, cooperation, coordination, and collaboration. To date, NEFP has worked together to collaborate on inter-agency regional issues such as drought, flooding, tribal infrastructure and relations, stormwater infrastructure, nature-based solutions, emergency planning, and government climate assessments such as the National Climate Assessment (NCA). In FY22, NEFP will be focusing on coordinating on infrastructure efforts (including those funded under the Bipartisan Infrastructure Law) and climate information services. Priority Action **84** was created to account for those efforts.

84. **ARD** and **WD** will coordinate and facilitate New England Federal Partners (NEFP) meetings to bring together federal partners on climate change issues.

NEPA

The R1 Environmental Review Program works with other federal agencies to help them analyze and address the environmental impacts of their actions under NEPA. Increases in flooding, extreme storm events, sea level rise, extreme heat, and high temperature days and associated air and water quality vulnerabilities from these threats should be addressed within the environmental reviews process under NEPA. In past NEPA reviews, R1 has routinely provided comments and suggestions to lead federal agencies on climate adaptation and mitigation measures to address climate impacts. To expand on this work, Priority Action **85** was created.

85. The **NEPA** program will work with lead federal agencies to help them address climate change, climate impacts, climate adaptation and mitigation during the NEPA process, as appropriate. This coordination could occur during pre-project coordination, NEPA scoping, or review of administrative drafts of Environmental Impact Statements (EISs) and draft and final Environmental Assessment (EA)/EISs.[7.1]

Communication and Outreach Support

R1's Office of Public Affairs (OPA) provides communication and outreach support to the other R1 divisions. Increased environmental risks/impacts from climate change will create a need for increased community awareness and communication on climate change in all of R1's programs. Priority Action **86** was created to support communication and outreach needs as they relate to other Priority Actions.

86. OPA will provide communication and outreach support, including press strategy as well as congressional, state, and local government coordination on Priority Actions, as requested.[7.2]

Grants and Program Support

R1's Grants and Program Support Branch provides grants oversight, project management and programmatic support to the Air and Radiation and Water Divisions. Increased environmental risks/impacts from climate change will create a resource need for R1's Grants and Program Support Branch to address increased impacts. Prior to 2022, climate change considerations were incorporated into Performance Partnership Agreements (PPA) with MassDEP, MEDEP, MassDEP, NHDES, and VTDEC, all 6 New England State's Priorities and Commitments (P&C) Lists, the regionally designed Healthy Communities Grants Program, and multipurpose grants. Priority Action **87-88** were created to support increased climate adaptation and resilience considerations within R1's PPAs, State P&C Lists, multipurpose grants, and Healthy Communities grants.

87. The **Grants and Programs Support** program will continue to incorporate and/or expand on climate change adaptation into PPAs, multipurpose grants, and P&C Lists.[7.3]
88. The **Grants and Programs Support** program will expand the focus on climate change resilience in the annual Healthy Communities Request for Applications (RFA).[7.4]

R1 will take steps to ensure the outcomes of infrastructure investments using Infrastructure Investment and Jobs Act (IIJA, or Bipartisan Infrastructure Law [BIL]) funds are resilient to the impacts of climate change. R1 will explore opportunities to integrate climate change considerations into its financial assistance programs in order to expand support for projects that increase climate resilience while delivering co-benefits for public health, the mitigation of greenhouse gases, and the reduction of other pollution. R1 will also provide technical assistance to recipients of BIL funds to help them make climate smart infrastructure investments.

Legal Support

The Office of Regional Counsel (ORC) is a service organization that provides a wide variety of legal services to the other R1 divisional offices. To ensure consistency in providing these legal services, ORC often consults and coordinates with attorneys from EPA's Office of General Counsel (OGC) and EPA's Office of Enforcement and Compliance Assurance (OECA), as well as with attorneys from other parts of the federal government, such as the Department of Justice (DOJ). In the context of carrying out R1's Priority Actions, Priority Action **89** was created to identify ORC's intent to provide various types of legal support, including support with regard to potential supplemental environmental projects related to climate adaptation efforts, to other divisions within R1 to advance our collective efforts to address the effects of climate change.

89. **ORC** will provide legal support to the various program offices for their Priority Actions, including legal work needed to help implement the program offices' Priority Actions. ORC may need to coordinate or consult with EPA's **OGC** and/or **OECA** on some questions.

Lab Support

The Lab Services and Applied Sciences Division (LSASD) works with other R1 divisional offices to provide field and analytical support. With climate change impacts, additional resources may be required for specific programs and to respond to extreme events. Priority Action **90** was created in response to this need.

90. **LSASD** will prioritize developing sufficient monitoring and analytical resources (FTE and equipment) for divisional programs to address climate change impacts and will coordinate with all divisions on resource needs.

Resilience and Adaptation in New England (RAINE)

There is a growing need for New England communities to take action to adapt to the impacts of climate change. In 2012, R1 developed the **Resilience and Adaptation in New England (RAINE)** database to create a mechanism for communities to share what they are doing and to assist each other in planning and adapting to climate change. The RAINE database is a searchable collection of state, regional, and community-level adaptation and resilience plans, reports, and webpages in New England. Each document is tagged with relevant search criteria and highlights the progressive adaptation and resilience actions New England communities are taking to respond to climate change. The RAINE team updates the database with new tagged documents on a biannual basis. As of January 2022, the RAINE database contains documents for 381 New England communities. Priority Actions **91-95** were created to outline the platform updates that the RAINE team will perform to increase the functionality of the tool, document collection volume, and outreach efforts. The platform update will feature a GIS version of the RAINE database.

91. The **RAINE** team will create Version 2 of RAINE (RAINE 2.0) and update the website (www.epa.gov/RAINE).
92. The **RAINE** team will update the RAINE Database with new climate plans and products and update the website to reflect changes on a biannual basis.
93. The **RAINE** team will add relevant climate layers for use on RAINE 2.0 as available.
94. The **RAINE** team will train internal staff on RAINE 2.0.
95. The **RAINE** team will train external partners on RAINE 2.0.

Section 4. Climate Science Needs

I. Introduction

Implementing effective strategies to adapt to the changing climate requires that decisions be grounded in the best available science on climate change risks, impacts, vulnerabilities, and adaptive management practices. Throughout EPA, there is a growing need for up-to-date information on existing data sets, models, and tools relevant to climate change adaptation. EPA's Office of Research and Development (ORD) will coordinate with the program and regional offices to identify and address priority research needs for the entire agency. This will support the integration of adaptation planning into the agency's activities. As part of the EPA-wide Climate Adaptation Plan process, all regional and program offices must identify their own science needs related to climate change adaptation.

The **Divisional Climate Workgroup Representatives** identified science needs across all divisions and media programs using guidance from ORD's Climate Workshop, where initial feedback on climate science research needs was solicited from the regions. The science needs are broken into the following programmatic areas: **1. Vulnerable Populations**, **2. Air Quality**, **3. Water Quality/Quantity**, **4. Contaminated Site Cleanup and Sustainable Development, 5 Cross-Sectional**. Each climate science need is specific to New England, and addresses how R1 anticipates using the research, the form of research needed, and when the research is needed by. If the science need addresses or is associated with a programmatic vulnerability (See R1 Programmatic Climate Vulnerability Assessment) then the vulnerability is linked as a red superscript after the primary science need or question (**x**[#]). An additional section, **R1 Actions to Address**, was included if any prior work, regional collaborative research projects with ORD, and/or Priority Action(s) were conducted or created in relation to the science need.

II. R1 Climate Science Needs

1. Vulnerable Populations

1. **How is climate change impacting New England Tribes' food sovereignty and security? What methods can R1 use to protect and restore food security and promote the Tribes' resilience?**[1.1]

Since the colonial era, the societal, economic, and industrial development of the US has left behind a legacy of impacts that have disproportionately affected tribal communities and disrupted traditional cultural hunting and fishing practices. Observed and future impacts from climate change threaten indigenous communities' access to traditional foods such as fish, game, and wild and cultivated crops, such as herring, moose, deer, fiddleheads, blueberries, and cranberries. These resources have provided sustenance as well as cultural, economic, medicinal, and community health for generations. If climate change threatens traditional Tribal wild foods, the Tribes may need to develop farmed cultivated foods to supplement their cultural and dietary needs. Informed by Tribal traditional ecological knowledge, research is needed in the form of data to provide more information to the Tribes on climate change impacts on food sovereignty and security as well as more information on the best restoration methods to protect tribal nations in New England. This research is needed immediately.

2. **What are the localized climate impacts and adaptation solutions for the Passamaquoddy Tribe - Pleasant Point's housing and Wastewater Treatment Plant in Pleasant Point, Maine?**[1.1]

Over the past decade, high-intensity storms have eroded the shoreline near Passamaquoddy Tribe – Pleasant Point, eroding the shoreline at a rate of approximately one foot each year. Tribal housing, as well as the wastewater treatment plant are being impacted. Future severe storms and flooding could further compromise Tribal housing and the treatment plant, cause saltwater to enter the plant, or discharge untreated sewage from the plant, triggering water contamination. Any significant down-time of the treatment plant would threaten the health and safety of Tribal members and require extensive temporary housing. The Tribe is currently seeking funding to address the vulnerability of the wastewater facility to storm surge and sea level rise. The form of research needed is site engineering and accompanying geotechnical analysis to design the proposed alternative, a barrier wall surrounding the wastewater treatment facility, to mitigate the impacts of climate change. The research is needed immediately.

R1 Actions to Address: With R1 and other federal partners' help, the Tribe received over $3 million in commitments of federal funding. R1 has assisted the Tribe with project management expertise, technical assistance, and facilitation of regular progress meetings. As of August 2021, the most vulnerable segment of the shoreline has been protected with the construction of the first phase of a shoreline revetment solution and planning for the next phase of shoreline revetment has begun. The Tribe has completed an EPA-funded vulnerability study of its wastewater treatment facility and related infrastructure, which incorporated EPA's guidance in evaluating facility elevations and vulnerable assets. **Priority Actions 1-2** were created in response to this need.

3. **How is the Atlantic salmon population distribution changing and how will it affect food security of the Houlton Band of Maliseet Indians/St. John River watershed in Northern Maine? What restoration efforts can be done to mitigate the decline of Atlantic salmon species?**[1.1]

Atlantic salmon has historically been the keystone species to the Maliseet people who reside in the Meduxnekeag River watershed, a tributary of the St. John River upon which the Houlton Band of Maliseet Indians rely for sustenance. However, Atlantic salmon have been absent in the Tribe's watershed for many years since the construction of the Mactaquac Dam in Frederickton, New Brunswick. While not currently listed as an endangered species, the Outer Bay of Fundy species of Atlantic salmon, once plentiful in the St. John River watershed, has declined rapidly due to a host of factors including habitat loss and fish passage obstructions. A changing environment contributes to the decline, as water temperatures rise, sediment loads from storms increase and water quality declines. Restoration of the St. John River, or "Wolastoq" in the Maliseet language, including the Atlantic salmon population, is the primary goal of the Tribe in order to restore food sovereignty and reverse the injustice caused by dams and other causes of aquatic species' decline. One area of research that is currently underway is a genomics study to determine strains of Atlantic salmon populations within specific tributaries in the watershed. Additional research is needed to obtain data on watershed vulnerabilities and barriers to fish passage, and to develop mobile environmental DNA (eDNA) technology to detect invasive species and confirm presence/absence of species. The research is needed immediately.

R1 Actions to Address: In collaboration with ORD on the FY20 RARE project, *Development of a Cloud-Based Population Diversity Database of Atlantic Salmon DNA*, R1 has begun working with the

Houlton Band of Maliseet Indians and U.S. and Canadian federal agency partners on the restoration of salmon to the St. John River "Wolastoq" International Watershed. The project aims to restore the species by mitigating climate impacts within their native habitat. **Priority Action 3** was created in response to this need.

4. **How does climate change impact communities with environmental justice concerns?**[1.2]

"Climate justice" is a term that acknowledges climate change can have differing disproportionate social, economic, public health, and other adverse impacts on underserved, historically marginalized, and overburdened populations. Communities with majority populations of people of color, indigenous, or low-income residents may experience a multiplier of adverse health impacts from climate change associated with higher exposures to environmental hazards, such as cardiovascular disease, asthma, and preterm and/or low birth weight. To assist communities with environmental justice concerns in R1, there is a need to better understand how climate change multiplies the adverse health impacts in these communities. Research on localized/regional modeling or GIS mapping to demonstrate regional multiplying effects or more data to inform public health risks from climate change is needed. This research, which should build on existing state and local vulnerability assessments, can be used to inform all programmatic work and resource allocation in R1. The research is needed immediately.

2. Air Quality

5. **How does climate change impact atmospheric patterns and regional air quality?**[2.1-2.3]

Tropospheric ozone levels in southeast CT have stayed consistently high in recent years even as ozone levels have continued to decrease in other areas of CT and New England. Additional research is needed to determine if there a climate component to this ongoing air quality issue that current air quality forecasting models do not adequately account for. The research could be used for regulatory action implementation, air quality planning, air permitting, air monitoring planning, public engagement, and providing information and guidance to other decision-makers. Additional research is also in the form of data collection through increased area of air quality monitoring systems and updated air quality models. The research is needed immediately to inform ongoing regional and national efforts to bring southeast CT into attainment with the National Ambient Air Quality Standards for ozone.

6. **What are the co-benefits and interconnections of reducing energy, greenhouse gases, and air pollution impacts?**[2.1-2.3]

Reducing energy use is an important way to decrease emissions of greenhouse gases, criteria, and toxic air pollutants. The U.S. Energy Information Administration data indicates that in 2019 nearly 80% of total energy demand was met by combusting fossil fuels. Reducing energy demand and increasing the percentage of energy supplied by non-emitting resources such as wind and solar power will reduce emissions of each of these pollutant types. This is recognized by the following quote taken from EPA's ENERGY STAR website:

> *In 2019 alone, ENERGY STAR and its partners helped Americans save nearly 500 billion kilowatt-hours of electricity and avoid $39 billion in energy costs. These savings resulted in associated emission reductions of nearly 390 million metric tons of greenhouse gases, roughly equivalent to 5% of U.S. total greenhouse*

gas emissions. These savings also led to reductions of 220,000 short tons of sulfur dioxide, 220,000 short tons of nitrogen oxides, and 27,000 short tons of fine particulate matter (PM2.5).

R1 considers energy demand reductions as an important method by which the NY-NJ-CT ozone nonattainment area can progress towards achieving the 2008 and 2015 ozone standards, as these states have adopted most of the known, conventional techniques for reducing ozone precursor emissions. Transitioning the motor vehicle fleet away from energy intensive combustion engines and towards electric vehicles is likely to be a key technique for this nonattainment area to meet the ozone standard. More analysis is needed to support the co-benefits of reducing GHGs and criteria pollutants and understanding the impacts of electrification on emissions and air quality. Given that the NY-NJ-CT ozone nonattainment area did not achieve the 2008 ozone standard by the August 2021 target date, and consequently will be "bumped up" from a "moderate" to "serious" nonattainment year with a new attainment date goal of August 2024, the research is needed immediately.

R1 Actions to Address: Through a Fiscal Year (FY) 2022 Regional Applied Research Effort (RARE) project, R1 collaborated with ORD and the Connecticut Department of Energy and Environmental Protection (CT DEEP) to create a pilot project on *Improving State-Level Multi-Pollutant Planning in Connecticut with Global Change Assessment Model (GCAM) Long-term Interactive Multi-Pollutant Scenario Evaluator (GLIMPSE)*. The pilot project is intended to support CT's ozone attainment planning efforts through a holistic systems analysis of the state's clean energy and climate policies, and multi-pollutant environmental impacts to enhance the GLIMPSE modeling tool's development in achieving state and regional analytical needs for air quality planning, as well as demonstrating the benefits of clean energy strategy integration into criteria pollutant planning.

3. Water Quality/Quantity

7. **How will increases in temperature and changes in streamflow conditions affect assumptions used for developing water quality standards and effluent limits for discharge permits (e.g., 7Q10, rate of nutrient uptake, algal bloom intensity)?**[3.1-3.3]

The development of numeric water quality criteria relies on data collected on the effect of different concentrations of a pollutant on aquatic life or human health, the duration of the exposure to that pollutant, and on other variables such as temperature, salinity, and hardness that are subject to changes from a warming climate. Many assumptions are based on previously collected data. New information and models are needed to forecast current and future conditions. The research is needed immediately.

8. **How will changes in temperature and precipitation patterns affect nutrient dynamics that contribute to the formation of harmful algal blooms (HABs)?**[3.1-3.3]

Changes in temperature and precipitation impact nutrient cycling and contribute to increased occurrences of harmful algal blooms (HABs). HABs are a significant and growing issue throughout R1, and one that State Agencies and municipalities are struggling to solve. Once a bloom is detected, municipalities are often unable to afford taking the next step in testing to determine the presence of a cyanotoxin or the repeat testing to detect when a HAB has abated. The result is likely an undercount of HABs throughout the region. In addition to increasing municipalities' capacity to monitor and respond to HABs, R1 could incorporate health data into a regional monitoring approach. The health effects of HAB exposure in humans can vary, but most symptoms present in mild to moderate severity consistent with general illness.

R1 needs include data collection, supported by laboratory and field analyses, on the growth rates and temperature interactions of blue green algae, especially in ponds, lakes, and impoundments. Modeling of future bloom conditions is also needed for planning and adaptation. The creation of a (statistically valid) regional remote sensing approach to quantify yearly blooms on a regional level would allow for a more systemic monitoring approach. This research could be used to support regulatory development, regulatory action, public engagement, and the provision of information and guidance to other decision makers. In addition to HABs detection and abatement, the development of a public engagement strategy is a critical component to safeguarding public health and ensuring people stay out of impacted waterbodies. Assessments performed within the Southeast New England Program (SNEP) boundary have demonstrated that public warnings (e.g., signage) have had mixed results, and that there doesn't appear to be consistent public messaging. Therefore, there is an additional need to better understand which types of public outreach are most successful and how current outreach methods can be improved. The research is needed immediately.

9. **How will changes in ocean and coastal acidification affect fish, plants, and other aquatic life? Shell-forming crustaceans like clams and oysters are especially vulnerable.**[3.1-3.3]

Increased atmospheric CO_2 absorbed by the open ocean, causes an increase in ocean CO_2 which ultimately decreases seawater pH (a measurement of acidity), known as ocean and coastal acidification (OCA). Nutrient enrichment of coastal waters exacerbates the decrease in pH and carbonate saturation. Because of colder waters, nutrient enrichment, and a valuable shellfish economy, New England is especially vulnerable to the impacts of OCA. One of the goals of EPA's OCA research program is to assess the ecological vulnerability to OCA and ultimately to support states that plan to develop water quality criteria for assessing OCA impacts. To accomplish this goal, there is a need to better understand the drivers of the coastal carbonate system, quantify localized risk of future OCA, and conduct laboratory or field experiments to determine the impact of ocean and coastal acidification on sensitive and commercially important species. Addressing these needs will require a greater investment in monitoring with both continuous, autonomous sensors and boat or shore-based sampling, as well as ecosystem and carbonate system modeling to extricate the factors, such as nutrient enrichment, respiration, atmospheric exchange, and temperature increases. The meta-analysis and literature review is needed immediately. The development of state OCA criteria is a long-term enterprise and could take between five to ten years.

R1 Actions to Address: R1 has worked with ORD on several OCA research projects over the past ten years, including the "Impacts of Coastal Ocean Acidification on the ecological health of shellfish in southern New England: ORD-R1 Research to support climate change adaptation" project which was funded by ORD's Regional/State/Tribal Innovation Program (RSTIP). As a result, a more detailed research plan was developed.

10. **What changes will be required to the design, sizing, construction, and siting of structural stormwater BMPs to account for projected climate change impacts in watersheds (extreme precipitation and increased intensity of storms, drought, rising groundwater, higher air and water temperatures, and sea level rise)?**[3.5]

Considering climate impacts, addressing the structural BMPs for the control of stormwater discharges is critical to the continued success of stormwater and nonpoint source management programs. BMPs designed to remediate water quality impacts in the Northeast may be insufficient to maintain water quality

under conditions associated with climate change. EPA and its partners need better tools and a better understanding of the relevant watershed characteristics that affect the health of a water body, how those characteristics can be affected by climate change, where existing BMPs are sited, and to what extent such systems can mitigate projected climate change impacts in the watershed. In addition, guidance is needed to inform future stormwater implementation projects including the identification of requisite adjustments to BMP design, sizing, or siting to ensure continued effectiveness of pollution control and hydrologic function. There is an immediate need to characterize new proprietary stormwater systems so that additional stormwater performance curves can be developed. Performance curves provide estimations of pollutant load reductions for structural stormwater control measures (i.e., BMP). Performance curves for proprietary systems will need to account for variations in regional geologic and climatic conditions, and account for water quality as a function of external nutrient loading versus internal nutrient recycling. Development and dissemination of such performance curves will assist municipal practitioners in managing nutrient pollution to offset the impact of nutrients on waterbodies. To this end, basic and/or applied research efforts would be used by EPA, grantees, and municipalities to support and facilitate watershed restoration planning and implementation. Such research that more specifically factors in climate change into stormwater planning and implementation is needed in the next five years.

R1 Actions to Address: R1 is currently in the process of piloting the development of stormwater performance curves to aid municipalities in determining which stormwater BMPs are most appropriate to address climate change projections.

11. **Are changes required to the design, sizing, construction, and siting of standard and Innovative/Alternative (I/A) septic systems to ensure their continued effectiveness in areas subject to extreme precipitation, drought, rising groundwater, higher air and water temperatures, and sea level rise?**[3.6]

The use of septic systems is commonplace throughout R1. While many of these systems are being phased out by municipal sewering, this transition can take decades to implement and is not feasible in many places, such as Cape Cod, a large peninsula extending into the Atlantic Ocean off Massachusetts. Traditional septic designs do not account for nitrogen reduction. As a result, old systems can leak and become a source of nutrient pollution that impacts local embayments. For example, on Cape Cod 78% of the controllable nitrogen pollution sourcing can be tied to leaky septic systems. It's critical that EPA and its partners obtain a better understanding of where these systems are located, as well as how these systems might be impacted by the worsening effects of climate change. Research would be used by EPA, states, and local health and planning departments to plan the siting of new and upgraded septic systems to limit their impacts on regional nutrient pollution and ensure that these systems remain effective in areas where sewering is either not possible or not anticipated to occur within the next several years. This research should consider the potential impacts on septic systems in areas prone to sea level rise, flooding, and/or rising groundwater levels. There is also a need for a review of the New England state septic system regulations to determine whether updated septic design and siting standards should be incorporated, such as the transition to Innovative/Alternative septic systems to address nutrient pollution. The research is needed in the next five years.

12. **How will warmer temperatures and related climate impacts affect the carbon sequestration capacity of salt marshes and submerged aquatic vegetation (eelgrass)?**[3.7]

"Blue Carbon" refers to carbon stored in coastal mangrove, marsh, and seagrass ecosystems, which are all highly sensitive and vulnerable to the impacts of climate change. A New England and Peconic Bay, NY, inventory of the carbon sequestration capacity of salt marshes and eelgrass beds has been completed, but the existing data only quantify carbon stocks to a depth of 30 cm, which significantly underestimates the resource. The research is needed to assess carbon stocks from deeper cores (down to refusal/bedrock) and measure environmental variables that impact seagrass survival. The research is needed immediately.

R1 Actions to Address: R1 has completed an inventory of the carbon sequestration capacity of salt marshes and eelgrass beds in New England and Peconic Bay, NY, through multiple ORD RARE projects and other regional funds. The final report recommends expanding the analysis to assess carbon stocks from deeper cores (down to refusal/bedrock). R1, in cooperation with ORD and R2, plan to continue to measure environmental variables that impact seagrass survival, which carries implications for the ecosystem services provided by these habitats. This work will build on multiple RARE projects examining carbon sequestration in eelgrass meadows throughout New England. Project findings are captured in the Blue Carbon Baseline Assessment for New England and NY available here. **Priority Action 33** was created in response to this need.

13. **Does eelgrass have the capacity to absorb greenhouse gases (GHGs)?**[3.7]

In addition to its ability to sequester carbon, emerging research suggests that eelgrass might have the capacity to directly absorb GHGs such as nitrous oxide, carbon dioxide, and methane. The GHGs, nitrous oxide and methane, are substantially more potent than carbon dioxide at trapping heat in the atmosphere. R1's goal is to gain a better understanding of the fluxes of these gases through an eelgrass meadow. If additional investigation demonstrates that eelgrass meadows are absorbing significant quantities of these more potent GHGs, it will dramatically increase their importance as buffers to climate change. The research is needed immediately and will build on related research described in **Research Need 8**.

R1 Actions to Address: R1 will submit this research proposal for FY22 Regional-ORD Applied Research (**ROAR**) funding to expand on previous efforts.

14. **How will warmer temperatures and associated changes in hydrology affect the viability of wetlands? What are the socioeconomic impacts from wetland changes and the benefits of their remediation and protection?**[3.7]

An increase in air and water temperature, extreme precipitation, drought, and sea level rise may lead to changes in wetland characteristics (i.e., soil dynamics, soil chemistry, hydrology, salinity levels, vegetation resilience and retreat, sedimentation and nutrient loading, and increases of new and existing invasive species) and in shifting and/or degrading wetland habitats. Research is needed to determine how these climate impacts will change wetland characteristics to help guide future jurisdictional determinations, the types of mitigation sought to offset unavoidable wetland losses, and restoration priorities and practices. A literature review could be conducted to determine the extent of these research gaps and to inform future Wetland Program Development Grant (WPDG) funding priorities. There is also a need to quantify and communicate the socioeconomic impacts of various types of environmental degradation on wetlands as well as the benefits of their restoration and/or protection. Potential end products could include the creation of municipal-level fact sheets that convey the total risk/benefit of habitat degradation/restoration or the creation of educational videos to be used across the regions. The research and communication support are needed within one to three years.

15. **How can EPA better incorporate climate change projections to improve its tracking of hypoxic conditions and their impacts?**[3.9]

In ocean and freshwater environments, the term "hypoxia" refers to low or depleted oxygen in a water body. Hypoxia is often associated with the overgrowth of certain species of algae, which can lead to oxygen depletion when they die, sink to the bottom, and decompose.[54] With a potential positive correlation between climate change effects and the prevalence of hypoxic conditions, EPA needs to increase its monitoring and modeling capabilities for hypoxic conditions throughout R1. This will help to determine where these hypoxic events occur and to track their frequency in given areas and model their future occurrence considering regional climate projections. By tracking the extent of hypoxia using rapid and reliable calculations and presentation of hypoxic area and volume, EPA can obtain a more accurate view of hypoxia levels and can use this data to inform BMPs and identify areas of concern. It is important to correctly model the dissolved oxygen response to nitrogen and carbon loading. The research is needed in the next five years.

16. **How can EPA incorporate climate change modeling to prevent unnecessary beach closures through the improvement of bacterial monitoring and reporting of marine and freshwater beaches?**[3.9]

To prevent unnecessary beach closures, there must be more optimization and implementation of rapid bacterial detection. Current efforts on using quantitative polymerase chain reaction (qPCR) monitoring techniques, a technique that uses DNA measurement, have not been successful and there is not a clear alternative. There is also a major lag in beach monitoring and data availability. If possible, EPA should identify beach monitoring approaches with quicker turnaround times to improve the effectiveness of beach monitoring in the region and/or create more effective regional models (such as an improved Virtual Beach model) to better inform beach monitoring efforts and issue preemptive closures by incorporating climate change data into new or improved models. Additionally, while EPA has a standardized beach monitoring approach supported by the EPA Beach Program, this approach is limited only to marine beaches. EPA should work to address and establish a standard monitoring approach and program for freshwater beaches. Standardizing a pathogen monitoring program for more marine and freshwater beaches and using microbial source tracking to identify bacterial sources would also be useful. Current Beach Program funds are limited to monitoring and cannot be applied to source tracking initiatives or other related uses. Providing new sources of funding or expanding the allowable uses of current funding, particularly to determine pollution source(s), should be considered. The research and additional efforts are needed in the next five years.

17. **How will sea level rise and coastal flooding impact drinking water infrastructure in coastal communities? How can EPA identify vulnerable infrastructure and assist affected communities, especially Tribes and communities with environmental justice concerns?**[1.2, 3.11]

Climate change will impact the quality and quantity of fresh water supplies available for drinking water. New England is especially vulnerable to sea level rise, which in certain areas may cause salt-water intrusion in groundwater tables, and combined with more extreme storms, may flood drinking water infrastructure. Data synthesis utilizing existing datasets and a literature review should be undertaken to determine current knowledge gaps pertaining to the impacts of sea level rise on drinking water

infrastructure and vulnerable communities, particularly in areas with environmental justice concerns. The outcome of this research would take the form of training workshops and exercises with states and water sector utilities on preparation, response, and recovery from the impacts of climate change on their water systems. The research is needed immediately.

18. **Where are existing unregulated impoundments located throughout the region? Which impoundments will be impacted by the worsening effects of climate change?**

Impoundments are artificially constructed bodies of water confined within an enclosure, such as a reservoir. R1 needs to better understand the existence of unregulated impoundments throughout New England and develop better practices, tools, and data to provide more effective technical and financial assistance at the state, tribal, and local levels. Unregulated impoundments are not maintained and can threaten local infrastructure if/when they fail. The likelihood of their failure is increased by the worsening effects of climate change, especially increased precipitation, and extreme storms. Therefore, it is critical for EPA and partners to gain a better understanding of the risks through creating an inventory of unregulated impoundments to include their location, condition, age, and downstream/upstream risks of failure so that EPA can better communicate the risks of these unregulated impoundments to private landowners, especially rural residents, where these impoundments are more likely to exist. Additionally, the inventory should include demographic information of the local area to assess potential environmental justice concerns. The research is needed in the next five years.

4. Contaminated Site Cleanup and Sustainable Development

19. **What are the localized climate impacts on hazardous waste sites in R1?**[4.1-4.5]

Flooding and other climate impacts may result in dispersal of contaminants, physical damage to remediation-related structures, and degradation of surface and groundwaters at hazardous waste sites. A more localized (e.g., certain regions, or rivers/waterbodies) analysis of climate impacts, specifically flooding, is needed for remedial decision making and emergency response actions. The data is needed in the form of software or modeling tools such as geographic information systems (GIS). The research is needed in the next one to three years.

R1 Actions to Address: R1 developed an internal pilot project, the National Priorities List (NPL) Climate Vulnerability Assessment Mapping tool and two subsequent versions for RCRA Corrective Action, RCRA TSDF and LQG sites. **Priority Actions 69-78 (*Climate Mapping for Hazardous Waste Sites*)** were created in response to this need.

20. **To what degree are the frequency and intensity of extreme storms increasing in R1 and how will it affect emergency response actions?**[4.1-4.5]

As the climate continues to change and severe weather patterns become more frequent, emergency responders and site remediation personnel need to understand the degree of impacts extreme weather will have on both emergency response and removal/remediation actions. This research will be used to aid in planning emergency response actions and developing new strategies for removal and response actions. The data are needed in the form of software or modeling tools such as GIS. The research is needed in the next one to three years.

R1 Actions to Address: Priority Action 70 (*Climate Mapping for Hazardous Waste Sites*) was created in response to this need.

5. Cross Sectional

21. **How will groundwater level rise affect permit requirements, infrastructure, especially EPA-funded drinking water and wastewater infrastructure and underground storage tanks, as well as our cleanup remedies?** 3.3-3.6, 4.1-4.5, 5.1-5.3

Climate change will affect the quantity and quality of groundwater through increased risks of drought, changes in precipitation and temperature, decreases in snowmelt, and rising sea levels. Groundwater in coastal regions of the US is particularly at risk due to a combination of changes in precipitation, withdrawal rates, and sea level rise.[55] The potential future impact and risks of groundwater changes must be understood to ensure climate-smart investment of federal funding and the accurate evaluation of stormwater BMPs. These data would also assist in evaluating the risks posed to regulated underground storage tanks and cleanup remedies. Data is needed to better estimate the risk of groundwater change in Region 1. The research is needed immediately.

Section 5. Climate Training Plan

I. Introduction

Consistent with the EPA-wide FY 2022-2026 EPA Strategic Plan, Goal 1: Tackle the Climate Crisis, R1 will provide training to enhance staff, management, and partner awareness and knowledge of relevant climate change data and information, impacts, and climate adaptation approaches. Training for staff will be focused on raising awareness, enhancing knowledge, and increasing understanding on how climate change is likely to impact EPA's mission and programmatic work.

II. Training Plan and Timeline

In accordance with the EPA-wide FY 2022-2026 EPA Strategic Plan, EPA program offices will develop, update, and expand existing climate adaptation training modules to prioritize two primary goals: (1) to increase awareness about the importance of climate adaptation and encourage all EPA staff and partners to consider the changing climate in the normal course of business; and (2) to introduce specific methods and tools for integrating climate adaptation into decision-making processes. Several program offices are scheduled to release a climate adaptation training module in FY22-23. The tentative schedule for program office module release is shown in **Table 5** along with tentative R1 administration dates, and staff targeted for each training module. However, all trainings will be open to interested R1 staff. Based on the module development schedule, R1 will administer and promote programmatic trainings via the **Region 1 Climate Network (RCN)**. The **RCN** hosts bi-monthly meetings that feature one main speaker on a timely climate topic, both internal and external to R1, and climate updates from staff working across the region which will provide additional training and increased knowledge for EPA R1 employees. After the release of OP's training module, Climate Adaptation 101, an outline of the full training schedule will be provided at an RCN meeting. The meetings are open to all R1 employees.

Climate Adaptation Training Module by Lead Office	**Tentative Date Modules will be Available**	**Tentative R1 Administration Dates**	**Targeted R1 Staff to be Trained**
Office of Policy (OP) Climate Adaptation 101	Summer 2022	Fall 2022, Fall 2023, Fall 2024	R1
Regulation Writers	End of 2022	Spring 2023, Spring 2024	Appropriate R1 Staff
Office of Water (OW)	End of 2022	Spring 2023, Spring 2024	WD and LSASD
Office of Land and Emergency Management (OLEM)	End of 2022	Spring 2023, Spring 2024	LCRD, SEMD, and LSASD
Office of Air and Radiation (OAR)	End of 2023	Spring 2024	ARD and LSASD
Office of Chemical Safety and Pollution Prevention (OCSPP)	End of 2023	Spring 2024	LCRD and LSASD
Office of Enforcement and Compliance Assurance (OECA)	End of 2023	Spring 2024	ECAD and LSASD

Office of Mission Support (OMS)	End of 2023	Spring 2024	MSD and LSASD
Office of Homeland Security (OHS)	End of 2023	Summer 2024	R1
Office of International and Tribal Affairs (OITA)	End of 2023	Summer 2024	R1
Office of Research and Development (ORD)	End of 2023	Summer 2024	R1

Table 5. Schedule for EPA Program Office Training Modules Release and R1 Administration Dates

III. Measurements and Progress

Training of R1 staff and progress will be measured through tracking the percentage of R1 or divisional staff, as defined in **Table 5**, who were trained on an annual basis for each training module for FY 22-24. The staff training targets for FY 22-24 are listed in **Table 6**. The percentages are additive, building on the prior year's targets with consideration of new hires and retired staff. The training schedule and targets will be updated as training modules become available by program offices. Taking Climate Adaptation 101 will be made a mandatory training for all new hires and be added into their Individual Development Plan (IDP).

Climate Adaptation Training by Lead Office	**FY 22 (% of Staff Trained)**	**FY 23 (% of Staff Trained)**	**FY 24 (% of Staff Trained)**
Office of Policy (OP) Climate Adaptation 101	100% of R1	100% of R1	100% of R1
Regulation Writers	0%	50% of R1	80% of R1
Office of Water (OW)	0%	50% of WD and Relevant LSASD Staff	80% of WD and Relevant LSASD Staff
Office of Land and Emergency Management (OLEM)	0%	50% of LCRD, SEMD, and Relevant LSASD Staff	80% of LCRD, SEMD, and Relevant LSASD Staff
Office of Air and Radiation (OAR)	0%	0%	50% of ARD and Relevant LSASD Staff
Office of Chemical Safety and Pollution Prevention (OCSPP)	0%	0%	25% of LCRD and Relevant LSASD Staff
Office of Enforcement and Compliance Assurance (OECA)	0%	0%	50% of ECAD and Relevant LSASD Staff
Office of Mission Support (OMS)	0%	0%	50% of MSD and Relevant LSASD Staff
Office of Homeland Security (OHS)	0%	0%	25% of R1
Office of International and Tribal Affairs (OITA)	0%	0%	25% of R1
Office of Research and Development (ORD)	0%	0%	25% of R1

Table 6. R1 Staff Training Targets

Section 6. Conclusions

Climate change is and will continue to have significant impacts on the health and well-being of Americans and the environment, with the greatest impacts falling disproportionately on historically underserved and overburdened communities. This Adaptation Plan identifies key programmatic vulnerabilities and the Priority Actions that will be taken to address those vulnerabilities over time. As the work called for in this Adaptation Plan is conducted, where resources are available and the communities and demographic groups most vulnerable to the impacts of climate change are identified, priority will be given to those areas. Region 1 will share information and coordinate with EPA Regional and Program Offices to leverage and enhance climate change and environmental justice activities that are already taking place. Additionally, EPA will strive to be transparent in our actions concerning this plan by providing updates on our accomplishments. As knowledge on climate change impacts evolves, the Region 1 Climate Adaptation Plan, programmatic vulnerabilities, and Priority Actions will be reviewed and updated annually.

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