U.S. Environmental Protection Agency

Climate Change Adaptation Plan

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Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

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Dedication

This Plan is dedicated to the memory of our colleague, David Guest, from the Office of International and Tribal Affairs (OITA). David was a most thoughtful and willing collaborator and friend in the preparation of the Agency *Climate Adaptation Plan*. Throughout his work with this Plan and with EPA he was an ardent advocate for the issues important to tribal governments, our crucial partners in environmental protection.

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Climate Change Adaptation Plan: Executive Summary

We live in a world in which the climate is changing at a rate faster than that which society has experienced in modern history. Because many of the environmental outcomes that EPA is working to attain (*e.g.*, clean air, safe drinking water) are sensitive to changes in weather and climate, these changes are posing new challenges to EPA's ability to fulfill its mission of protecting human health and the environment.

To address these challenges, EPA has developed a *Climate Change Adaptation Plan.* The *Adaptation Plan* relies on peer-reviewed scientific information and expert judgment to begin to identify potential vulnerabilities to EPA's mission from climate change. The *Adaptation Plan* also presents priority actions the Agency will take to integrate climate adaptation planning into its programs, policies, rules, and operations to ensure they are effective in a changing climate. EPA's focus on climate adaptation is part of a larger federal effort to promote a healthy and prosperous nation that is resilient to a changing climate. EPA's *Climate Change Adaptation Plan* provides a road map and commitment from the Agency to addressing the direction provided in the President's *Climate Action Plan*, and Executive Order 13653, *Preparing the United States for the Impacts of Climate Change*.

Vision of the Future EPA

EPA's *Policy Statement on Climate-Change Adaptation*, issued in 2011, called for EPA to plan for future changes in climate and to mainstream considerations of climate change into its activities. As part of that effort, the *Policy Statement* called for the Agency to develop and implement a *Climate Change Adaptation Plan*. It also called for each EPA National Environmental Program Office and all of the Regional Offices to develop Implementation Plans to explain how they will carry out the work called for in the Agency-wide Plan. EPA made these Implementation Plans available as drafts for public comment late in 2013 and they have been revised with this Plan.

EPA's *Climate Change Adaptation Plan*

- **EPA's *Adaptation Plan* identifies ways in which climate change could affect EPA's ability to fulfill its mission.**
- **EPA's *Adaptation Plan* describes priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions.**

EPA's vision is for the Agency to continue to fulfill its mission of protecting human health and the environment even as the climate changes. EPA will build and strengthen its ***adaptive capacity*** and work with its partners to build capacity in states, tribes,

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, and/or coping with the consequences.**

and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with data, information, and tools to integrate climate adaptation into their work.

Identifying Vulnerabilities to EPA's Mission from Climate Change

Using the best available science, EPA has begun to identify ways in which its mission, facilities, and operations are vulnerable to climate change. EPA will refine this initial effort to identify and understand areas of vulnerability by undertaking research, assessment, and monitoring activities in the coming years. EPA's *Climate Change Adaptation Plan* summarizes known vulnerabilities related to the Agency's five strategic goals:

Vulnerability assessment is an ongoing process. EPA's Climate Change Adaptation Plan should be viewed as a living document that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission.

- **Taking Action on Climate Change and Improving Air Quality.** Climate change is likely to affect air quality in a variety of ways. For example, higher air temperatures, more frequent wildfires, heavy precipitation events, and changes in atmospheric transportation patterns may lead to increased tropospheric ozone levels, changes in particulate matter exposure, worsened indoor air quality, changes to the stratospheric ozone layer, and changes in deposition of sulfur, nitrogen, and mercury in ecosystems.
- **Protecting America's Waters.** More frequent hurricanes, rising sea levels, increasing water temperatures, ocean acidification, and changing precipitation patterns may all have adverse effects on water quality protection, the operation of water management infrastructure, the quality and availability of drinking water supplies, and the restoration and protection of watersheds, wetlands, oceans, and aquatic ecosystems.
- **Cleaning Up Communities and Advancing Sustainable Development.** Flooding from sea-level rise, more intense and frequent storm surges, as well as melting permafrost could disrupt waste management networks and may also lead to releases from contaminated sites under EPA's jurisdiction. Changes in temperature and precipitation may impact the performance and efficiency of cleanups. Increased frequency and intensity of extreme weather events may affect EPA's capacity to manage debris and respond to emergencies.
- **Ensuring the Safety of Chemicals and Preventing Pollution.** Climate change may affect exposures to a wide range of chemicals due to changing use patterns and environmental conditions. For example, EPA's decisions about how pesticides are

registered may be affected by the impact of climate change on pest pressure and how and where pesticides are used.

- **Enforcing Environmental Laws.** More frequent extreme weather events might divert EPA's staff and resources away from enforcement and toward disaster response and remediation.

Mainstreaming Climate Change Adaptation at EPA

Climate change is one of many factors that can influence the effectiveness of EPA's activities over time. It is essential for the Agency to account for climate change as it designs its programs, policies, and rules, in the same way that other factors such as population growth and economic development are regularly considered. EPA's *Climate Change Adaptation Plan* identifies a broad set of priority actions that EPA will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities:

- **Continue to fulfill strategic measures in *FY 2011–2015 EPA Strategic Plan*:** EPA's *FY 2011-2015 Strategic Plan* established the Agency's first "Strategic Performance Measures" for integrating climate adaptation into EPA's day-to-day operations. The *Strategic Plan* committed EPA to integrating considerations about climate change science and adaptation into (1) five rulemaking processes, (2) five major grant, loan, contract or technical assistance programs, and (3) five major scientific models or decision-support tools, all by 2015.

- **Protect Agency facilities and operations:** EPA will develop and implement measures to protect its workforce, operations, and underlying infrastructure against extreme weather events such as floods.

- **Factor legal considerations into adaptation efforts:** EPA's *Climate Change Adaptation Plan* encourages managers in the Agency's programs and regions to consult with EPA's attorneys to ensure that all adaptation work is within the scope of the Agency's statutory authorities.

- **Strengthen adaptive capacity of EPA staff and partners through training:** EPA will design and implement climate change adaptation training for its staff and its partners in states, tribes, and local communities.

- **Develop decision-support tools that enable EPA staff and partners to integrate climate adaptation planning into their work:** EPA is committed to developing decision-support tools to improve the quality and efficacy of decisions that are sensitive to changes in climate.

- **Identify cross-EPA science needs related to climate adaptation:** EPA's Office of Research and Development will coordinate an effort to identify priority research needs for the entire Agency to support the integration of adaptation planning into EPA's activities. This will produce research results that benefit multiple program areas of EPA.

- **Partner with tribes to increase adaptive capacity:** Each EPA Program and Regional

Office will support the development of adaptive capacity in the tribes and identify clear steps for ongoing collaboration with tribal governments where appropriate.

- **Focus on most vulnerable people and places:** EPA will help increase the resilience of the most vulnerable people and places by improving their capacity to predict, prepare for, and avoid adverse impacts from climate change.

- **Measure and evaluate performance:** EPA will evaluate its climate change adaptation actions on an ongoing basis, in order to maintain progress toward the long-term goal of integrating climate adaptation into the Agency's programs, policies, rules, and operations.

- **Develop Program and Regional Office Implementation Plans:** EPA's National Environmental Program Offices and all of the Regional Offices have each developed their own Implementation Plans and they are being released along with this EPA Agency Plan. The Implementation Plans describe how the Offices are integrating climate adaptation into their planning and work, and how they are addressing the cross-EPA priorities identified in this Agency-wide *Adaptation Plan*. Each Implementation Plan reflects unique program or regional circumstances and goals.

Measuring and Evaluating Performance

Because of the uncertainties involved in understanding how climate change will affect EPA's programs and activities, EPA's adaptation planning will include a continuing effort of evaluation and adjustment. In the near term, EPA will evaluate its adaptation planning efforts using the three strategic performance measures from its *FY 2011-2015 Strategic Plan*. In the longer term, EPA will develop additional measures to evaluate the outcomes and effectiveness of the broader set of actions described in its *Climate Change Adaptation Plan*.
Based on these assessments, EPA will identify program areas where its climate adaptation activities have had the greatest impact, and program areas needing improvement. The lessons learned will be shared across the Agency and with EPA's partners and other stakeholders. On the basis of these lessons, EPA will make adjustments to the way adaptation is integrated into its activities.

The Importance of Program Evaluation

Because EPA's Programs and Regions will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved.

Part 1: Vision of the Future EPA

We live in a world in which the climate is changing. Changes in climate have occurred since the formation of the planet. But humans are now influencing Earth's climate and causing it to change in unprecedented ways.

It is in this rapidly changing world that EPA is working to fulfill its mission to protect human health and the environment. Many of the outcomes EPA is working to attain (e.g., clean air, safe drinking water) are sensitive to changes in weather and climate. Until now, EPA has been able to assume that climate is relatively stable and future climate will mirror past climate. However, with climate changing more rapidly than society has experienced in the past, the past is no longer a good predictor of the future. Climate change is posing new challenges to EPA's ability to fulfill its mission.

Vision

EPA continues to fulfill its mission of protecting human health and the environment even as the climate changes.

It is essential that EPA adapt to anticipate and plan for changes in climate. It must integrate, or mainstream, considerations of climate change into its programs, policies, rules and operations to ensure they are effective under future climatic conditions. Through climate adaptation planning, EPA will continue to protect human health and the environment, but in a way that accounts for the effects of climate change.

EPA has not yet conducted a detailed quantitative assessment of the vulnerability of its mission to climate change. This Climate Change Adaptation Plan uses expert judgment, combined with information from peer-reviewed scientific literature on the impacts of climate change, to identify potential vulnerabilities. It then presents priority actions the Agency will take to begin integrating climate adaptation planning into its activities.

EPA's focus on climate adaptation is part of a larger federal effort to increase the nation's *adaptive capacity* and promote a healthy and prosperous nation that is resilient to a changing climate. A central element of EPA's efforts to adapt to a changing climate will be to strengthen the adaptive capacity of its own staff and its partners across the country. It will increase staff's awareness of ways that climate change may affect their ability to implement effective programs. It will empower staff to integrate climate adaptation into the work they do by providing them with the necessary data, information and tools.

Adaptive Capacity

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, and/or coping with the consequences.

EPA will also strengthen the adaptive capacity of its partners across the country in ways that are critical to attaining the Agency's mission. States, tribes, and local communities share responsibility for protecting human health and the environment, and partnerships with EPA are at the heart of the country's environmental protection system. These partnerships will be critical for efficient, effective and equitable implementation of climate adaptation strategies. EPA's Regional and Program Offices will therefore work with their partners, engage local stakeholders, and use a diversity of approaches to build adaptive capacity and encourage climate adaptation planning depending upon state, local, and tribal needs and conditions. EPA will continue to work with other federal agencies and international partners to enhance understanding of climate change risks and leverage collective knowledge about climate adaptation planning.

EPA *Policy Statement on Climate-Change Adaptation*

EPA issued its first *Policy Statement on Climate-Change Adaptation* in June 2011.[1] The Policy Statement recognized that climate change can pose significant challenges to EPA's ability to fulfill its mission. It called for the Agency to anticipate and plan for future changes in climate and incorporate considerations of climate change into its activities.

> **"I skate to where the puck is going to be, not where it has been."**
> **—Hockey great, Wayne Gretzky**

The Policy Statement noted that many programs throughout the Agency have already begun to anticipate and address the implications of a changing climate. These efforts laid a solid foundation on which to build climate adaptation planning into EPA's activities. Nevertheless, more needs to be done.

The *Policy Statement* called for the development and implementation of this EPA Climate Change Adaptation Plan to integrate climate adaptation into the Agency's programs, policies, rules and operations. Priority activities were also identified to be undertaken by the Program and Regional Offices, and reflected in the EPA's annual budget submissions. This Plan lays out the priority actions to begin the long-term process of integrating climate adaptation into the Agency's activities.

The *Policy Statement* also directed every EPA Program and Regional Office to develop an Implementation Plan that provides more detail on how it will meet the priorities and carry out the work called for in the agency-wide plan. The *Policy Statement* recognized that each Office is best positioned to determine how to integrate climate adaptation into its own activities, and provided each Office with the flexibility to develop its Implementation Plan in a manner consistent and compatible with its own circumstances and objectives. EPA is updating its Policy Statement to reflect the progress that has been made thus far and focus more fully on implementation activities and on helping states, tribes and communities build their capacity to adapt to climate change. The updated Policy Statement will be released in June 2014.

EPA's ongoing work is guided by principles representing EPA's core values. EPA's efforts to integrate climate adaptation into existing programs and activities will use the best available science, protect populations and locations most vulnerable to climate change and with the least ability to adapt, and use sensible analytic methods and approaches for developing adaptation strategies. Partnerships will be forged that include multiple levels of government, as well as private and nongovernmental partners throughout the country and internationally.

The *Policy Statement* acknowledges that mainstreaming adaptation planning will be an ongoing, long-term activity. The effectiveness of the Agency's adaptation activities will be monitored and evaluated to continually assess the effectiveness of actions. Lessons will be learned and shared across the Agency and with its partners at home and abroad. Likewise, EPA will learn from the experiences of its international counterparts and partners. Adjustments to the Agency's approaches and plans will be made as necessary. These adjustments will be reflected in regular updates to this agency-wide Plan.[2]

Initial Strategic Measures

EPA has established initial goals for mainstreaming climate adaptation planning into its activities. The *FY 2011-2015 EPA Strategic Plan* contains the Agency's first "strategic performance measures" for integrating climate adaptation into its day-to-day operations.[3] Explicit commitments to attain the performance measures are now included in EPA's annual budget submissions to Congress.

The strategic performance measures contained in the *FY 2011-2015 Strategic Plan* commit the Agency to integrating adaptation planning into five major rulemaking processes and five major financial assistance mechanisms by 2015, using existing authorities. They also call for the integration of adaptation planning into five major scientific models or decision-support tools used in implementing Agency environmental management programs. These *Strategic Plan* commitments represent the Agency's best and most informed judgment about the most effective mechanisms for building adaptive capacity and promoting adaptive planning within EPA and by its partners. They also provide a set of measures for monitoring the Agency's progress on adaptation planning.

EPA emphasizes the importance of evaluating activities and acting on the lessons learned. EPA will seek to identify where its climate adaptation activities might have the greatest impact on protecting human health and the environment, replicate its successes, and identify areas needing improvement. It will be an ongoing challenge to measure the direct impact of EPA's adaptation planning activities on the resilience of its programs, and on the human health and environmental outcomes it is striving to attain. The Agency will continue to explore, test and evaluate other approaches for mainstreaming adaptation planning besides those already contained in the strategic performance measures. If necessary, it will develop improved

strategic measures and annual performance measures. This ongoing process of evaluation and learning is consistent with EPA's commitment to transparency and accountability.

Contribution to a Healthy and Prosperous Nation

The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government. Federal agencies now recognize that climate change poses challenges to their missions, operations and programs. Ensuring the capacity of federal government agencies to maintain essential services and achieve their missions in the face of climate change is critical for successful adaptation by the entire nation. Federal agencies are working together to plan for climate change using approaches that no longer assume past conditions are good indicators of the future. Although there is no single planning approach appropriate for all agencies, the use of consistent, but flexible, frameworks facilitates coordination across agencies and allows them to leverage common tools and methods.[4]

The federal government has an important and unique role in climate change adaptation, but is only one part of a broader effort that must include public and private partners throughout the country and internationally. Partnerships with states, tribes, local communities, other governments and international organizations, many of which have already begun to implement adaptation measures, are essential.

EPA's leadership and commitment to help build the nation's adaptive capacity are vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Endnotes

[1] U.S. Environmental Protection Agency, *Policy Statement on Climate-Change Adaptation*, June 2, 2011, http://epa.gov/climatechange/Downloads/impacts-adaptation/adaptation-statement.pdf.

[2] Executive Order 13514 resulted in a process that requires every federal agency to submit annual progress reports to its sustainability and climate change adaptation plans.

[3] U.S. Environmental Protection Agency, *FY 2011-2015 EPA Strategic Plan, Achieving Our Vision* (2011), http://epa.gov/planandbudget/strategicplan.html.

[4] White House Council on Environmental Quality, *Progress Report on the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy* (Washington, DC, October 5, 2010).

Part 2: Known Vulnerabilities to EPA's Mission from Climate Change

2.1 Climate Change and Climate Impacts

The global climate is changing, and the impacts of this change are being felt across the United States and the world. These impacts pose new challenges to EPA as it strives to fulfill its mission of protecting human health and the environment. It is essential for the EPA to adapt if it is to reduce the vulnerability of its mission to climate change and continue fulfilling its statutory, regulatory and programmatic requirements. It is vital that the EPA anticipate and plan for future changes in climate and incorporate considerations of climate change into many of its programs, policies, rules, and operations where appropriate to ensure they remain effective under future climatic conditions.

Vulnerability

Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

During the past 50 years, average temperature across the United States has risen more than 2°F, while precipitation has increased an average of about 5 percent. Some extreme weather events, such as heat waves, intense precipitation events and regional droughts, have become more frequent and intense. One of the precipitation trends in the United States is the increasing frequency and intensity of heavy downpours (the types of events that cause runoff of pollutants and pathogens into our rivers and streams, and cause combined sewer systems to overflow in our cities). This change in heavy downpours was responsible for most of the observed increase in overall precipitation during the last 50 years.[1] Also, during the past 50 years, sea level has risen up to 8 inches or more along some coastal areas of the United States, and has fallen in other locations.[2]

These trends are expected to continue, partly due to past and future emissions of heat-trapping greenhouse gases from human activities, but will occur against a background of natural variations in climate.[3] In the United States, temperatures are projected to warm substantially over the 21st century under all projections of future climate change. These changes pose risks for a wide range of human and environmental systems, including public health, the quality of the air we breathe and the water we drink, freshwater resources, the coastal environment, wildlife and ecosystems, infrastructure, economic activity, cultural resources and social well-being. As such, the impacts of climate change introduce vulnerabilities across the mission and goals of EPA.

Around the world all countries are expected to feel the effects of climate change, although the specific impacts will vary. The impacts, however, are expected to disproportionately affect developing countries and those already at risk.[4] Within the United States, certain parts of the

population may be especially vulnerable to climate change[5]. For example, EPA recognizes that climate change may have significant impacts on subsistence resources in rural communities, Alaskan Native villages, and Indian Country. EPA's efforts to anticipate and adapt to the effects of climate change on its core mission, therefore will include helping the most vulnerable people and places reduce their exposure to climate change and improving their capacity to predict, prepare for and avoid adverse impacts.[6]

2.2 Synthesis of EPA's Vulnerabilities

The best available science directs our attention to areas where EPA's mission, facilities, and operations may be adversely affected by climate change. EPA has not yet conducted a detailed quantitative assessment of the vulnerability of its mission to climate change. This Climate Change Adaptation Plan uses expert judgment, combined with information from peer-reviewed scientific literature on the impacts of climate change, to identify potential vulnerabilities.

The assessment of EPA's climate-related vulnerabilities is an ongoing process. This summary of known vulnerabilities should be viewed as a living document that will be updated as needed to account for new knowledge, data and scientific evidence.

This section summarizes the Agency's known mission, facility, and operational vulnerabilities. As scientific understanding increases, other vulnerabilities may join the list. This summary is organized by EPA's five strategic goals, which represent EPA's approach to its work and reflect the results it works to achieve on behalf of the American people:[7]

- Goal 1: Taking Action on Climate Change and Improving Air Quality
- Goal 2: Protecting America's Waters
- Goal 3: Cleaning Up Communities and Advancing Sustainable Development
- Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution
- Goal 5: Enforcing Environmental Laws

In addition to known vulnerabilities affecting each of the five goals, EPA has begun to assess the vulnerabilities of its facilities and operations to a changing climate. EPA must ensure the safety of its personnel, the safe and continued operation of its buildings and other critical assets (*e.g.,* vehicles), and the integrity of its grants and procurement systems. In the event of any catastrophic weather event, EPA's people, buildings and operations could be impacted. These vulnerabilities are summarized in this section. Finally, this section includes information on climate change impacts on the most vulnerable communities. For example, the Agency has a priority focus on children's environmental health and environmental justice, including minority, low-income, and indigenous populations, and these populations are discussed.

The assessment of EPA's climate change vulnerabilities is a dynamic process. The extent to which vulnerabilities have been identified and are understood varies across goals. The science of climate change will improve over time, providing greater weight of evidence to evaluate the consequences of existing and expected impacts. EPA will continue to identify new vulnerabilities and improve its understanding of known vulnerabilities as it undertakes more research, assessment, and monitoring activities, and fills in data gaps.

Examples of Data, Information, and Research Needs to Improve EPA's Assessment of its Vulnerabilities from Climate Change

Potential vulnerabilities remain difficult to assess in some areas because of limited scientific understanding of the potential impacts of climate change on some of EPA's programs. Examples of data, information, and/or research needs include:

- **Characterization of local impacts to precipitation and hydrology for use in planning long-lived water infrastructure.**
- **Monitoring shifts in water quality and aquatic ecosystems in watersheds, and methods for incorporating such changes into water quality programs.**
- **The potential impact of more intense weather events on EPA's disaster response planning efforts.**
- **The site-specific impacts of climate change on Brownfields, Corrective Action Facilities under the Resource Conservation and Recovery Act (RCRA), Superfund sites, RCRA Treatment, Storage and Disposal (TSD) facilities, non-hazardous solid waste facilities, and Leaking Underground Storage Tanks.**
- **The effect of climate change on energy efficiency programs given changes in energy demand and supply.**
- **The interactions between climate and the stratospheric ozone layer.**
- **The effects of climate change on multi-pollutant interactions in ecosystems.**
- **A characterization of climate-related trends in chemical use (*e.g.*, changing patterns of pesticide use and new chemical exposures to people and the environment), and implications for the review process for new chemicals or the registration process for new pesticides.**

2.2.1 Goal 1: Taking Action on Climate Change and Improving Air Quality

America's communities face health and environmental challenges from air pollution, some of which are exacerbated by the growing effects of climate change. EPA is working with its partners to protect public health and the environment with programs that address indoor and outdoor air quality, climate change, pollution prevention, energy efficiency, industrial air pollution, pollution from vehicles and engines, radon, acid rain, stratospheric ozone depletion, and radiation protection. Within this broad portfolio, several programmatic areas are vulnerable to future climate change, presenting challenges for EPA to continue to achieve its core mission.

The extent of vulnerability, however, differs across program areas and is tied to EPA's understanding of the science and projections of future climate change impacts. Some key areas of known vulnerability for EPA's air programs are:

Tropospheric ozone pollution is likely to increase in certain regions due to the effects of climate change. The relationship between temperature changes and tropospheric ozone formation is well understood. With climate change, higher temperatures and weaker air circulation in the United States will lead to more ozone formation even with the same level of emissions of ozone forming chemicals.[8] Studies project that climate change could increase tropospheric ozone levels over broad areas of the country, especially on the highest-ozone days.[9] Climate change also has the potential to lengthen the ozone season (the months of the year when weather conditions, along with pollutants in the air, can result in the formation of ground-level ozone in particular locations around the country), and may increase individuals' vulnerability to air pollution.[10]

EPA is working to reduce the number of areas in America that do not meet air quality standards. Increases in ozone due to climate change may make it more difficult to attain or maintain ozone standards. This will need to be taken into account when designing effective ozone precursor emission control programs.

Climate Change Impacts on Tropospheric Ozone Pollution

Studies project that climate change could increase tropospheric ozone levels over broad areas of the country. Climate change also has the potential to lengthen the ozone season, and may increase individuals' vulnerability to air pollution.

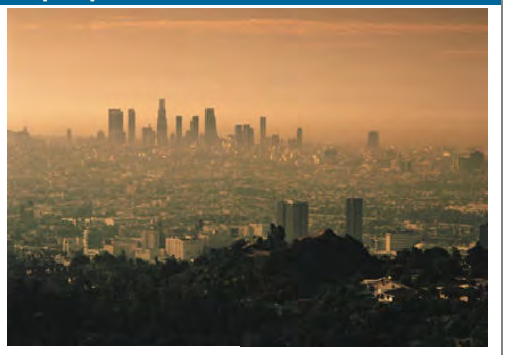


Photo: U.S. EPA

Sources: (1) U.S. EPA (2009). Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone. An Interim Report of the U.S. EPA Global Change Research Program. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-07/094F. (2) K. Katsouyanni, et al., "Air Pollution and Health: A European and North American Approach (APHENA)," HEI Health Review Committee, Research Report #142 (Boston, MA: Health Effects Institute, October 2009), 5-90.

Increases in tropospheric ozone concentrations due to climate change would increase the public health burden from air pollution. The potential impacts on public health include more respiratory illnesses and increased risk of premature deaths.[11] This is a particular concern to sensitive subpopulations which are at risk for health effects from exposure to ozone. In order to better protect human health, Federal, state, tribal, and local governments will need to respond by improving the effectiveness of existing emissions control programs for ozone precursors or by implementing new control measures that will ensure attainment of the ozone National Ambient Air Quality Standards (NAAQS).

Particulate matter (PM) levels are likely to be affected through changes in the frequency or intensity of wildfires. While the impact of climate change on ambient PM levels remains somewhat uncertain, there is evidence indicating that climate change will affect PM levels through changes in the frequency or intensity of wildfires.[12] The Intergovernmental Panel on Climate Change (IPCC) has reported with very high confidence that in North America, disturbances such as wildfires are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons.[13] Forest fires are likely to increase in frequency, severity, distribution and duration in the Southeast, the Intermountain West and the West due to climate change. The potential increase in PM resulting from wildfires may increase the public health burden in affected areas, which may include sensitive subpopulations at risk for increased health effects from being exposed to PM pollution and also complicate state efforts to attain the PM NAAQS and address regional transport of air pollution.

Climate change may worsen the quality of indoor air. Climate change may worsen existing indoor environmental problems and introduce new ones as it alters the frequency or severity of adverse outdoor conditions. Some examples of potential indoor air quality impacts include:

- Heavy precipitation events may contribute to increases in indoor dampness and building deterioration, increasing occupants' exposure to mold and other biological contaminants and emissions from building materials, as well as outdoor environmental pollutants, due to breakdown of the protective building envelope.
- Temperature increases may affect the emergence, evolution and geographic ranges of pests, infectious agents and disease vectors. This may lead to shifting patterns of indoor exposure to pesticides as occupants and building owners respond to new infestations.
- Warmer average temperatures may lead to changes in occupant behavior that may create health risks. Moreover, residents may weatherize buildings to increase comfort and indoor environmental quality in addition to saving energy. Although in general, these actions should be encouraged, this may lead to a reduction in ventilation and an increase in indoor environmental pollutants unless measures are taken to preserve or improve indoor air quality.[14]

These impacts may increase public health risks, particularly to the young, the elderly, and other disproportionately impacted populations.

Climate change may alter the effects of and strategic priorities within EPA's regulatory and voluntary programs to help restore the stratospheric ozone layer. The interactions between the changing climate and ozone layer are complex. Climate change affects the ozone layer through changes in chemical transport, atmospheric composition and temperature. In turn, changes in stratospheric ozone can have implications for the weather and climate of the

troposphere. Stratospheric ozone depletion and increases in global tropospheric ozone that have occurred in recent decades have differing contributions to climate change. Additionally, climate change may exacerbate the health effects of ozone layer damage at some latitudes and mitigate them at others.[15] Ozone depletion and climate change are also linked because both ozone depleting substances and most of their principal substitutes are significant greenhouse gases. While the science continues to evolve, potential climate change impacts are included in the planning and implementation of the Agency's programs to protect stratospheric ozone.

Scientific understanding related to ways that climate change may affect the interactions of sulfur, nitrogen, and mercury deposition with ecosystems is evolving. While there is limited scientific evidence on this topic, additional research is underway to better understand how patterns in the atmospheric deposition of sulfur, nitrogen, and mercury with projected changes in the climate and carbon cycle will affect ecosystem growth, species changes, surface water chemistry, and mercury methylation and bioaccumulation.[16] The potential impacts could have consequences for the effectiveness of ecosystem protection from Agency emissions reduction programs.

2.2.2 Goal 2: Protecting America's Waters

The nation's water is the lifeblood of our communities, supporting our economy and way of life, and is the basis of all ecosystems.

EPA works with its state, local and tribal partners to protect and restore the nation's waters. Together we protect public health by reducing human exposure to contaminants in drinking water, fish and shellfish, and recreational waters. We protect and restore watersheds and aquatic ecosystems by protecting the quality of rivers, lakes, streams, wetlands and coastal and ocean waters. EPA's programs include support for drinking water, wastewater and stormwater infrastructure; setting standards for protecting water quality and regulating municipal, and industrial discharges of pollutants to waters; working to control nonpoint sources of pollution; monitoring conditions of surface water, watersheds, beaches and coastal and ocean waters; and implementing programs to preserve healthy watersheds and to restore impaired waters.

Climate change alters the hydrological cycle, changing the background conditions in which natural and man-made systems function. Changes have already been observed and are expected to continue, such as warming air and water, changes in the location and amount of rain and snow, increased intensity of rainfall and tropical storms, sea level rise, changes in ocean chemistry, and indirect effects related to energy generation and fuel production.[17]

While there is relatively high confidence in our ability to project temperature increases due to climate change, projected changes in precipitation and its effects on hydrology at the local scale are less certain. Therefore, a key challenge will be how to help local decision makers understand potential local impacts, and how to make long-term plans under a new range of uncertainty about future hydrologic conditions. Water resource managers will also need to consider the local impacts of climate change as they grapple with other challenges– including population growth, land use changes, economic constraints, and a variety of stressors to the quality and quantity of our nations waters.

Climate Change Impacts on Water

Climate change impacts include too little water in some places, too much water in other places, and degraded water quality. Some locations will be subject to all of these conditions during different times of the year. Water cycle changes are expected to continue and will affect water infrastructure, energy production and use, human health, transportation, agriculture, and ecosystems.

Source: USGCRP, "Global Climate Change Impacts in the U.S."(2009), Water Sector, at: http://globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/water-resources

Photo: www.water.ky.gov

Protection of water quality, and restoration and protection of watersheds, wetlands, oceans, and aquatic ecosystems will be greatly challenged by changes in climate throughout the United States. EPA, working with its state, tribal, and local partners, is responsible for developing and implementing a portfolio of regulatory and non-regulatory programs to protect and improve water quality in the nation's watersheds and estuarine, coastal and ocean waters. As better information is developed for local decision making, changes may be needed in how EPA and our partners implement water quality programs, including Water Quality Standards, Total Maximum Daily Loads (TMDL), Effluent Guidelines, National Pollutant Discharge Elimination System (NPDES), nonpoint pollution control programs, and other watershed management programs.

The potential vulnerabilities of EPA's water quality programs to climate change include:

- Higher air and water temperatures will increase pollutant concentrations and lower dissolved oxygen levels, potentially resulting in additional water bodies not meeting water quality standards and being listed as impaired.
- Higher air and water temperatures combined with nutrient pollution will increase the incidence of Harmful Algal Blooms, threatening ecosystems and public health.

- Warmer waters and other ecological shifts will threaten aquatic habitats and aquatic species, such as cold water fisheries, with the potential for significant impacts on subsistence fishing tribes.
- Increased intensity of rainfall events and storms will cause an increase in the number of sewer overflows and wastewater bypasses, fouling streams.
- Increased intensity of rainfall events and storms will cause increased pollutant loads in runoff, and the velocity of runoff will scour and erode creek beds.
- Areas experiencing periods of less precipitation, drought, lower stream flow and limited ground water recharge will result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments. Competition will be exacerbated for limited water supplies for municipal, industrial, energy, agricultural, and ecological uses.
- Areas with increased intensity of drought or that may experience increases in events such as wildfires may see alterations in the structure and function of wetlands and watersheds.
- Sea-level rise combined with coastal development will challenge the ability of coastal wetlands to migrate.
- Ocean acidification resulting from the absorption of CO_2 will continue to stress coral reefs.
- As the nation pursues alternative strategies for producing energy and fuel, both to reduce greenhouse gases and to increase energy independence, local or regional demand for limited water supplies for energy and fuel production may increase, placing additional pressures on water quality programs.
- The ecological effects of climate change, such as shifts in aquatic species and their habitats or the quality of snowpack, are likely to affect the economic and cultural practices of tribal communities.
- Sea level rise and coastal surges increase erosion that can affect coastal zones that support aquatic species.

Climate change will have a significant impact on water infrastructure. In most of the United States, we enjoy the benefits of clean and safe water resulting from an extensive network of drinking water, wastewater and stormwater infrastructure. EPA recognizes that this infrastructure is aging and is being further taxed by the impacts of climate change. Additionally, as state, tribal and local governments face more demands for increasingly limited resources, the ability to respond to these growing infrastructure pressures becomes more complicated. Climate change will create vulnerabilities in the nation's infrastructure system in the following ways:

- Changes in rainfall patterns beyond the design capacity of drinking water, wastewater and stormwater infrastructure, or flooding due to increased intensity of storms, could overwhelm and damage infrastructure.
- Sea-level rise could affect water infrastructure, including drinking water intakes and wastewater outfalls, and could push saline water into coastal aquifers. Combined with tropical storms and associated storm surges, the integrity of coastal water infrastructure systems may be at increased risk.
- Drinking water and wastewater utilities need to take an "all hazards" approach to planning for emergencies and extreme weather events, which may be impacted by climate change. In order to support the efforts of such utilities, it is important for EPA guidance, tools, and technical support to also support this all hazards approach.
- Vulnerable and economically deprived communities may be particularly at risk, both for access to clean and safe water as well as for their ability to respond to emergencies during extreme events.

Climate change will affect the quality and availability of drinking water supplies. More than 290 million people living in the United States rely on the safety of tap water provided by public water systems that are subject to national drinking water standards. EPA ensures that these water systems are sustainable and secure by developing and revising water standards, ensuring compliance with these standards, and protecting sources of drinking water from contamination.

EPA's role in drinking water is solely to protect the quality of what Americans consume. EPA does not have a direct role in ensuring adequate water supplies. However, changes in water quantity may affect water quality. The issue of water quantity is a significant issue for many communities, and will be increasingly so especially in the west and southeast. We can expect increasing numbers of communities grappling with increased drought, reduced snow pack, and challenges to water supplies. Such communities will be faced with managing competition between municipal supplies, energy production, industrial use, agricultural use, and ecological needs, and it is likely that EPA and our partners will be called on to address water quality issues

in this context. EPA has identified a number of areas where its programs designed to protect drinking water are vulnerable to climate change. These vulnerabilities include:

- Higher air and water temperatures will promote increased growth of algae and microbes, which will increase the need for drinking water treatment.
- Changes in water temperature can lead to increased risk from invasive species that can disrupt water and waste water systems.
- Increased stormwater runoff will wash sediment and other contaminants into drinking water sources, requiring additional treatment.
- Sea-level rise could increase the salinity of both surface water and ground water through saltwater intrusion, encroaching upon coastal drinking water supplies.
- Reduced annual precipitation or increased intensity and duration of drought in some regions will affect water supplies, causing drinking water providers to reassess supply plans and consider alternative pricing, allocation and water conservation options.
- Warming temperatures will cause precipitation in some areas to increasingly fall as rain rather than snow. Combined with seasonal shifts in springtime snowmelt, areas relying on snowpack to serve as a water 'reservoir' may need to develop new plans for ensuring water supplies.
- In areas with loss of snowpack or less precipitation, water demand may shift to underground aquifers or prompt development of underground storage of treated water, which will require EPA to assure the safety of such underground sources of drinking water.

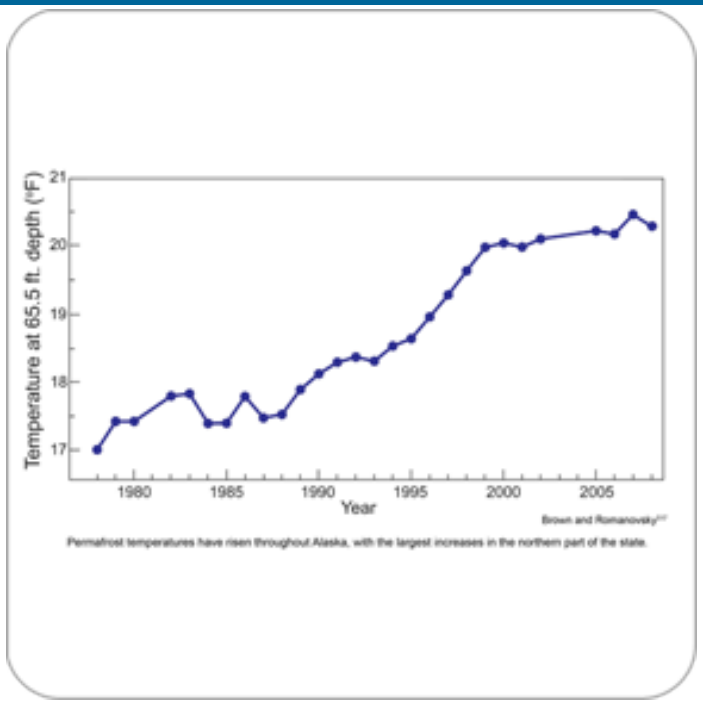
2.2.3 Goal 3: Cleaning Up Communities and Advancing Sustainable Development

EPA's highest priorities under this goal are to prevent and reduce exposure to contaminants and accelerate the pace of cleanups across contaminated sites and properties, including Brownfields, Resource Conservation and Recovery Act (RCRA) Corrective Action Facilities, Superfund sites and Leaking Underground Storage Tanks.[18]

A range of major climate change stressors may affect contaminated sites, which in turn could affect how EPA addresses contamination and manages cleanups. In order to understand the potential impacts to these sites, EPA has begun to use broad screening analysis mapping to identify the sites most likely threatened by climate change impacts. EPA has a general understanding of the potential vulnerabilities at these sites. Key vulnerabilities identified by EPA include:

Flooding from more intense and frequent storms and sea-level rise, as well as melting permafrost, may lead to contaminant releases from Corrective Action sites, Superfund sites, Brownfield sites and landfills. Inundation and flooding may lead to transport of contaminants through surface soils, ground water, surface waters and/or coastal waters. Saltwater intrusion and increased ground water salinity in coastal aquifers may also increase the permeability of clay liners installed at waste sites, such as landfills, allowing contaminants to spread to nearby properties. Melting permafrost may allow contaminants to migrate and may cause land shifting and subsidence. These contaminant releases may pose an increased risk of adverse health and environmental impacts.

Increased Temperatures May Represent a Significant Risk for Waste Sites in Alaska



Temperature increases associated with climate change may lead to the melting of permafrost – which acts as a barrier to the transport of contaminants – in northern latitudes. With increased temperatures, thawing could allow contaminants to migrate more freely to adjoining areas.
Source: Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf .

Changes in precipitation patterns and temperature may adversely affect the performance of the cleanup remedy and alter the efficacy of cleanups. To the extent that climate change leads to more prolonged droughts, water-intensive remedies may be impacted and the risk of wildfires spreading to contaminated sites may increase. Changes in precipitation may affect the rate at which vegetation grows at various sites and may affect phytoremediation and ecological revitalization efforts. The impacts may be positive or negative, depending on conditions at each site. Ground water processes may also be altered, resulting in potential adverse impacts on the performance and cost of remediation. To the extent that temperatures increase with climate change, contaminants at cleanup sites may become more volatile, increasing risks for local populations. The extent of this effect will depend on the contaminants at individual sites.

Climate change may also affect the ability of EPA's emergency management workforce to respond to natural disasters. For example, the release of hazardous substances or chemicals through flooding or storm surge creates demand for emergency response personnel and assets to monitor environmental conditions and respond. EPA has several programs to respond and minimize exposure to human populations and ecosystems, including the Oil Spill Response Program and Superfund Emergency Response. These programs provide an institutional framework to use and build upon when responding to climate change impacts. When responding to emergencies, EPA often coordinates with other Federal agencies, as well as state, tribal and local organizations. These organizations will be important partners in EPA's work responding to natural disasters of increased severity and frequency.

Flooding from more intense and frequent storms and sea-level rise may disrupt existing waste management networks Flooding from sea level rise or severe storms may disrupt the transportation system in place to handle waste. For example, flooding may disrupt the pick-up of waste in neighborhoods and business or the work performed at transfer stations. Cities with transfer stations along waterways are at particular risk. A major storm event may increase the amount of solid waste generated and lead to the release of fuel or hazardous materials. Smaller entities with hazardous materials may lack resources for emergency planning, which may increase the risk of abandoned hazardous materials during a flooding or storm event. Changes in precipitation may impact waste management practices such as composting by affecting biological processes.

2.2.4 Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution

A major component of EPA's mission is ensuring the safety of chemicals. Increasingly, the chemicals used to make our products, build our homes, and support our way of life end up in the environment and in our bodies. A changing climate can affect exposures to a wide range of chemicals. Exposures may change because of changing environmental conditions or changing use patterns. EPA's efforts to reduce exposures may be affected.

Impact of Climate Change on Pesticide Exposure Models

Many of EPA's tools and models for examining exposure to chemicals rely on inputs that are sensitive to climate data (*e.g.*, changing weather patterns, temperatures, stream flow rates, air currents and precipitation rates). EPA is in the early stages of examining the vulnerability of its models to climate change, beginning with a review of its pesticide exposure models.

Source: U.S. EPA, Memorandum: Transmittal of Meeting Minutes of the FIFRA Scientific Advisory Panel (SAP) held December 7, 2010, on Pesticide Exposure Modeling and Climate Change, March 3, 2011. SAP minutes, No. 2011-01.

EPA relies heavily on tools and models to help estimate exposures to chemicals when monitoring data are unavailable. The Agency is in the early stages of examining the ways in which its models may have to be updated to account for climate change. It has begun with a review of the potential implications of climate change for its current approaches to evaluating pesticide exposures to people and the environment.[19] These approaches are currently and will continue to be used to assess exposures to the general population, as well as children, agricultural workers and other groups who may be disproportionally affected.

EPA consulted with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Scientific Advisory Panel (SAP) to provide guidance on its model review and preliminary conclusions, and on sources of information that may help fill knowledge gaps. The SAP concluded that climate change is likely to affect future decisions because of its impact on pest pressure, how and where pesticides are used, and the quantity of pesticides used. Since EPA reviews pesticide registrations every 15 years using assessment methodologies that are conservative and protective of human health and the environment, it is expected that the assessments, and decisions based on them, will remain protective. However, the SAP also concluded that weather data used in models that estimate pesticide exposure are becoming dated, and thus may not adequately reflect recent changes in climate. Some of EPA's exposure models that contain climate-related variables may have to be updated as weather patterns, temperatures, stream flow rates, air currents, precipitation rates, and other climate variables continue to change. The Agency has not yet conducted vulnerability assessments of the potential impacts of climate change on exposures of people and the environment to other types of chemicals. For example, there may be increased risk of exposure to lead and asbestos as homes, buildings, and other community infrastructure are damaged by fires, high winds, and flood events. Similarly, climate change may lead to the development of new chemicals submitted for Agency review that have uses for water purification and desalinization, wastewater treatment, antimicrobial disinfection, and disease prevention. EPA will explore the need for future assessments that evaluate potential impacts like these.

Climate Change and FIFRA

An increase in the frequency of emergency pest problems could lead to an increase in the need for emergency exemptions under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) if currently registered pesticides are ineffective. This would allow for the use of chemicals which are not registered.

2.2.5 Goal 5: Enforcing Environmental Laws

EPA protects human health and the environment through vigorous and targeted civil and criminal enforcement and by ensuring compliance with environmental laws. Climate change may affect decisions related to the enforcement of environmental laws. For example:

- The risks posed by climate change may affect decisions by EPA about where resources should be allocated to ensure compliance with rules or regulations it believes to be priorities. These enforcement priorities may be derived from a variety of sources, ranging from the Administrator's identified goals for EPA, to program-specific guidance memoranda to assist enforcement personnel in selecting appropriate enforcement mechanisms depending on site-specific circumstances.
- A flood, hurricane or wildfire can swiftly divert the Agency's focus.[20] If climate change leads to more intense weather events and increases EPA's involvement in disaster response and remediation, then enforcement efforts (as well as efforts in other EPA programs) could be affected due to a scarcity of available staff and resources.

2.2.6 EPA's Facilities and Operations

EPA must ensure the security of its personnel, the safe and continued operation of its buildings and other critical assets (*e.g.,* vehicles), and the integrity of its grants and procurement systems. In the event of any catastrophic weather event, EPA's people, buildings and operations could be affected. Based on the potential for climate change to alter water supplies and increase the frequency and severity of extreme weather events, EPA has identified the following vulnerabilities to the Agency's continued safe and efficient operations:

Increased frequency and severity of extreme weather events may affect Agency facilities, personnel safety, physical security and emergency communications. Some extreme weather events are expected to become more commonplace as the climate changes, increasing the occurrence of flooding, heat waves, lightning and high winds. An increase in these events would increase the risk to EPA's personnel in the field and EPA facilities. EPA has begun to assess these vulnerabilities and has identified the following areas of potential impact:

- Severe weather and flooding could cause damage to EPA facilities, especially in coastal areas. The Agency has already seen such damage to its Gulf Ecology Division Laboratory in Florida. Sea Level rise could also impact low lying coastal facilities and their access roads, especially when coupled with storm surges and flooding.
- Extreme weather events, including severe winds and lightning could cause damage to EPA's long-term environmental monitoring assets, particularly in coastal and flood prone areas. The Agency has already seen such damage to equipment at sites in the Clean Air Status and Trends Network and the National Atmospheric Deposition Program.

EPA's Gulf Ecology Division Laboratory

When Hurricane Ivan tore through Florida's Gulf Coast in September 2004, it served as a powerful reminder to EPA's Gulf Ecology Division Laboratory facilities that intelligent facility design in the 21st century requires the highest standards for safety and durability, as well as sustainability. Located on Sabine Island, a 16-acre patch of land off the coast of the Florida Panhandle, the laboratory campus was especially vulnerable to the hurricane's devastating winds and rain. In the wake of the storm, six of the 40 buildings at the campus were destroyed and had to be temporarily replaced with modular structures.

In 2008, these buildings were permanently replaced with a new Computational and Geospatial Sciences Building. This facility was designed to meet the Florida Building Code, which requires stringent hurricane mitigation techniques. It has also earned the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) Silver 2.2 certification for New Construction. This building meets the demands of its environment in a sustainable manner.

(Source: "Sustainable Facilities at EPA: Computational and Geospatial Science Building, Gulf Breeze, Florida," U.S. Environmental Protection Agency, EPA-200-F-09-002, Washington, DC, 2009.)

- Seasonal temperature changes and changing weather patterns can affect air quality and the general comfort of outdoor activities. Extreme heat, bad air quality or other weather conditions exacerbated by climate change may increase the health risks of EPA employees and contractors engaged in field work, such as sampling, remediation and inspections.
- Severe winds, lightning and other extreme weather events could cause power outages that disrupt EPA's security systems, outdoor lighting and emergency communication systems. Some of these systems are not linked to an uninterruptible power supply or backup

generators. Outdoor lighting and security cameras are also vulnerable to direct impacts from high winds and other severe weather.

An increase in the number of extreme weather events could affect planning and management of emergency operations. During and after extreme weather events, EPA employees and contractors are dispatched to assess impacts to the environment and human health. The Agency also awards acquisitions and grants to support stakeholder emergency response. An increase in extreme weather events could result in the following impacts:

- An increase in the occurrence of extreme weather events may affect the availability of the Agency's personnel and resources to support the dispatch of emergency management personnel to assess environmental damage and test sites for air quality, water quality and other human health and environmental threats. At the same time, EPA personnel would increasingly be drawn away from their normal day-to-day activities to respond to extreme weather events or emergencies.
- EPA's Strategic Sustainability Performance Plan (SSPP) addresses issues related to resiliency in the Agency's suppliers, supply chain, and real property procurement under Goal 2: Sustainable Buildings and Goal 6: Sustainable Acquisition. Climate change adaptation, mitigation, and resiliency planning are incorporated into sustainable procurement efforts through the Agency's Balanced Scorecard Initiatives, and acquisition, real property and leasing decisions incorporate sustainability through the *GreenCheck* process. Facility locations and siting decisions are driven by the National Environmental Policy Act (NEPA) process, which reviews all environmental aspects of new facilities, sites, and construction.
- Changing weather patterns and weather events may increase the demand for protective gear and appropriate vehicles and vessels to meet the demands of extreme working conditions during research, field work, and emergency management.
- EPA continues to award and manage acquisitions and grants during severe weather events; both those that are required for ongoing needs and those required for emergencies. An increase in such events could affect EPA's ability to assess contractor readiness and capabilities, process and award contracts, provide financial assistance, enter into interagency agreements and train essential personnel.

Changing water supplies may pose a risk to the quality of water used at EPA facilities. Shifts in snowpack in some regions of the country could mean a change in the disposition of water supplies and potentially compromise the quality of water available to the Agency. EPA laboratories require water to conduct experiments and meet building cooling requirements. Water shortages and quality issues could have significant impacts on the Agency's ability to manage its facilities and conduct important research, particularly in drought-prone regions.

2.3 Climate Change Impacts on the Most Vulnerable Communities

Climate change will have a disproportionate effect on particular geographic locations, communities, and demographic groups.

The impacts of climate change raise environmental justice issues. Environmental justice focuses on the health of and environmental conditions affecting minority, low-income, and indigenous populations. EPA places emphasis on these populations because they have historically been exposed to a combination of physical, chemical, biological, social, and cultural factors that have imposed greater environmental burdens on them than those imposed on the general population. Climate change is likely to exacerbate existing and introduce new environmental burdens and associated health impacts in communities dealing with environmental justice challenges across the nation.[21] EPA's *Policy Statement on Climate Change Adaptation* calls on the Agency to focus on incorporating consideration of environmental justice into the design and evaluation of adaptation strategies.

The populations most vulnerable to climate change often include, but are not limited to, the communities that are the focus of EPA's environmental justice program. Children, the elderly, the poor, the infirm, and tribal and indigenous populations are among the most vulnerable.[22] For example, children living and playing outdoors in regions with higher ozone levels resulting from increased temperature will be at higher risk for experiencing asthma symptoms and exacerbations. The elderly are more vulnerable to heat stress because they are often in poorer health, have debilitating chronic diseases and are less able to regulate their body temperature during periods of extreme heat. They may also be taking medications that increase risk for dehydration and may live alone or have fewer social contacts, which may further exacerbate their vulnerabilities.[23] Economic constraints can also place low-income households at disproportionate risk to extreme heat events due to lack of air conditioning or failure to use air-conditioning to cut down on associated energy costs.[24]

EPA has a special obligation to work consultatively with the tribes to help them as sovereign governments address their climate adaptation concerns. EPA's 1984 *Policy for the Administration of Environmental Programs on Indian Reservations* directs the Agency to work "in a manner consistent with the overall Federal position in support of Tribal 'self-government' and 'government-to-government' relations between Federal and Tribal Governments."

EPA is committed to integrating environmental justice and climate adaptation into its programs, policies, rules and operations in such a way that to the extent possible, it effectively protects all demographic groups, geographic locations and communities, and natural resources that are most vulnerable to climate change. The Agency will place special emphasis on overburdened populations that are least able to help themselves, and work in partnership with them to empower them to effectively adapt to climate change.

Coastal Climate Change Impacts on Low-Income Minority Communities

Climate change will affect certain groups of people more than others, depending on where they live and their ability to cope with different climate hazards. For example, a combination of sea level rise and land subsidence in coastal Louisiana has increased the area's vulnerability to storm surge and hurricane damage.[1,2] Hurricane Katrina , though not necessarily directly a result of climate change, provides an illustrative example of how storm surges can result in catastrophic effects for coastal communities and how social vulnerabilities can be manifested in the form greater vulnerability for lower income minority communities and unequal access to resources. Barriers for the community to avoid the risks posed by Katrina included the lack of material resources, such as cash and access to transportation, for evacuation purposes.[3,4,5] These factors contributed to disproportionate impacts on minority and low-income communities in New Orleans. For example, African Americans were overrepresented in mortality rates in all age categories compared to their proportion of the pre-Katrina population.[6] The impacts of Hurricane Katrina were devastating and highlight the environmental as well as social vulnerabilities of coastline communities.

1. Sources:USGCRP (2009). *Global Climate Change Impacts in the United States* . Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.
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Climate Change Impacts on Tribal Communities

Indigenous people are among the most vulnerable communities in North America.[1] Tribes are more vulnerable to climate change impacts because of their dependence upon a specific geographic area for their livelihoods, the degree to which those geographic areas embody climate-sensitive environments, and their unique cultural, economic, or political characteristics and contexts. Also, tribes generally have fewer resources to prepare for, respond to, and recover from natural hazards, including those related to climate change.[2] The disproportionate vulnerability of tribes to climate change affects EPA's mission to protect human health and the environment in Indian country.

Examples of the impacts climate change is already having on tribes include:

- **The coastal Inupiat village of Shismaref Alaska is one of many coastal villages in Alaska facing relocation due to threats from flooding and erosion related to a rise in sea level and a decrease in sea ice. Sea walls have been broken and homes washed away. Residents have decided to relocate farther inland for safety, giving up their traditional fishing, sealing, and home-building sites.[3]**
- **Drought is perhaps the most pervasive climate-induced weather impact on tribes. Water is at the heart of many tribal cultures and the foundation of their livelihoods, economies, subsistence, and treaty rights. Water is essential to the sustainability of the fish, wildlife, and plants on which tribes rely. The recent trend toward more severe and frequent droughts, especially in the American Southwest, threatens the very underpinnings of tribal communities. The Southwest is already in the midst of a 10-15 year drought, and climate projections suggest the Southwest may transition to a more arid climate on a permanent basis over the next century and beyond.[4] In fact, climate observations indicate that this transition may have already begun.[5]**
- **Moose, a species important to many tribes in the Great Lakes region, are suffering the impacts of warmer weather. In a recent study of moose at the southern edge of their range in northwest Minnesota, researchers found that over the past 40 years, declines in the moose population are related to increases in mean temperature with winter and summer temperatures increasing by an average of 12°F and 4°F, respectively, over this period. Lack of food resources and increased exposure to deer parasites associated with warmer summer temperatures appear to be the primary causes of more decline.[6]**

Sources:

1. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds). Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. "Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability." *Cambridge University Press*, Cambridge, United Kingdom and New York, NY, USA, 2007.

2. Cutter, S.L. and C. Finch. 2008. "Temporal and spatial changes in social vulnerability to natural hazards." *Proceedings of the National Academy of Science* 105(7): 2301-2306.

3. National Research Council, *Adapting to the Impacts of Climate Change*, America's Climate Choices: Panel on Adapting to the Impacts of Climate Change, The National Academies Press, Washington, DC, 2010.

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5. Seager, R., et al., 2007. Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America. *Science*, 316: 1,181-1,184.

6. U.S. Fish and Wildlife Service. *Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change* http://www.fws.gov/home/climatechange/pdf/CCStrategicPlan.pdf

2.4 Summary of Key Areas of Known Vulnerability

The current list of known vulnerabilities of EPA's programs to climate change are summarized in the table at the end of this report. The vulnerabilities listed in the table help to guide the Agency in identifying areas to focus its adaptation planning efforts. For several of the vulnerabilities, current scientific understanding is that the climate impact is likely or very likely to occur and EPA's best judgment is that there is a high likelihood the program will be affected. The Agency, as part of its efforts to mainstream adaptation into its programs (addressed in Part 3 of this document), will conduct a more comprehensive vulnerability assessment to determine which programs and areas are most suitable to initiate action. This qualitative assessment has been done at a national level. It identifies vulnerabilities to entire programs within EPA to help focus the Agency's climate adaptation efforts. However, there is a "regional texture" to the impacts of climate change. The severity and importance of known vulnerabilities will vary across regions. EPA's Program and Regional Climate Change Adaptation Implementation Plans capture the regional differences and identify the vulnerabilities of greatest importance, including identifying the most vulnerable people and places within these programs. The Implementation Plans describe how climate change adaptation will be integrated into Program and Regional planning and work in a manner consistent and compatible with their own circumstances and objectives.

Endnotes

[1] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[2] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[3] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[4] *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Parry, M.L., Canziani, O. F., Palutikof, J. P., van der Linden, P. J., et. al., contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change 2007, "Summary for Policy Makers" (2007), 11-12.

[5] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), 89–106, http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[6] U.S. Environmental Protection Agency, *Policy Statement on Climate-Change Adaptation*, June 2, 2011, http://epa.gov/climatechange/Downloads/impacts-adaptation/adaptation-statement.pdf.

[7] While the discussion of vulnerabilities is organized by goal, some of the impacts of climate change are expected to cut across goals. For example, climate change may increase the number of weather-related emergencies to

which the Agency is called to respond, potentially drawing staff from multiple locations and program areas. Staff participating in emergency response work would be unavailable to complete their normal program responsibilities. Climate change is also expected to affect many of the models that EPA programs and the states use to make environmental decisions.

[8] Denman, K.L., et al. (2007). Couplings Between Changes in the Climate System and Biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[9] U.S. EPA (2009). Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone. An Interim Report of the U.S. EPA Global Change Research Program. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-07/094F.

[10] Katsouyanni, K., et al.; HEI Health Review Committee (2009). Air pollution and health: a European and North American approach (APHENA). Research Report Health Effects Institute. 2009 Oct;(142):5-90.

[11] U.S. EPA. Air Quality Criteria for Ozone and Related Photochemical Oxidants (2006 Final). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-05/004aF-cF, 2006.

[12] Committee on Environment and Natural Resources, "Scientific Assessment of the Effects of Global Change on the United States" (Committee on Environment and Natural Resources of the National Science and Technology Council, U.S. Climate Change Science Program, 2008), http://www.climatescience.gov/Library/scientific-assessment/Scientific-AssessmentFINAL.pdf.

[13] C.B. Field et al., "North America," Chapter 14 in *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2007).

[14] Institute of Medicine, *Climate Change, the Indoor Environment, and Health* (Washington, DC: The National Academies Press, 2011).

[15] World Meteorological Organization, *Scientific Assessment of Ozone Depletion: 2010*, Global Ozone Research and Monitoring Project—Report No. 52 (Geneva, Switzerland, 2011).

[16] Burns, D.A., Lynch, J.A., Cosby, B.J., Fenn, M.E., Baron, J.S., US EPA Clean Air Markets Div., 2011,National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment, National Science and Technology Council, Washington, DC, 114 p.

[17] "Global Climate Change Impacts in the U.S."(2009), Water Sector, at: http://globalchange.gov/publications/reports/scientific-assessments/us-impacts/climate-change-impacts-by-sector/water-resources.

[18] There may be additional sites not included in this list that occur as a result of emergency response activities or unanticipated events.

[19] Conclusions from EPA consultations with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Scientific Advisory Panel (SAP), a panel of external experts established under FIFRA to provide the Agency with advice on pesticide-related science matters.

[20] U.S. Environmental Protection Agency, "FY 2011-2015 EPA Strategic Plan, Achieving our Vision" (2011), 43, http://epa.gov/planandbudget/strategicplan.html.

[21] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), 89–106, http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[22] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), 89–106, http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

[23] G. Luber et al., "Climate Change and Extreme Heat Events," *Am J Prev Med* 35(5), August 2008.

[24] Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., *Global Climate Change Impacts in the United States* (New York, NY: Cambridge University Press, 2009), 89–106, http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

Part 3: Mainstreaming Climate Change Adaptation in EPA

3.1 Building Adaptive Capacity

EPA's *Policy Statement on Climate-Change Adaptation* acknowledges the importance of adapting to climate change if the Agency is to continue fulfilling its statutory, regulatory and programmatic requirements. It is vital that the EPA anticipate and plan for future changes in climate and incorporate considerations of climate change into many of its programs, policies, rules and operations to ensure they remain effective under future climatic conditions.[1]

EPA will continue to protect human health and the environment, but in a way that accounts for the effects of climate change.

Climate change is one of many factors that can influence the effectiveness of EPA's activities over time. It is essential the Agency account for climate change as it designs its programs, policies and rules, in the same way other factors such as population growth and economic development are regularly considered. EPA will integrate, or mainstream, climate change adaptation by strengthening the adaptive capacity of its own staff. EPA will empower them to account for climate change in the normal course of doing business. It will increase staff's awareness of ways that climate change may affect their ability to implement effective programs, and provide them with the necessary data, information and tools to integrate climate adaptation into the work they do.

EPA will work to strengthen partners' adaptive capacities. The Agency will work with its state, tribal and local partners and will strive to ensure that to the greatest extent possible, their human health and environmental protection programs are resilient to climate change. This is particularly important since the Agency authorizes many states and tribes to implement various environmental programs. Also, EPA's efforts to help communities become more environmentally and economically sustainable could be affected by the impacts of climate change. EPA will work with its partners in states, tribes and communities to look for opportunities to create co-benefits from implementation of adaptation plans. For instance, where communities take steps to improve storm water system resilience by reducing combined sewer overflows, these actions may also reduce energy use for water. EPA will need to ensure that its tools, research, and technical assistance evolve to help communities and other entities take projected climate changes into account as they plan development. International partnerships and collaboration on adaptation will also be important to address the transboundary impacts of climate change.

The Agency's investment in building adaptive capacity is an ongoing effort. It will require a sustained, long-term commitment to empower EPA's workforce and partners by providing the information and tools necessary to account for climate change.

3.2 Guiding Principles for Adaptation at EPA

EPA has adopted a set of principles to guide all of its efforts to integrate climate adaptation into its programs, policies and rules. The principles affirm EPA's approach of integrating climate adaptation into existing programs and activities to ensure their effectiveness as the climate changes. They uphold EPA's core values of using the best available science, protecting populations and locations most vulnerable to climate change, and using sensible analytic methods and approaches for developing and implementing adaptation strategies. EPA has an important and unique role in climate adaptation, but is only one partner in a broader effort that must include multiple levels of government, as well as private, nongovernmental, and international partners. The principles call for ongoing evaluation of the effectiveness of climate

Guiding Principles for Adaptation

- **Adopt integrated approaches: Adaptation should be incorporated into core policies, planning, practices and programs whenever possible.**
- **Prioritize the most vulnerable: Adaptation plans should prioritize helping people, places and infrastructure that are most vulnerable to climate impacts and be designed and implemented with meaningful involvement from all parts of society.**
- **Use best-available science: Adaptation should be grounded in the best-available scientific understanding of climate change risks, impacts and vulnerabilities.**
- **Build strong partnerships: Adaptation requires coordination across multiple sectors and scales and should build on the existing efforts and knowledge of a wide range of public and private stakeholders.**
- **Apply risk-management methods and tools: Adaptation planning should incorporate risk-management methods and tools to help identify, assess and prioritize options to reduce vulnerability to potential environmental, social and economic implications of climate change.**
- **Apply ecosystem-based approaches: Adaptation should, where relevant, take into account strategies to increase ecosystem resilience and protect critical ecosystem services on which humans depend to reduce vulnerability of human and natural systems to climate change.**
- **Maximize mutual benefits: Adaptation should, where possible, use strategies that complement or directly support other related climate or environmental initiatives, such as efforts to improve disaster preparedness, promote sustainable resource management, and reduce greenhouse gas emissions including the development of cost-effective technologies.**
- **Continuously evaluate performance: Adaptation plans should include measureable goals and performance metrics to continuously assess whether adaptive actions are achieving desired outcomes.**

(Source: The White House Council on Environmental Quality, "Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy," October 5, 2010, http://www.whitehouse.gov/sites/default/files/microsites/ceq/Interagency-Climate-Change-Adaptation-Progress-Report.pdf.)

change adaptation approaches, recognizing that the Agency will continue to learn how to adapt effectively over time.

3.3 Agency-wide Priorities

EPA has identified priority actions it will take to begin integrating climate change adaptation into its programs, policies, rules and operations. These priorities represent EPA's commitment to address the known vulnerabilities of its mission to climate change, and to continue to identify other vulnerabilities its programs may have to climate change.

Agency-wide Priorities

- **Fulfill Strategic Measures in *FY 2011–2015 EPA Strategic Plan***
- **Protect Agency facilities and operations**
- **Factor legal considerations into adaptation efforts**
- **Strengthen adaptive capacity of EPA staff and partners through training**
- **Develop decision-support tools that enable EPA staff and partners to integrate climate adaptation planning into their work**
- **Identify cross-EPA science needs related to climate adaptation**
- **Partner with tribes to increase adaptive capacity**
- **Focus on most vulnerable people and places**
- **Measure and evaluate performance**
- **Develop and Implement Program and Regional Office *Implementation Plans***

3.3.1 *Priority:* Fulfill Strategic Measures in *FY 2011-2015 EPA Strategic Plan*

EPA expects that its understanding of how to integrate climate adaptation into its programs, policies, rules and operations will improve over time. The FY 2011–2015 EPA *Strategic Plan* identified three initial mechanisms through which the Agency will begin mainstreaming climate adaptation by 2015:[2]

Strategic Measures in *FY 2011-2015 EPA Strategic Plan*

By 2015:

1. **Integrate climate change adaptation into rulemaking processes.**
2. **Integrate climate adaptation into financial mechanisms.**
3. **Develop decision-support tools.**

1. **Integration of climate change adaptation into rulemaking processes:** EPA will integrate climate change trend and scenario information into five rulemaking processes to further EPA's mission, consistent with existing authorities. The integration of climate adaptation into Agency rulemaking processes will help ensure the rules are effective as the climate changes.[3] A variety of "entry points" can be considered, including the development of the rule itself; related policy and guidance development; and post-rule permitting, monitoring and enforcement.

   EPA will enhance the ability of rule makers to address the implications of climate change through updates to the Action Development Process (ADP). This process was developed by EPA to guide the Agency's rulemaking activities from the start of the rulemaking process through the analysis of regulatory options to the final publication of a regulation. EPA will integrate climate adaptation into the ADP by:

   - **Identifying process points where climate change adaptation considerations need to be identified, analyzed and discussed.** The rulemaking process[4] includes opportunities to discuss climate change adaptation considerations, both internally and with stakeholders. An Analytic Blueprint spells out a workgroup's plan for data collection and analyses to support development of a specific action. The development of an Analytic Blueprint provides an early opportunity to articulate any climate change adaptation issues that need analysis.
   - **Developing guidance documents and training rule writers to understand the implications of climate change impacts.** EPA has guidance on addressing children's health and environmental justice for

Progress is already being made to fulfill the Strategic Measures

EPA is already making progress to fulfill the three Strategic Measures. For example, the Agency issued guidance in October 2011 encouraging all Offices to include climate adaptation evaluation criteria into announcements of competitive funding opportunities The guidance is relevant to announcements in which the outcomes to be supported by the awards are sensitive to changes in climate (*e.g.,* ability to attain air quality standards; effectiveness of water infrastructure), or the projects being solicited would be more effective if they addressed climate change adaptation issues (*e.g.,* development of models and tools to support decision making). EPA is also making progress on integrating climate adaptation into its categorical funding mechanisms such as the Clean Water and Safe Drinking Water State Revolving Funds in the Water Program and Brownfields Restoration Grants in the Office of Solid Waste and Emergency Response.

EPA is also already developing tools to support climate adaptation planning. For example, the BASINS tool that is designed for use by regional, state, and local agencies in performing watershed and water quality-based studies now includes a Climate Assessment Tool (CAT). CAT provides a capability for understanding how water resources could be affected by a range of potential changes in climate, and the possible effectiveness of management practices for increasing resilience of water resources to climate change.

all of its rulemakings. EPA will develop a similar guide for climate change adaptation, and provide training. This will improve the regulatory work groups' understanding of climate change adaptation and how to consider it in rulemaking, when appropriate.

- **Tracking and monitoring rulemakings where climate change adaptation may be an important consideration.** To help identify rulemakings where climate change adaptation may be relevant, EPA will use its internal regulatory tracking databases to manage and report on regulatory development. This will allow EPA workgroups and stakeholders to plan and allow for integration of climate change considerations when identified in the critical process points described above.

2. **Integration of Climate Change into financial assistance mechanisms:** EPA will integrate considerations of climate change impacts and adaptive measures into five major grant, loan, contract or technical assistance programs. This will further EPA's mission, consistent with existing authorities. The integration of "climate adaptation criteria" into financial mechanisms will encourage recipients to account for climate change.

   Although this Strategic Measure is limited to a goal of five major financial assistance mechanisms by 2015, the ultimate goal is to integrate climate adaptation into all financial assistance agreements, where appropriate.

3. **Development and use of decision-support tools:** EPA will integrate climate change trend and scenario information into five major scientific models or decision-support tools used to implement Agency environmental management programs. The development of decision-support tools will help build the adaptive capacity of the Agency's workforce and its partners.

These three mechanisms represent different pathways through which the Agency can integrate climate change into ongoing programs and priorities, to attain desired environmental and human health outcomes and sustain them as the climate changes. EPA will continue to explore more pathways through which the resilience of the Agency's mission can be enhanced.

3.3.2 *Priority:* Protect Agency Facilities and Operations

EPA is committed to the safety of its personnel, the integrity of its buildings, and the efficiency of its operations, but the increasing frequency and severity of extreme weather events poses risks to meeting these objectives. Climate change could disrupt the operation of the Agency's programs, compromise the safety of its staff, or affect the integrity of its physical infrastructure. Adaptation planning to protect EPA's workforce, operations and underlying infrastructure is crucial.

EPA will develop and implement measures to protect its workforce and increase the resilience of its facilities and operations to climate change. For example, where possible, EPA will enhance the resilience of existing facilities in coastal areas to protect them from severe

weather, flood damage, and sea level rise. The Agency will also work with other government agencies, particularly the General Services Administration, to account for climate change in the design and construction of new facilities, or when new buildings are leased.

3.3.3 *Priority:* Factor Legal Considerations into Adaptation Efforts

As a general matter, the Agency's broad mandates to protect human health and the environment afford a large reservoir of legal authority to support EPA adaptation work. However, specific legal questions that may arise in the course of adaptation issues cannot be answered in the abstract.

As a federal agency, EPA derives its authority to act from the U.S. Constitution and the laws passed by Congress. The Agency is committed to ensuring that its actions are constitutional, authorized by statute, consistent with Congress's vision and intent, and otherwise legally supported. The 2011 EPA *Policy Statement on Climate-Change Adaptation* called on the Agency to "identify for the Office of General Counsel areas where legal analysis is needed to carry out agency actions called for in this policy statement." Because the legality of its actions is such a high priority for EPA, program managers and staff are encouraged to freely and frequently consult with the appropriate attorneys in the Office of General Counsel (OGC), Offices of Regional Counsel (ORC), and the Office of Enforcement and Compliance Assurance (OECA) as they conduct their adaptation work.

Important variation exists among the statutes EPA administers, as well as the regulatory programs EPA designs, implements, and enforces under those laws. Some of these laws, like the Clean Air Act and the Clean Water Act, give EPA regulatory powers, such as the authority to write regulations, set standards, issue permits, ensure compliance, and authorize state and tribal environmental programs. Other laws govern EPA actions in a variety of areas essential to its mission, such as research and development, budget and personnel management, contracts, and the award of financial assistance. Still other laws impose obligations on EPA, such as responsibilities to evaluate the effect of its activities on state and local governments, overburdened communities, small businesses, and endangered species, among others.

Each of these laws, whether granting EPA authority or imposing an obligation, may deserve special attention and analysis in resolving legal questions related to adaptation work. For example, EPA may need to determine the extent of its authority to incorporate adaptation measures into the terms and conditions of financial assistance mechanisms; evaluate the legal basis for considering climate change impacts in setting standards or issuing permits under the Clean Air Act and Clean Water Act; or review the adequacy of its emergency response authorities in the context of more frequent natural disasters. These examples are merely illustrative of the diversity of ways in which legal issues may arise for EPA as it mainstreams climate adaptation.

Important variation also exists in the level of scientific understanding of climate change impacts and the sensitivity of EPA programs to those impacts. These variations inform the analysis of

EPA's legal authority and responsibilities. For instance, under the Administrative Procedure Act, federal agencies like EPA have a basic obligation to act transparently and rationally. This is generally demonstrated through an administrative record that documents the analysis and reasoning leading to a final decision and responds appropriately to concerns raised by interested parties and the public, using the information available to the Agency at the time of its decision. The relative weight climate change considerations should be given in evaluating options for EPA action may depend on factors such as the time and geographic scale of the potentially relevant climate impacts compared to the temporal and spatial scale of the proposed EPA action; the strength of the scientific understanding of the climate impacts; and the environmental and economic consequences estimated to result from including or choosing not to include climate change adaptation measures or considerations in the EPA action.

Considerations such as these are by definition case specific. Over time, however, EPA anticipates that more detailed policy principles and legal precedents will emerge to further guide and inform EPA's adaptation efforts.

3.3.4 *Priority:* Strengthen Adaptive Capacity of EPA Staff and Partners Through Training

An organization with adaptive capacity has the ability to craft and adopt new means to achieve its goals as circumstances change. EPA needs its personnel and partners in states, tribes, and local communities to have adaptive capacity if it is to achieve its mission in the midst of climate change. EPA will build adaptive capacity through ongoing education and training. Equipped with an understanding of expected climate-related changes and adaptation approaches, and provided with and trained on how to use new decision-support tools, EPA and its partners will be able to incorporate climate change adaptation into their plans and decisions.

EPA's training, education and outreach programs that are focused on climate adaptation will evolve over time. As an initial step, EPA will design and implement a training program for its staff and its partners focused on topics relevant to EPA's mission. One goal is to increase awareness about the importance of climate change adaptation, and to encourage all EPA staff and partners to consider the changing climate in the normal course of business. A second goal of EPA's training will be to expose its staff and partners to specific approaches and tools for integrating climate adaptation into decision-making processes.

3.3.5 *Priority:* Develop Decision-Support Tools that Enable EPA Staff and Partners to Integrate Climate Adaptation Planning into their Work

The fact that the climate is no longer relatively stable, but will continue to change in new ways, presents a major challenge for decision makers working to protect human health and the environment. Many standard practices may no longer be effective unless they account for climate change. For example, standard methods used for estimating the probability and expected frequency of floods for flood plain mapping, designing infrastructure systems, and estimating runoff of pollutants and sediments into rivers and streams are based on the assumption of climate stationarity.[5] The end of climate stationarity means that EPA and its partners need to alter their standard practices and decision routines to account for a continuously changing climate.

The assumption of stationarity

Until now, EPA (for those programs not explicitly focused on climate change) has been able to assume stationarity of climate; that is, climate is relatively stable and future climate will mirror past climate. But the past is no longer a good predictor of the future.

The development of decision-support tools plays a central role in EPA's overall efforts to adapt to climate change. Following the recommendations of the National Research Council, EPA is committed to developing decision-support tools to improve the quality and efficacy of decisions related to outcomes that are sensitive to changes in climate.[6] These tools will empower staff to consider climate, as well as changes in social and economic conditions that are influenced by climate change. They will enable staff to integrate climate adaptation planning into their work and decision-making processes. Priority will be given to the development of tools that would benefit end-users in multiple areas of EPA.

Decision Support Tools

"The effectiveness of any decision support tool depends on whether it provides information that is relevant to decision makers. Tools need to be useful at space and time scales that are meaningful and relevant for specific decisions and decision makers, and they also need to be based on up-to-date and reliable information"

(Source: National Research Council, *Informing an Effective Response to Climate Change*, America's Climate Choices: Panel on Informing Effective Decisions and Actions Related to Climate Change, The National Academies Press, Washington, DC, 2010.)

EPA will also support capacity-building for state, tribal, local, and international partners by working with them to develop and use effective decision-support tools. EPA will coordinate with other Federal agencies on developing decision-support tools with partners, when appropriate.

3.3.6 *Priority:* Identify Cross-EPA Science Needs Related to Climate Adaptation

Implementing effective strategies to adapt to the changing climate requires that decisions be grounded in the best available science on climate change risks, impacts and vulnerabilities, and adaptive management practices. Throughout EPA, there is a growing need for up-to-date information on the existing models, tools, data and information relevant to climate change adaptation.

EPA has made great progress in climate-related research and with the development of models and tools. However, the complex interactions of climate change impacts mean that uncertainties and data gaps persist and that multiple Agency stakeholders have a role to play in developing a research agenda. In order to identify the most pressing science needs for improved adaptation decision making, *priority* research needs related to climate change adaptation will be identified and periodically updated for the *entire* Agency through a coordinated approach. This approach is designed to produce research results that benefit end-users in multiple areas of EPA.

EPA will advance a rigorous basic and applied science program that will inform, enable and deliver innovative and sustainable solutions to environmental problems in a changing climate. The EPA Office of Research and Development (ORD) has the primary responsibility of coordinating with the Program and Regional Offices to identify the priority science needs of the Agency and its partners. This coordination is essential since some of the priority science needs will be met by ORD's research program, and some by scientists in Program and Regional Offices. In cases where other agencies could produce the scientific information needed, ORD will play a major role representing EPA's needs to other federal agencies. For example, ORD is EPA's primary representative to the U.S. Global Change Research Program (USGCRP), which coordinates and integrates climate change research across 13 federal departments and agencies.

Available data, tools, and information will be shared across the Agency and with its partners to avoid redundancy given the Agency's limited resources. To facilitate the ongoing sharing of information, EPA will establish a central repository of data (and associated metadata), models, tools and information related to climate adaptation that are produced by the Agency. The repository will also include information ("lessons learned") about methods for mainstreaming climate adaptation that have been used by particular EPA Offices that may be applicable to other users across the Agency. Where relevant to the adaptation efforts of EPA and its partners, the repository will be linked to other databases and repositories of information within EPA, as well as those produced by other federal agencies and non-federal entities.

3.3.7 *Priority:* Partner with Tribes to Increase Adaptive Capacity

EPA is committed to strengthening its partnerships with tribes on their priorities related to climate change adaptation. A unique government-to-government relationship exists between the U.S. Government and the 565 federally recognized tribes. EPA gives special consideration to tribes in developing policies that may affect their interests. EPA recognizes that tribes will likely be disproportionately vulnerable to climate change. This disproportionate vulnerability is partly due to their dependence on specific geographic areas for their livelihood; unique cultural, economic and political characteristics; and limited resources to prepare for, respond to and recover from climate-related hazards (*i.e.*, limited adaptive capacity).[7]

EPA is committed to an ongoing partnership with tribes to build their adaptive capacity and address their adaptation-related priorities.

Each Program and Regional Office Implementation Plan will support the development of adaptive capacity in the tribes and identify clear steps for ongoing collaboration with tribal governments where appropriate. These efforts will include increasing tribal capacity to identify vulnerabilities in order to adapt to a changing climate. EPA will work with tribes to support the effectiveness of national climate change adaptation programs in Indian country. The Agency will support the development of climate science to meet priority research needs and decision-support tools useful to the tribes. EPA will also work with the tribes to identify and support the use of climate change relevant traditional ecological knowledge (TEK) in decision making. EPA recognizes that TEK, as an expression of key information that links historical, cultural and local ecological conditions, may help tribes choose how they adapt to climate change while also protecting resources and resource uses important to their culture and livelihood. These efforts will leverage existing EPA partnerships with the tribes and tribal networks.

On a national level, EPA will work with other Federal agencies to collectively support tribes as they assess their vulnerabilities to climate change and plan and implement adaptation actions. Regional Offices will seek opportunities to work together with other Federal agencies' regional offices to provide strong support to tribes on their particular climate change challenges.

3.3.8: *Priority:* Focus on Most Vulnerable People and Places

The Agency places special emphasis on, and works in partnership with, overburdened populations. As discussed in Part 2 of this report, certain parts of the population, such as children, the elderly, the poor, Tribes and indigenous people can be especially vulnerable to the impacts of climate change. This may be due to susceptibility to health impacts of environmental contaminants, economic status, health status, education or access to information. Also, certain communities will be particularly vulnerable, such as those that are in low-lying coastal areas or subsistence fishing tribal communities. EPA is also concerned about

the potential impacts on human health and the environment in rural communities, including agricultural communities. In these communities, some climate change effects such as long-term drought or severe storms have the potential to cause severe effects on local economies. EPA's efforts to anticipate and adapt to the effects of climate change on its core mission, therefore, will include helping the most vulnerable people and places reduce their exposure to climate change and improving their capacity to predict, prepare for and avoid adverse impacts. For example, Program and Regional implementation plans will include a focus on understanding the environmental-justice implications of climate change impacts, identifying populations and communities vulnerable to climate change and with limited ability to adapt, and incorporating consideration of environmental justice issues into the design and evaluation of adaptation strategies.

The Agency will make special efforts to connect with populations that have been historically underrepresented in decision-making in order to support the development of adaptation plans that are culturally sensitive and that improve their capacity to predict, prepare for, and avoid climate change impacts. The Agency will also continue to focus on life stages vulnerable to climate change.[8] The development of effective adaptation plans and strategies will also be improved by examining the interaction of multiple stressors, including climate change, on communities and populations.

3.3.9 *Priority:* Measure and Evaluate Performance

Evaluation is a systematic way to learn from experiences. In its *Strategic Plan*, EPA emphasizes the importance of evaluating activities and acting on the lessons learned. Through systematic evaluation, the Agency can identify where activities have the greatest impact on protecting human health and the environment; provide the roadmap needed to replicate successes; and conversely, identify areas needing improvement.

EPA will evaluate its climate change adaptation actions on an ongoing basis to assess the Agency's progress toward attaining the desired long-term outcome of mainstreaming climate change adaptation into the Agency's programs, policies, rules and operations. Based on lessons learned about the most effective climate change adaptation strategies, EPA can make adjustments to the way adaptation is integrated into its activities.

EPA's commitment to measuring and evaluating the progress it is making to integrate climate adaptation into its programs, policies, rules, and operations is discussed in greater detail in Part 4.

3.3.10 *Priority:* Develop and Implement Program and Regional Office *Implementation Plans*

EPA includes National Environmental Program Offices and National Support Offices headquartered in Washington, D.C., and 10 Regional Offices around the country. The 2011 EPA *Policy Statement on Climate-Change Adaptation* directed the development of programmatic Implementation Plans. EPA National Environmental Program Offices[9] and Regional Offices developed their own Implementation Plans providing more detail on how they will integrate climate adaptation into their planning and work, and help address the cross-EPA priorities identified in this agency-wide plan. The National Environmental Program and Regional Offices had flexibility to develop their Implementation Plans in a manner consistent with their own circumstances and objectives. Support Offices will assist with the implementation of the Agency-wide Plan and National Environmental Program and Regional Office Plans as they do for other initiatives. The ultimate goal of the Implementation Plans is to focus on the core missions and priorities of the Program and Regional Offices, and to ensure that their programs and operations are resilient and effective in a changing climate.

While flexibility was essential to produce Implementation Plans that are effective and responsive in meeting each specific organization's needs, Environmental Program and Regional Offices cooperated as they developed their respective plans, shared experiences and lessons learned, and coordinated on issues that cut across Agency programs and regions. The EPA National Water Program developed a second iteration of its National Water Program Strategy: Response to Climate Change. The 2008 Strategy and 2012 revision provided opportunities for lessons learned and examples of how other EPA programs could approach development of their plans.[10]

The Cross-EPA Work Group on Climate Adaptation Planning will oversee the development of the Implementation Plans and identify required interim products (*e.g.,* comprehensive vulnerability assessments) that will facilitate the development of the Plans.

Common Areas of Focus for Implementation Plans

1. **Vulnerability assessments**
2. **Priority actions on climate adaptation**
3. **Agency-wide Strategic Measures on climate adaptation**
4. **Legal and enforcement issues**
5. **Training and outreach**
6. **Partnerships with tribes**
7. **Vulnerable populations and places**
8. **Evaluation and cross-Office pilot projects**

Annual highlights of progress from each Environmental Program and Region will be included in updates to the agency-wide Climate Change Adaptation Plan that will be submitted on an annual basis with the Agency's Sustainability Plan. The Implementation Plans will also be used to provide input to the Agency's annual planning and budgeting process, where appropriate.

In order to promote consistency, the Implementation Plans for all Environmental Program and Regional Offices have several common areas of focus, as outlined in the table below. There is diversity among the plans and some offices may have a broader scope in some areas than others. For instance, Regional Offices focus their efforts on particular geographic locations more than National Program Offices.

1. **Vulnerability assessments:** Each Implementation Plan (Office or Region) contains an initial assessment of the implications of climate change for the organization's priorities and objectives. This assessment builds on the work presented in Part 2 of this document. Program and Regional Offices are at different stages of understanding and addressing the ways climate change may affect their respective missions. Some Implementation Plans therefore have more detailed information on vulnerabilities than others.

2. **Priority actions for climate adaptation:** Each Implementation Plan describes the organization-specific priorities related to climate change adaptation. At the core of each Implementation Plans a description of the activities that the Program or Regional Office will pursue over time to integrate climate change adaptation into its programs, policies and operations. The Plans describe how these activities address both organization-specific priorities and the cross-Agency priorities. In addition, Implementation Plans describe how Program and Regional Offices will work together on actions that are most effectively accomplished by more than one Office or Region.

   For each action, the Implementation Plan identifies the organization's key partners at the international, federal, state, tribal, local, public and private sector levels, including state, tribal and local co-regulators. Attention will be given to engaging those partners who have been historically under-represented.

   Activities include both short- and long-term actions. Short-term activities include actions that are readily achievable, such as specific training needed to begin building adaptive capacity. Short-term activities also focus on areas where the organization has relative certainty about climate impacts, and therefore feels that action cannot be delayed. The more immediate actions enable the organization to learn what works. Armed with the lessons learned, the organization can move forward with insights and information as it tackles additional issues. Longer-term activities will focus more broadly on building resilient, healthy communities that have the knowledge and tools needed to inform decisions.

3. Agency-wide Strategic Measures on climate adaptation: At a minimum, the Implementation Plans consider activities that address the three existing Agency-wide Strategic Measures (discussed in Section 3.3.1 and in Part 4), to the extent they are applicable to the organization.

4. Legal and enforcement issues: Specific legal questions may have arisen as each Program and Regional Office integrates adaptation planning into its programs, policies, and rules. Each Office describes how its program managers and staff will consult with the appropriate attorneys in the Office of General Counsel (OGC), Offices of Regional Counsel (ORC), and the Office of Enforcement and Compliance Assurance (OECA), as they conduct their adaptation work.

5. Training and outreach: All Program and Regional Offices will benefit from Agency-wide training activities that they will work together to develop and implement under the auspices of the Cross-EPA Work Group on Climate Change Adaptation. Each Implementation Plan describes the ways in which the organization will use the Agency-wide training resources to educate its staff. Each Implementation Plan also indicates how the organization will then, over time, integrate climate adaptation where appropriate into *existing* Office-specific training programs used by its workforce and external partners. Regional Offices, working in coordination with HQ Program Offices as needed, may also choose to take the lead on cross-media training and awareness-building among states and other external partners.

6. Partnerships with tribes: Each Program and Regional Office Implementation Plan includes actions to address the tribes' adaptation issues relevant to the Office. The Implementation Plans identify how the Office will work collaboratively with tribes to increase the adaptive capacity of the tribes. This partnership will help ensure that priority tribal adaptation needs are addressed, and efforts to build adaptive capacity within tribes are effective. The Office of International and Tribal Affairs (OITA) will support the efforts of all Offices to consult and partner with the tribes to develop and implement the actions. Also, OITA will help coordinate the interactions of EPA Offices with tribes to promote unified EPA consultations with individual tribes.

7. Vulnerable populations and places. Each implementation plan describes how the Program or Regional office will identify vulnerable populations and places to climate change. The process of conducting vulnerability assessments and determining priority actions for climate adaptation should consider how each Program and Regional Office can help vulnerable populations and places reduce their exposure to climate change and how to improve their capacity to predict, prepare for, and avoid adverse impacts. The plans are a useful tool to account for the regional variability in how climate change will impact people and places already overburdened by environmental pollution or other stressors.

8. Evaluation and cross-organization pilot projects: Each Implementation Plan includes a process for measuring and evaluating the effectiveness over time. Program and Regional Offices are encouraged to partner with each other to conduct pilot projects that test climate adaptation approaches that are broadly applicable. Relevant Implementation Plans describe these joint efforts, as well as Office-specific pilot projects. The goal is to learn what approaches work and why. The Implementation Plans will periodically be adjusted to improve the organization's efforts to integrate climate adaptation into its activities.

3.4 Importance of Partnerships

EPA believes strong partnerships are critical to fulfilling its mission of protecting human health and the environment. As stated in the EPA *Strategic Plan*, successful partnerships make the most effective use of partners' respective bodies of knowledge, resources and talents. Partnerships are keys to effective integration of climate change adaptation considerations into the protection of human health and the environment. In general, EPA will focus adaptation work on existing geographic-based partnerships with the goal of increasing effectiveness in climate change adaptation efforts.

Climate Change Collaboration - **One potential model of place-based collaboration is C3 (the Climate Change Collaboration) in EPA Region 10 (Seattle, Washington). C3 includes 13 agencies focused on climate change that meet monthly (http://www.c3.gov/). The group was formed through a bottom-up approach when representatives from several agencies realized they were working (redundantly) on the same topics. Through its participation in C3, Region 10 has gained better access to information and technical assistance to support adaptation efforts at local and regional levels; it was also able to learn from the adaptation efforts of states and communities within and outside the region. Similar efforts beyond Region 10 include those in New England, the Southeast, the Great Lakes, and the Gulf Coast.**

States, tribes, and local communities share responsibility for protecting human health and the environment, and partnerships with EPA are at the heart of the country's environmental protection system. These partnerships will be critical for efficient, effective and equitable implementation of climate adaptation strategies. EPA's Regional and Program Offices will therefore work with their partners, engage local stakeholders, and use a diversity of approaches to form the development of adaptive capacity and encourage climate adaptation planning depending upon state, tribal, and local needs and conditions.

EPA will continue to build and maintain strong partnerships with other federal agencies. For example, EPA will continue to actively participate in the interagency Council on Climate Preparedness and Resilience established under EO 13653 and related working groups. EPA is

part of the Federal Agency Climate Change Adaptation Community of Practice, a forum that allows agency staff working on adaptation to share knowledge and experience on adaptation planning, implementation and evaluation. The Program and Regional Office Implementation Plans identify specific areas of collaboration with other federal agencies, such as in delivering support to tribes.

Cross-cutting national strategies relevant to adaptation planning at EPA

- *President's Climate Action Plan*
- Executive Order 13653 - *Preparing the United States for the Impacts of Climate Change*
- *National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate*
- *Draft National Fish, Wildlife and Plants Climate Adaptation Strategy*
- *Draft National Ocean Policy Implementation Plan*

(For more information: http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation)

Finally, climate change impacts do not stop at our borders, but instead can pose risks globally. EPA is committed to working with our international partners to share expertise, practical experiences, information and data to address adaptation issues.

Endnote

[1] U.S. Environmental Protection Agency, *Policy Statement on Climate-Change Adaptation*, June 2, 2011, http://epa.gov/climatechange/Downloads/impacts-adaptation/adaptation-statement.pdf.

[2] U.S. Environmental Protection Agency, "FY 2011-2015 EPA Strategic Plan, Achieving Our Vision" (2011), 43, http://epa.gov/planandbudget/strategicplan.html.

[3] It will also be important, as EPA moves forward, to examine what impact rules being developed now could have in the future, taking climate into consideration.

[4] ICF Incorporated, "The Reg Map: Informal Rulemaking," 2003, http://www.reginfo.gov/public/reginfo/Regmap/regmap.pdf.

[5] National Research Council, *Informing Decisions in a Changing Climate*, Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change, Division of Behavioral and Social Sciences and Education (Washington, DC: The National Academies Press, 2009).

[6] National Research Council, *Informing Decisions in a Changing Climate*, Panel on Strategies and Methods for Climate-Related Decision Support, Committee on the Human Dimensions of Global Change, Division of Behavioral and Social Sciences and Education (Washington, DC: The National Academies Press, 2009).

[7] S.L. Cutter and C. Finch, "Temporal and Spatial Changes in Social Vulnerability to Natural Hazards," *Proceedings of the National Academy of Science* 105(7) (2008), 2301-2306.

[8] In 2005 EPA started using the term life stages to refer to age-defined groups. The term life stage refers to a distinguishable time frame in an individual's life characterized by unique and relatively stable behavioral and/or physiological characteristics that are associated with development and growth. For example, EPA views childhood

as a sequence of lifestages. There are other lifestages that may be important to consider when assessing human exposure and risk including, pregnancy, nursing, and middle and later years.

[9] This includes the Office of Air and Radiation (OAR), Office of Water (OW), Office of Research and Development (ORD), Office of Solid Waste and Emergency Response (OSWER), Office of Enforcement and Compliance Assurance (OECA), Office of Chemical Safety and Pollution Prevention (OCSPP) and the Office of International and Tribal Affairs (OITA).

[10] National Water Program Strategy: Response to Climate Change. 2008 and 2012. Available at: http://www.epa.gov/water/climatechange

Part 4: Measuring and Evaluating Performance

4.1 Existing Strategic Performance Measures

The *FY 2011-2015 EPA Strategic Plan* outlines the Agency's long-term goals, objectives, and strategic measures, which are the measurable human health and environmental results the Agency is working to achieve.[1] The *EPA Strategic Plan* acknowledges that the ability of communities to respond to changes in climate over the coming decades is critical to achieving many of the environmental outcomes the Agency is working towards. Consequently, the *EPA Strategic Plan* contains three strategic measures intended to promote the integration of climate adaptation planning into the Agency's activities.[2] The three strategic measures are focused on core Agency activities that influence its ability to fulfill its mission: (1) rule-making processes; (2) the distribution of financial resources and technical assistance; and (3) the development of science models and decision-support tools.

FY 2011-2015 Strategic Measures on Climate Adaptation

By 2015, EPA will account for climate change by integrating climate change science trend and scenario information into five rule-making processes to further EPA's mission, consistent with existing authorities (preference for one related to air quality, water quality, cleanup programs, and chemical safety.)

By 2015, EPA will build resilience to climate change by integrating considerations of climate change impacts and adaptive measures into five major grants, loan, contract, or technical assistance programs to further EPA's mission, consistent with existing authorities (preference for one related to air quality, water quality, cleanup programs, and scientific research).

By 2015, EPA will integrate climate change science trend and scenario information into five major scientific models and/or decision-support tools used in implementing Agency environmental management programs to further EPA's mission, consistent with existing authorities (preference for one related to air quality, water quality, cleanup programs, and chemical safety.)

The strategic measures are used by the Agency to design annual performance measures that are presented in EPA's *Annual Plans and Budgets*, and to establish priorities in the annual National Program Manager (NPM) Guidance. The Agency then reports on its performance against these annual measures in the *Annual Performance Reports*.

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[1] U.S. Environmental Protection Agency, "FY 2011-2015 EPA Strategic Plan, Achieving Our Vision" (2011), 43, http://epa.gov/planandbudget/strategicplan.html.

[2] Performance measures can be used to provide accountability, as well as to guide decisions about program refinement and prioritization. They can be used to provide program managers and staff, and other external stakeholders, with valuable information about whether a project or program is meeting the desired goals. Measures can help identify when program goals are not being met and whether changes need to be made to meet those goals.

In its *FY 2011-2015 Strategic Plan*, EPA emphasizes the importance of continuously evaluating activities based on their progress and performance, and acting on lessons learned. EPA is already using the three strategic measures pertaining to climate change adaptation to begin evaluating its actions on an ongoing basis. Through ongoing evaluation, the Agency will learn how to effectively mainstream climate adaptation planning into its activities. EPA will evaluate what worked and why, as well as what didn't work and why not. Based on the lessons, EPA will make adjustments to the way adaptation is integrated into its activities.

Importance of Program Evaluation

Because EPA programs and regions will be learning by experience as we integrate climate change adaptation into regulation, financial mechanisms and information tools, it will be essential to apply evaluation as a tool to better understand how well approaches work and how they can be improved upon.

4.2 New Performance Measures

Over time, the Agency will identify where its adaptation activities have or can have the greatest impact on protecting human health and the environment. However, it will be an ongoing challenge to measure the direct impact of EPA's adaptation planning activities on the resilience of its programs, and on the human health and environmental outcomes it is striving to attain. Metrics that enable one to attribute changes in resilience of environmental and human health outcomes to EPA's adaptation efforts, where this is possible, do not yet exist. Such metrics need to be developed over time.

Although the three existing strategic measures do not directly attribute changes in resilience of environmental and human health outcomes to EPA's adaptation efforts, they are focused on essential processes and outcomes (*e.g.,* increased adaptive capacity gained through changes in knowledge and changes in behavior) that are important steps toward achieving the long-term goal of resilience to climate change.

As the Agency works to fulfill each of the three existing strategic measures, it might be possible to identify additional actions that must be taken to successfully attain the measures. For example, as EPA Program Offices integrate climate change adaptation into major rulemaking processes, they may discover that an effective approach is through the development of guidance for states and tribes authorized to implement Federal environmental programs. Identification of key steps like this might lead to the development of additional measures (*e.g.,* numbers of states applying climate-related aspects of EPA guidance) for evaluating EPA's progress.

As EPA works with interested states and tribes to consider climate adaptation as they implement environmental programs, it could work with them to explore ways to measure changes in their adaptive capacity. Metrics could reflect *changes in knowledge* (*e.g.,* number of partners taking formal training to increase their awareness of the importance of adaptation planning), *changes in behavior* (*e.g.,* increases in the use of decision support tools to integrate climate adaptation planning into state

and local planning activities such as infrastructure planning decisions), and *changes in state/condition* (*e.g.,* changes in the ability of communities to withstand more frequent and intense storm events and avoid, for example, combined sewer overflow events).

Some of the pilot projects that will appear in Program and Regional Office Implementation Plans may also explore innovative ways for measuring changes in adaptive capacity through changes in knowledge, changes in behavior, or changes in state/condition. These will also inform the development of future Agency strategic measures.

EPA recognizes that the integration of climate adaptation planning into its programs, policies, rules, and operations will occur over time. This change will happen in stages and measures should reflect this evolution. The earliest changes in many programs will be changes in knowledge and awareness (*e.g.,* increase in the awareness of EPA staff and their external partners of the relevance of adaptation planning to their programs). Building on this knowledge, they then will begin to change their behavior (*e.g.,* increase their use of available decision support tools to integrate adaptation planning into their work). As programs mature, there will be evidence of more projects implemented as a result of increased attention to climate-related programmatic issues. Finally, in the long-term, adaptation planning efforts will lead to changes in condition (*e.g.,* percentage of flood-prone communities that have increased their resilience to storm events) to directly support EPA's mission to protect human health and the environment.

Summary of Program Vulnerabilities to Climate Change Impacts by EPA Strategic Goal

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**
Goal 1: Taking Action on Climate Change and Improving Air Quality	• Increased tropospheric ozone pollution in certain regions	• Likely[1]	• Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	• High	• Could become more difficult to attain NAAQS for ozone in many areas with existing ozone problems
	• Increased frequency or intensity of wildfires	• Likely[2]	• Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	• Medium	• Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) pollution in areas affected by more frequent wildfires
	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very Likely[3] • Likely[3]	• Protect public health by promoting healthy indoor environments through voluntary programs and guidance	• Medium	• Could increase public health risks, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations
	• Effects on the stratospheric ozone layer	• Likely[4]	• Restoring the stratospheric ozone layer • Preventing UV-related disease • Providing a smooth transition to safer alternatives	• High	• Unable to restore ozone concentrations to benchmark levels as quickly at some latitudes
	• Effects on response of ecosystems to atmospheric deposition of sulfur, nitrogen, and mercury	• Likely[5]	• Ecosystem protections from Agency emissions reduction programs	• Low	• Based on evolving research, could have consequences for the effectiveness of ecosystem protections under those programs

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**
Goal 2: Protecting America's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely[9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Increasing intensity of hurricanes • Increasing flood risk	• Likely[3] • Likely[3] • Very likely[6] • Likely[3] • Likely[7]	• Drinking water, wastewater and stormwater infrastructure	• High	• Water infrastructure could be overwhelmed or damaged. • Drinking water intakes and wastewater outfalls could be affected. • Integrity of coastal water infrastructure systems could be put at increased risk. • Drinking water and wastewater utilities will need an 'all hazards' approach to planning for emergencies and extreme weather events. • Problems of safety as well as access to clean and safe water will be exacerbated for vulnerable and economically deprived communities.
	• Increased water temperatures • Increasing heavy precipitation events • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Loss of snowpack	• Very likely[9] • Likely[3] • Very likely[6] • Likely[7] • Very likely[10]	• The quality and availability of safe drinking water	• Medium	• High water temperatures and increased stormwater runoff will increase the need for drinking water treatment, raising costs. • May cause saltwater intrusion in surface water and ground water, placing increased demands on drinking water treatment. • Water supplies may be affected, forcing communities to seek alternative sources. • Water demand may shift to underground aquifers or prompt development of reservoirs or underground storage of treated water, requiring EPA to ensure safety.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**
Goal 3: Cleaning Up America's Communities & Advancing Sustainable Development	• Sea Level Rise • Increasing heavy precipitation events • Increasing risk of floods • Changes in temperature	• Very likely[6] • Likely[7] • Likely[7] • Very likely[3]	• Cleaning up Contaminated Sites and Waste Management	• Medium	• Increased risk of contaminant release from EPA Sites • May need to alter selected remedies to ensure protection. • Hazardous waste permitting may need to be updated to reflect climate change impacts.
	• Melting permafrost in Northern Regions	• Likely[10]	• Cleaning up Contaminated Sites and Waste Management	• High	• Increased risk of contaminant release at sites and potential impact to drinking water where permafrost was utilized as a containment remedy. • May need to implement new remedies to contain contaminants at sites previously protected by permafrost. •
	• Increasing intensity of hurricanes • Increasing heavy precipitation events • Increasing risk of floods	• Likely[3] • Likely[3] • Likely[7]	• Emergency Response	• Medium	• Increased need for emergency response. • Possible limitations to response capability due to staff and financial resource constraints. • Current waste management capacity, including interim capacity, may be insufficient to handle surges in necessary treatment and disposal of hazardous and municipal wastes, as well as mixed wastes generated from severe weather events.
Goal 4: Ensuring Safety of Chemicals & Preventing Pollution	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very likely[3] • Likely[3]	• Protecting human health and ecosystems from chemical risks.	• Low	• Assure that chemical exposure models reflect changes in the environment • Changing in planting timing or location may affect the volume and timing of agricultural chemical use which could impact the appropriate risk management decisions.
Facilities and Operations	• Increased Water Temperatures • Decreasing precipitation days and increasing drought intensity	• Very likely[9] • Likely[7]	• Water usage at EPA facilities	• High	• Water temperatures impact research activities or cooling requirements. • Facilities could be located in areas with water shortages

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**
	• Increasing risk of floods • Increasing intensity of hurricanes • Sea level rise • Increasing extreme temperatures	• Likely [7] • Likely[3] • Very likely[6] • Very likely[3]	• Operations of Agency facilities, personnel safety, physical security, and emergency communications • Emergency management mission support (protective gear and acquisition)	• Medium	• Facilities in coastal or flood-prone areas • Personnel engaged in field work and vulnerable to extreme temperatures or events • Security, lighting and communication systems without backup power • Personnel and real property supporting emergency response and management

Footnotes for Summary of Climate Change Vulnerabilities to Climate Change Impacts by EPA Goal Table

[a]This table summarizes vulnerabilities by goal for four of the five goals in EPA's Strategic Plan. Goal 5 "Enforcing Environmental Laws" is not included in this table. Please note that the table also summarizes vulnerabilities to EPA facilities and operations; this is not part of the EPA Strategic Plan goal structure but is an important element of EPA's vulnerability assessment. Please see Section 2 of this document for a fuller discussion of impacts.

[b]Climate Change Impacts are based upon peer-reviewed scientific literature

[c] Programmatic Impacts are based upon EPA best professional judgment at this time.

[d] Impacts can vary by season and location.

[e] In general, the sources cited in this section use Intergovernmental Panel on Climate Change (IPCC) likelihood of outcome terminology where the term 'very likely' means 90-100% probability and the term 'likely' means 66-100% probability. For some impacts in the table, additional discussion on the likelihood term is provided in the associated footnote.

[f] **High** assumes the program will be affected by the impact; **Medium** assumes the program could be affected under some conditions by the impact; **Low** assumes that there is a potential for the program to be impacted or uncertainty currently exists as to the potential nature and extent of the impact. This assessment is based on best professional judgment within EPA at this time. Please note, this column does not reflect several important considerations. For example it does not distinguish timeframes (current, near-term, long-term). It does not account for regional and local variations. And it does not reflect the priority of actions the agency may undertake now or in the future.

1) Denman, K.L., et al. (2007). Couplings Between Changes in the Climate System and Biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

2) C.B. Field et al., "North America," Chapter 14 in *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2007).

3) IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea,K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

4) World Meteorological Organization, *Scientific Assessment of Ozone Depletion: 2010*, Global Ozone Research and Monitoring Project—Report No. 52 (Geneva, Switzerland, 2011). Note: the word "expected" is used in the report to characterize projected climate change impacts on the stratospheric ozone layer. For purposes of this table the word "likely" has been used as a proxy for "expected."

5) Burns, D.A., Lynch, J.A., Cosby, B.J., Fenn, M.E., Baron, J.S., US EPA Clean Air Markets Div., 2011,National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment, National Science and Technology Council, Washington, DC, p. 114.

6) IPCC, 2012: "It is very likely that mean sea level rise will contribute to upward trends in extreme coastal high water levels in the future."

7) USGCRP, 2009: *Global Climate Change Impacts in the United States* . Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

8) NRC, 2010: National Research Council of the National Academies, America's Climate Choices: Panel on Advancing the Science of Climate Change, 2010. p 41. "One of the most certain outcomes from increasing CO_2 concentrations in the atmosphere is the acidification of the world's oceans." For purposes of this table, the term "certain" is used.

9) USGCRP, 2009: p. 46. [In the case of freshwater] "Increased air temperatures lead to higher water temperatures, which have already been detected in many streams, especially during low-flow periods." For the purposes of this table "very likely" is used.

10) Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 2008: Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, p. 130

EPA Office of Air and Radiation Climate Change Adaptation Implementation Plan

June 26, 2014

Disclaimer

To the extent this document mentions or discusses statutory or regulatory authority, it does so for informational purposes only. This document does not substitute for those statutes or regulations, and readers should consult the statutes or regulations to learn what they require. Neither this document, nor any part of it, is itself a rule or a regulation. Thus, it cannot change or impose legally binding requirements on EPA, States, the public, or the regulated community. Further, any expressed intention, suggestion or recommendation does not impose any legally binding requirements on EPA, States, tribes, the public, or the regulated community. Agency decision makers remain free to exercise their discretion in choosing to implement the actions described in this Plan. Such implementation is contingent upon availability of resources and is subject to change.

Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Bob Perciasepe
Deputy Administrator

September 2013

EPA Office of Air and Radiation Climate Change Adaptation Implementation Plan

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Background

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment. EPA's *Policy Statement on Climate Change Adaptation*, issued in June of 2011, calls for the Agency to anticipate and plan for future changes in climate and incorporate considerations of climate change into its activities. In response, the EPA drafted an agency-wide Climate Adaptation Plan in June 2012. This document recognized that climate change can pose significant challenges to EPA's ability to fulfill its mission. It also directed every Program and Regional Office within the EPA to develop an Implementation Plan detailing how they will integrate climate adaptation into their work, and address the priorities identified in the Agency-wide plan. This document is the Implementation Plan for EPA's Office of Air and Radiation (OAR).

Programmatic Vulnerability Assessment

I. Introduction

The OAR Programmatic Vulnerability Assessment builds on the work presented in Part 2 of the EPA Climate Change Adaptation Plan. OAR's contribution to this plan is based on Goal 1: Taking Action on Climate Change and Improving Air Quality in the EPA's FY 2011-2015 Strategic Plan. OAR primarily relied on the Fourth Assessment Report to the International Panel on Climate Change (IPCC), the US Global Change Research Program's 2009 report *Global Climate Change Impacts in the United States*, and assessment reports from the National Academies of Science to identify OAR program vulnerabilities. The brief summaries below also identify where limitations in the current science exist. As the science continues to grow and evolve in key areas, OAR will evaluate and update its vulnerabilities as needed. A summary table at the end of this section provides an overview of the programmatic vulnerabilities identified in the narrative.

OAR intends to fulfill its mission, even in the face of a changing climate. The Office must consider climate change impacts and vulnerabilities in the regular course of work, all while meeting its goals and building more resilient and climate-responsive programs. This vulnerability assessment focuses on evaluating how climate change may affect the OAR mission and programs, using the best available science. This is an evaluation of program vulnerabilities rather than an assessment of all potential impacts of climate change. Therefore, it does not include discussion of all impacts whether negative or potentially positive.

II. OAR Vulnerabilities to Climate Change Impacts

Tropospheric ozone pollution is likely to increase in certain regions due to the effects of climate change. The relationship between temperature changes and tropospheric ozone formation is well understood. With climate change, higher temperatures and weaker air circulation in the United States will lead to more ozone formation even with the same level of emissions of ozone forming chemicals.[i] Studies project that climate change could increase tropospheric ozone levels over broad areas of the

country, especially on the highest-ozone days.[ii] Climate change also has the potential to lengthen the ozone season (the months of the year when weather conditions, along with pollutants in the air, can result in the formation of elevated levels of ground-level ozone in particular locations around the country), and may increase individuals' vulnerability to air pollution.[iii]

Increases in tropospheric ozone concentrations due to climate change would increase the public health burden from air pollution. The potential impacts on public health include more respiratory illnesses and increased risk of premature deaths.[iv] This is a particular concern to sensitive subpopulations which are at greater risk for health effects from exposure to ozone. Furthermore, potential increases in tropospheric ozone, also known as surface ozone, due to climate change would lead to more pollution controls being required to attain or maintain ozone National Ambient Air Quality Standards (NAAQS) than would be necessary under the present day climate.

There are uncertainties associated with the precise timing and location of expected climate impacts. While there is a consensus that ozone air quality levels will increase, different regional climate models provide varying estimates of the magnitude of the ozone increases from a changing climate. On-going changes in emissions levels (expected to decline over the next decade) and the significant year-to-year variability in ozone levels we already see from natural variability in weather patterns are additional complicating factors. The state-of-the-science continues to evolve and will serve to inform specific measures to counteract this vulnerability. EPA will continue to evaluate and improve our regional climate tools to allow for more refined estimates of ozone impacts for specific climate scenarios. Additionally, we will continue to monitor and assess trends of ozone air quality. To the extent that it becomes apparent that a changing climate is preventing attainment of national air quality goals and depending on the specific circumstances, Clean Air Act provisions may require identification of additional control measures at both the State and national levels.

Particulate matter (PM) levels are likely to be affected through changes in the frequency or intensity of wildfires. While the impact of climate change on ambient PM levels remains somewhat uncertain, there is evidence indicating that climate change will affect PM levels through changes in the frequency or intensity of wildfires.[v] The Intergovernmental Panel on Climate Change (IPCC) has reported with very high confidence that in North America, disturbances such as wildfires are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons.[vi] Forest fires are likely to increase in frequency, severity, distribution and duration in the Southeast, the Intermountain West and the West due to climate change. PM emissions will also be affected by changes in the production of wind-blown dust due to changes in soil moisture.[vii] There are technical challenges associated with assessing the specific impacts that climate change will have on PM concentrations. As an example, it is particularly difficult to accurately determine how precipitation and wildfire patterns will evolve in a changing climate. These second-order climate effects have the potential to significantly impact future aerosol air quality. Coupled climate and air quality modeling systems can show significant variation of future impacts on particulate matter by season and by region. As with ozone, this uncertainty will need to be taken into account.

The potential increase in PM resulting from wildfires may also increase the public health burden in affected areas, which may include sensitive subpopulations at risk for increased health effects from being exposed to PM pollution. This potential increase may also complicate state efforts to attain the PM NAAQS and address regional transport of air pollution.

Climate change may worsen the quality of indoor air.[1] Climate change may worsen existing indoor environmental problems and introduce new ones as it alters the frequency or severity of adverse outdoor conditions.

Heavy precipitation events may contribute to increases in indoor dampness and building deterioration, increasing occupants' exposure to mold and other biological contaminants and emissions from building materials, as well as outdoor environmental pollutants, due to breakdown of the protective building envelope. As more severe flooding and storms are expected, the built environment will be more susceptible to damage. This may require increased engagement across public and private sectors as mold and moisture problems become more pervasive in some areas.

Additionally, due to climate projections of increased storms and flooding events, the availability of biomass fuels for cooking in developing nations may be affected. More research is required to better understand the influence that climate change has on indoor air quality and biomass burning in low-income countries.

Temperature increases may affect the emergence, evolution and geographic ranges of pests, infectious agents and disease vectors. This may lead to shifting patterns of indoor exposure to pesticides as occupants and building owners respond to new infestations.

Increased stress on the building envelope from temperature shifts and more extreme weather events may decrease the capability of homes and buildings to protect occupants from shifts in the numbers or types of organisms in a given area. In addition, increased outdoor temperatures may lead rodents and other pests into the indoor environment, leading to potential increases in pesticide use. Exposures to the pests themselves, and the pesticides used to respond to infestations, can contribute to illness and disease, including allergy and asthma exacerbation. More research on the relationships between climate changes, pest infestation, and prevention and adaptation strategies by occupants is needed. EPA may need to increase its intra- and inter-agency interactions, as well as update its guidance and messaging to ensure climate projections are accounted for in comprehensive asthma intervention programs.

Warmer average temperatures may lead to changes in occupant behavior that may create health risks. For example, residents may spend more time indoors and in so doing, may become more prone to health risks from indoor environmental conditions. Moreover, residents may weatherize buildings to increase comfort and indoor environmental quality in addition to saving energy. Although in general these actions should be encouraged, this may lead to a reduction in ventilation and an increase in indoor environmental pollutants unless measures are taken to preserve or improve indoor air quality.

EPA has developed practical guidance for improving or maintaining indoor environmental quality during home energy upgrades or remodeling in single-family homes and schools. EPA's guidance and protocols may need to be revised to include state and local considerations for projected climatic changes. In addition, these programs may need to increase partnerships with other Federal agencies to address training needs and workforce development for building owners, managers, and others, as

[1] All information in this section is cited from the following: Institute of Medicine, *Climate Change, the Indoor Environment, and Health* (Washington, DC: The National Academies Press, 2011).

well as develop new tracking mechanisms to assess the effectiveness of weatherization and remodeling techniques as they relate to indoor environmental quality.

As homes and buildings are constructed or weatherized/recommissioned with greater energy conservation in mind, potential reductions in ventilation or changes in pressurization could occur. These actions might increase exposure to radon and its decay products. For example, shielding spaces from extreme shifts in temperature may involve increased building below ground level, which may be more cost effective in saving energy, but if spaces are occupied, could lead to increased levels of radon exposure. EPA may need to update its voluntary guidance or increase its work with other federal and industry partners to ensure that homes and buildings continue to be built with or near materials that have low radium content, and that buildings are built or modified to ensure that effective exposure prevention mechanisms are in place.

Climate change may alter the effects of and strategic priorities within EPA's regulatory and partnership programs to help restore the stratospheric ozone layer. The interactions between the changing climate and ozone layer are complex. Climate change affects the ozone layer through changes in chemical transport, atmospheric composition and temperature. In turn, changes in stratospheric ozone can have implications for the weather and climate of the troposphere. Stratospheric ozone depletion and increases in global tropospheric ozone that have occurred in recent decades have differing contributions to climate change. Additionally, climate change may exacerbate the health effects of ozone layer damage at some latitudes and mitigate them at others.[viii] Ozone depletion and climate change are also linked because both ozone depleting substances and their principal substitutes are significant greenhouse gases. While the science continues to evolve, potential climate change impacts are included in the planning and implementation of the Agency's programs to protect stratospheric ozone.

Specific potential vulnerabilities of EPA stratospheric ozone programs include:

- Different ozone depleting substances (ODS) have different atmospheric lifetimes and patterns of transport in the atmosphere. If climate change increases the heterogeneity of processes that influence ozone destruction and production, increased regional disparities may need to be taken into account when implementing programmatic priorities.
- Climate change may lead to increased use of cooling devices in commercial, residential, and transportation applications as well as increased use of insulation foams containing ODS or their substitutes. Such a shift in demand might impact how EPA plans and operates its programs concerned with the ODS that are used to produce and operate these devices and materials. A shift in demand for ODS may also increase imports of ODS, which could affect EPA's oversight of such imports.
- EPA's Significant New Alternatives Policy (SNAP) program evaluates and regulates substitutes for ODS, seeking a constantly improving suite of chemicals for protection of the environment. Evaluation of substitutes can depend on factors influenced by climate change, for example the effectiveness of various refrigerants varying with ambient temperature. A changing climate may influence priority setting and operation of SNAP in relation to the suitability of substitutes.

Scientific understanding related to ways that climate change may affect the interactions of sulfur, nitrogen, and mercury deposition with ecosystems is evolving. While there is limited scientific evidence on this topic, additional research is underway to better understand how patterns in the atmospheric deposition of sulfur, nitrogen, and mercury with projected changes in the climate and carbon cycle will affect ecosystem growth, species changes, surface water chemistry, and mercury methylation and bioaccumulation.[ix] The potential impacts could have consequences for the effectiveness of ecosystem protection from Agency emissions reduction programs.

Additional areas of interest and exploration:

Climate change may increase the frequency and severity of extreme weather events and may affect the Agency's capacity to reliably monitor and assess the effectiveness of certain Agency programs. As the climate changes, extreme weather events such as regional droughts and heat waves have already increased. These patterns are projected to continue in the coming years, bringing heavier precipitation, stronger hurricanes, and an increase in conditions favorable to severe thunderstorms.[x]

Specific potential vulnerabilities related to an increase in the frequency and severity of extreme weather events may include:

- Extreme weather events, including severe winds and lightning, could cause damage to EPA's long-term environmental monitoring assets, particularly in coastal and flood prone areas. The Agency has already seen such damage to equipment at sites in the Clean Air Status and Trends Network (CASTNET) and the National Atmospheric Deposition Program (NADP).
- More frequent and intense weather events could impact OAR's disaster response planning efforts, requiring consideration of more frequent events and more complex responses.

III. Conclusion

This is an initial assessment of the potential vulnerabilities EPA's Office of Air and Radiation may face due to a changing climate. It provides a foundation on which to examine OAR's programs and is meant to provide flexibility so that emerging scientific understanding may be incorporated over time.

IV. Programmatic Vulnerability Summary Table

Goal	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**
Goal 1: Taking Action on Climate Change and Improving Air Quality	• Increased tropospheric ozone pollution in certain regions	• Likely[1]	• Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	• High	• Could become more difficult to attain NAAQS for ozone in many areas with existing ozone problems
	• Increased frequency and intensity of wildfires	• Likely[2]	• Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	• Medium	• Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) pollution in areas affected by more frequent wildfires
	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very Likely[3] • Likely[3]	• Protect public health by promoting healthy indoor environments through voluntary programs and guidance	• Medium	• Could increase public health risks, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations
	• Effects on the stratospheric ozone layer	• Likely[4]	• Restoring the stratospheric ozone layer • Preventing UV-related disease • Providing a smooth transition to safer alternatives	• High	• Unable to restore ozone concentrations to benchmark levels as quickly at some latitudes
	• Effects on response of ecosystems to atmospheric deposition of sulfur, nitrogen, and mercury	• Likely[6]	• Ecosystem protections from Agency emissions reduction programs	• Low	• Based on evolving research, could have consequences for the effectiveness of ecosystem protections under those programs
	• Increased frequency and severity of severe weather events	• Very Likely[7]	• Monitoring and assessing the benefits and effectiveness of Agency emissions reduction programs • Agency disaster response planning	• Medium	• Could decrease the amount and/or quality of data collected by the Agency

Footnotes for Program Vulnerability Summary Table

[a]This table summarizes vulnerabilities by goal in EPA's Strategic Plan. OAR's program vulnerabilities all fall under Goal 1: Taking Action on Climate Change and Improving Air Quality.

[b]Climate Change Impacts are based upon peer-reviewed scientific literature

[c] Programmatic Impacts are based upon EPA best professional judgment at this time.

[d] Impacts can vary by season and location.

[e] In general, the sources cited in this section use Intergovernmental Panel on Climate Change (IPCC) likelihood of outcome terminology where the term 'very likely' means 90-100% probability and the term 'likely' means 66-100% probability. For some impacts in the table, additional discussion on the likelihood term is provided in the associated footnote.

[f] **High** assumes the program will be affected by the impact; **Medium** assumes the program could be affected under some conditions by the impact; **Low** assumes that there is a potential for the program to be impacted or uncertainty currently exists as to the potential nature and extent of the impact. This assessment is based on best professional judgment within EPA at this time. Please note, this column does not reflect several important considerations. For example it does not distinguish timeframes (current, near-term, long-term). It does not account for regional and local variations. And it does not reflect the priority of actions the agency may undertake now or in the future.

1) Denman, K.L., et al. (2007). Couplings Between Changes in the Climate System and Biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

2) C.B. Field et al., "North America," Chapter 14 in *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2007).

3) IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea,K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

4) World Meteorological Organization, *Scientific Assessment of Ozone Depletion: 2010*, Global Ozone Research and Monitoring Project—Report No. 52 (Geneva, Switzerland, 2011). Note: the word "expected" is used in the report to characterize projected climate change impacts on the stratospheric ozone layer. For purposes of this table the word "likely" has been used as a proxy for "expected."

5) USGCRP, 2009: *Global Climate Change Impacts in the United States, "Energy Use and Supply" Chapter*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA. Note: The USGCRP chapter "Energy Use and Supply" characterizes some impacts discussed above as "likely" and others as "very likely." For this table we use "very likely" to indicate that at least one impact related to energy production is characterized this way in the assessment literature.

6) Burns, D.A., Lynch, J.A., Cosby, B.J., Fenn, M.E., Baron, J.S., US EPA Clean Air Markets Div., 2011, National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment, National Science and Technology Council, Washington, DC, p. 114.

7) USGCRP, 2009: *Global Climate Change Impacts in the United States, "Energy Use and Supply" Chapter*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA. Note: The USGCRP chapter "Energy Use and Supply" characterizes some impacts discussed above as "likely" and others as "very likely." For this table we use "very likely" to indicate that at least one impact related to severe weather events is characterized this way in the assessment literature.

Priority Actions

I. Introduction

EPA's Office of Air and Radiation (OAR) works to fulfill EPA's Strategic Goal 1: Taking Action on Climate Change and Improving Air Quality. In doing so, OAR implements programs including those that address air quality, climate change, stratospheric ozone, atmospheric deposition and indoor air. OAR works closely with EPA's Program and Regional Offices and other federal agencies to implement many of the programs and establishes collaborative partnerships with the business community when implementing certain programs. OAR also collaborates closely with researchers and modelers to more fully understand, characterize and project the potential impacts of climate change on air quality, indoor air, and other environmental and public health endpoints that are the subject of OAR programs. Furthermore, OAR works with an extensive set of stakeholders from states and local communities, tribal nations, and various business, environmental, and health organizations to effectively reach the public. Many of these efforts provide opportunities to consider factoring in climate change.

While OAR has initiated certain regulatory actions under the Clean Air Act to reduce greenhouse gases, the primary pollutants that cause climate change, this plan is designed to address adaptation of OAR's programs in response to climate change, including considering when and how analytical tools relied upon can be adapted to better reflect a changing climate.

OAR derived its priority actions from the vulnerabilities in the Agency's *Climate Change Adaptation Plan*. In determining these priority actions, OAR considered the following:

- The strength of the science
- The extent of the threat to the program
- Complexity in implementation
- How easily OAR can integrate climate change adaptation into a particular program
- Legal authorities

The three categories below represent different types of efforts and timeframes over which OAR intends to implement these priority actions. The categories range from relatively easily incorporating adaptation into ongoing programs to actions that will require an initial step before implementation. For example, before recalibrating any regulatory or program models, OAR would follow all existing Clean Air Act procedures for public engagement and initiate a process for a transparent and methodological approach to incorporate climate change. Consistency across OAR programs, and across the Agency, will be important. While OAR is committed to accomplishing the following actions, implementation of these actions will depend on availability of appropriate resources (e.g.; staff and funding). This list of priority actions reflects the Office's best current understanding and is designed to be amended as the science and knowledge about vulnerabilities and adaptation issues expands.

II. OAR Categories of Priority Actions

Category 1: Outreach and Education

These actions are considered achievable in the short-term by leveraging and building on existing OAR efforts.

- Work within EPA and with external stakeholders, as necessary, to review and revise information for citizens, especially at risk populations, on the impact of climate change on ozone health impacts, particulate matter (PM) health impacts, and indoor air quality.
- Incorporate climate change adaptation information into guidance, ongoing outreach tools, and communications for partnership program participants and other federal agencies, state, local, and tribal stakeholders.
- Updating existing indoor air guidance to incorporate climate change adaptation strategies and equip stakeholders to build adaptive capacity in communities.

Category 2: Research and Collaboration

These actions are stepping stones that will inform potential future actions.

- Promote and foster research, internally and externally, on climate change adaptation and its effects on OAR programs.
- Collaborate with the environmental research community on climate change interactions with atmospheric deposition of pollutants and ecosystem impacts. This also includes collaborating with the long-term monitoring community on the impacts of climate change and extreme weather events on atmospheric deposition, and consideration of potential implications for long-term monitoring sites and networks.
- Collect information necessary to consider the effects of climate change in the implementation of the ozone-depleting substances (ODS) phase-out.

Category 3: Modeling and Analysis

These actions require additional considerations prior to implementation; they constitute potential long-term actions for OAR. A good deal is known about the impacts of climate change (e.g., on tropospheric ozone, indoor air, etc.) and as the science continues to grow, existing processes will be utilized to incorporate the science. However, incorporating scientific projections of future climate change into analytical tools, including ones that are relied upon for regulatory purposes, require additional steps to assure transparency and consistency. OAR will plan to engage in and, as appropriate, facilitate that process prior to implementing the actions identified below.

- Incorporate the latest research on ozone, PM, and climate change into National Ambient Air Quality Standards (NAAQS) development and implementation.
- Determine if modifications to the air quality monitoring program, guidance and procedures are necessary to account for a changing climate.
- As appropriate, adjust air quality modeling tools and guidance to incorporate projections of meteorological parameters (e.g., temperature, precipitation) and potential changes in emissions resulting from climate change.

- Incorporate climate change and adaptation (e.g., costs) to a greater extent in economic modeling.
- Re-calibrate models of transition of refrigerants and refrigerant-containing equipment due to the effects of a warmer climate (e.g., changes in effectiveness of refrigeration and air conditioning systems under different temperature scenarios).
- Integrate climate change into models of skin cancer incidence and other health risks.

III. Agency-wide Priorities

Partnerships with Tribes

EPA values its unique government-to-government relationship with Indian tribes in planning and decision making. Existing policies recognize and support the sovereign decision-making authority of tribal governments.

Supporting the development of adaptive capacity among tribes is a priority for the EPA. Tribes are particularly vulnerable to the impacts of climate change due to the integral nature of the environment within their traditional lifeways and culture. OAR is committed to developing adaptation actions that help to reduce or avoid the impact of climate change on Indian tribes.

EPA engaged tribes through a formal consultation process in the development of the Agency's *Climate Change Adaptation Plan*. Tribes identified some of the most pressing issues as erosion, temperature change, drought and various changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. At the same time, tribes challenged EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative burdens are reduced.

OAR's efforts outlined in this plan will benefit from the expertise provided by our tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in understanding the current and future impacts of climate change and has been used by tribes for millennia as a tool to adapt to changing surroundings. Consistent with the principles in the 1984 *EPA Policy for the Administration of Environmental Programs on Indian Reservations*, TEK is viewed as a complementary resource that can inform planning and decision-making.

Existing networks, partnerships, and sources of funding and training/technical assistance will be used to assist tribes with climate change issues, including Regional Tribal Operations Committees, the National Tribal Air Association, the Institute for Tribal Environmental Professionals, and the Indian General Assistance Program. Additionally, efforts will be made to coordinate with other Regional and Program Offices in EPA, since climate change has many impacts that transcend media and regional boundaries. Transparency and information-sharing will be a focus, in order to leverage activities already taking place within EPA Offices and tribal governments.

Vulnerable Populations and Vulnerable Places

Certain parts of the population, such as children, the elderly, minorities, the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. 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.

One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most vulnerable to climate impacts, designing and implementing the plan with meaningful involvement from all parts of society. OAR currently integrates environmental justice and tribal issues into its voluntary indoor air program guidance, but may have to increase its work with partners and regional staff to update or change guidance so that it further addresses the adaptive capacity to climate change impacts among disproportionately impacted populations.

This Implementation 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 Plan is conducted, where appropriate and technically possible, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts can be informed by experiences with previous extreme weather events (*e.g.*, Hurricane Katrina and Superstorm Sandy) and the subsequent recovery efforts.

Measuring and Evaluating Performance

I. Introduction

EPA's Climate Change Adaptation Plan emphasizes the need for measuring and evaluating performance in order to ensure that climate change adaptation is successfully integrated into the Agency's operations.

The integration of climate adaptation planning into Agency programs, policies, rules, and operations will occur gradually over time. This will happen in stages and measures should reflect this evolution. The earliest changes in many programs may be changes in knowledge and awareness, followed by changes in behavior and the incorporation into and use of climate change adaptation tools, and then implementation of projects that build adaptive capacity and lead to changes in state, condition, and preparedness.

OAR plans to update the information and analysis in this implementation plan, evaluate the status of activities, and continually improve the process of EPA programmatic adaptation to climate change. Since this is an emerging field, OAR's initial measurement and evaluation plan will focus on learning and the capacity building elements of the plan. OAR will utilize existing mechanisms and forums whenever possible and ensure that these efforts do not include any new budget implications.

II. Measures and Evaluation

Strategic Performance Measures

The *FY 2011-2015 EPA Strategic Plan* contains the Agency's first strategic performance measures for integrating climate adaptation into its activities. These strategic performance measures commit the Agency to integrate adaptation planning into five major rulemaking processes and five major financial assistance mechanisms by 2015. They also call for the integration of adaptation planning into five major scientific models or decision-support tools used in implementing Agency environmental management programs. Keeping this in mind, OAR will evaluate its priority actions to determine which of these strategic measures we are able to support.

Training

OAR will participate in the Agency workgroup tasked with developing an Agency-wide climate change adaptation training module for EPA staff. Training for staff will be focused on both raising awareness of the elements of climate change in general, as well as how climate change is likely to impact our mission. OAR will evaluate the Office's participation level in this training in an ongoing basis.

Outreach

OAR supports activities to cooperate with other EPA offices, Federal agencies, and other organizations interested in addressing the impacts of a changing climate on EPA programs. These ongoing activities provide an opportunity to measure internal and external engagement levels in adaptation awareness.

- OAR will track the number of hits on the adaptation pages of the climate change website and overlay that data with information about new additions to the site in order to determine interest levels.

- OAR will continue to publish the *State and Local Climate and Energy Newsletter*, which includes adaptation related resources and events. OAR will measure listserv membership levels, with a goal of increasing the number of addresses in 2013.
- OAR will work to increase engagement with EPA Regions to support adaptation efforts and qualitatively evaluate these relationships in an ongoing basis.
- OAR will continue to aggregate the number of health care professionals trained annually on indoor environments and health. Moving forward, training will be supplemented to include climate impacts and adaptation approaches.
- OAR will continue to track the number of outreach, training and technical assistance activities to advance indoor air programs and guidance for health buildings, and foster implementation of climate adaptation activities.

OAR will periodically evaluate its climate change adaptation activities, particularly the identified priority actions, to assess progress toward mainstreaming climate change adaptation into our programs.

OAR will also review emerging scientific understanding on climate impacts and vulnerabilities, OAR programs, and Agency practices on an ongoing basis. As new information emerges, OAR is prepared to update this plan accordingly.

The initial focus of our evaluation will be a qualitative narrative description of the outputs and outcomes of the identified priority actions. This may include successes and accomplishments, what efforts and strategies are working well – and why – as well as an identification of those activities that are not proving successful, the reasons, and any recommendations for new or different approaches that would yield better results and outcomes. This type of evaluation will best allow OAR to highlight our progress, and learn from our efforts in order to continually improve the effectiveness of our climate change adaptation efforts.

III. Conclusion

Measurement and evaluation of progress toward adaptation goals is an important component of the overarching climate change adaptation strategy as it facilitates robust understanding of the effectiveness of our programs. OAR must ensure that its policies and procedures continue to protect human health while being cognizant of the additional programmatic burdens as a result of climate change.

Evaluating progress on these actions is particularly important because climate change adaptation is a new field and there will be a lot of learning throughout the process. Based on lessons learned about the most effective climate change adaptation actions, OAR will make appropriate adjustments to its approach.

This implementation plan is not an endpoint. It is intended to be a living document that will change and mature as the Agency's knowledge of, and experience with, climate change adaptation grows.

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U.S. Environmental Protection Agency

Climate Change Adaptation Plan

Office of Administration and Resources Management (OARM)

June 2014

Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Bob Perciasepe
Deputy Administrator

September 2013

Office of Administration and Resources Management Climate Change Adaptation Implementation Plan June 2014

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2. High-Level Vulnerability Assessment
3. Current Efforts to Address Climate Change
4. Possible New Action Items
5. Monitoring and Evaluation
6. Appendix: Potential Analysis Tools

Introduction

The U.S. Environmental Protection Agency (EPA) is committed to the safety of its personnel, the efficient operation of its buildings, and the sustainability of the communities in which its facilities are located. One of the areas where EPA demonstrates its mission is preparing for and mitigating the potential effects of global climate change, including severe weather events, water shortages, and sea level rises. Adaptation planning to protect EPA's workforce and increase the resiliency of its facilities to ensure continued operations is a critical part of OARM's mission.

As the office within EPA responsible for facilities, transportation, security, health and safety, human resources, grants, and procurement, OARM is responsible for ensuring the safe and continued operation of the Agency's buildings, contracts, grants, and personnel. EPA's people, buildings, and operations could be impacted by any number of potential climate change effects. As required by the EPA Policy Statement on Climate Change Adaptation (June 2014), OARM has revised its Climate Change Adaptation Implementation Plan (dated June 2013).

EPA has made great strides in both preparing for and mitigating climate change effects wherever possible. The Agency's Strategic Sustainability Performance Plan (SSPP), for example, outlines numerous goals and achievements in reducing the Agency's greenhouse gas (GHG) emissions, energy dependence, water use requirements, solid waste, pollution, and other environmental impacts. EPA also has in place an extensive continuity of operations plan (COOP) designed to address natural disasters and other events that could interrupt Agency operations.

Where necessary, EPA will develop and implement new action items to protect its workforce, facilities, and operations against climate change effects and become more resilient to these effects. For example, EPA will consider enhancing the resilience of existing facilities in coastal areas to protect them from severe weather, flood damage, and sea level rise. The Agency will also work with other government agencies, particularly the U.S. General Services Administration (GSA), to account for climate change effects and resiliency in the design and construction of new facilities, or when new buildings are leased. Before undertaking any actions, EPA will assess the need and

OARM Primary Functions

Office of Human Resources (OHR): Manages traditional human resource functions and provides Agency-wide policy development, strategic planning, and direction for EPA's human resource programs.

Office of Administration (OA): Enables, manages, and maintains sustainable, safe and secure workplaces and manages facilities, safety, and security activities in support of the Agency's mission.

Office of Grants and Debarment (OGD): Provides cradle-to-grave administrative management of all Headquarters-administered grants, loans, cooperative agreements, fellowships, interagency agreements, and Suspension and Debarment program management.

Office of Acquisition Management (OAM): Manages the planning, awarding, and administering of contracts and procurement policy for the Agency.

Office of Administrative Law Judges (OALJ): Conducts hearings and renders decisions in proceedings between the EPA and persons, businesses, government entities, and other organizations that are, or are alleged to be, regulated under environmental laws.

Environmental Appeals Board (EAB): Acts as the final Agency decision maker on administrative appeals under all major environmental statutes that the Agency administers.

Office of Diversity, Advisory Committee Management and Outreach (ODACMO): provides strategic leadership in furthering the EPA's commitment to building a high performing organization that draws on the talents, experience and perspectives from all segments of society and the EPA workforce.

evaluate the potential for effectiveness of each activity, as well as estimate the resources needed to implement it.

This plan includes the following key components:

- High-level vulnerability assessment
- Current efforts to address climate change
- Possible new action items
- Measurement and performance evaluation
- Additional analysis tools and criteria for prioritizing action items

High-Level Vulnerability Assessment

In 2011, OARM developed a high-level assessment of the Agency's vulnerabilities to climate change specific to its functional areas. Based on the potential effects of climate change, OARM has identified the following vulnerabilities as medium to high priority. *Note: This assessment does not address EPA research capabilities that might be affected, only its ability to maintain the facilities, operations, procurement, security, and personnel in support of those needs.*

Water Quality and Supply: Changes to water ecosystems—including increasing water temperatures, decreasing precipitation days, and increasing drought intensity—could mean a change in the disposition of water supplies and potentially compromise the quality and quantity of water available for use. EPA laboratories require water to conduct experiments and meet building cooling requirements. Water shortages and quality issues will require better water conservation planning, especially in drought-prone regions.

Severe Weather or Flooding Damage: Facilities in coastal or flood-prone areas could face the effects of increasing floods, intense hurricanes, and extreme temperature shifts. In addition to planning and preparing for such severe weather events before they occur, EPA may have to shift its real estate priorities and resources to respond to damage incurred by facilities in coastal regions and other affected locations.

Field Worker Safety: Because a portion of EPA employees and contractors are engaged in field work, they may be vulnerable to extreme temperatures or other weather events. Emergency management mission support must include procuring the proper personal protective equipment to be prepared for such types of working conditions while conducting sampling, remediation, and other outdoor/field activities.

Physical Security: In many EPA locations, closed-circuit television (CCTV) security cameras, intrusion detection systems, outdoor lighting, and access control devices must run continuously. EPA should ensure that these devices are secure in severe weather conditions and continue to be powered by an uninterruptible power supply (UPS) or have access to a backup generator as needed if climate-related conditions cause interruptions in the power supply.

Security Operations and Emergency Communications: Severe weather events and other climate-related conditions causing interruptions in power could limit electronic communications, cell phone services (including radio communication "walkie-talkie" service), and analog phones in EPA locations where public address systems are not connected to backup power. EPA's COOP should address emergency communications in such instances.

Current Efforts to Address Climate Change

Even before such measures were required under Executive Order (EO) 13514, EPA undertook a variety of climate change mitigation strategies, setting aggressive goals to quantify and reduce the carbon footprint associated with its facilities, employees, and operations. Following are just a few of OARM's efforts and recent results in this area.

GHG Emissions Inventory and Reductions

In fiscal year (FY) 2013, EPA's Scope 1 and 2 GHG emissions were 57.4 percent lower than its FY 2008 emissions baseline (far exceeding the Agency's goal to reduce Scope 1 and 2 emissions 25 percent by FY 2020), thanks in large part to energy efficiency projects at its facilities, improved fleet management practices, and extensive green power purchases. EPA's Scope 3 GHG emissions decreased 40.4 percent compared to its FY 2008 baseline, due to reductions in business air travel, increased use of telework, and cuts in travel budgets.

Energy Efficiency

EPA's FY 2013 energy intensity was 25.6 percent below the FY 2003 baseline, exceeding the EO 13514 requirements. EPA closely tracks and manages its energy use and plans to continue making significant progress in reducing its energy intensity by focusing on implementing key projects identified during facility energy assessments. The Agency also exceeded the EO 13514 petroleum use reduction requirement by using 38.9 percent less fuel in fleet vehicles compared to the FY 2005 baseline.

High Performance Sustainable Buildings

Approximately 11.5 percent of EPA's Federal Real Property Profile buildings met the *Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings* in FY 2013.

To make the Agency's facilities more climate-resilient, EPA has reviewed resiliency-related municipal regulations, zoning ordinances, building codes, subdivision specifications, and other literature from federal, state, and local entities and from academia. As part of this effort, EPA has also discussed climate resiliency planning with GSA's Office of Mission Assurance and is examining proposed and existing green building rating systems for relevant climate resiliency considerations. EPA has developed an initial list of climate resiliency planning considerations, which it will use to update the Agency's space planning and leasing guidelines in FY 2015 and 2016.

Water Conservation

In FY 2013, EPA's water intensity reduction of 38.8 percent far exceeded the EO 13514 requirement of 10 percent. EPA also far exceeded requirements for reducing landscaping water use, achieving a 95.3 percent reduction compared to FY 2010.

Pollution Prevention and Waste Reduction

EPA adopted a more aggressive waste reduction goal of 55 percent compared to the 50 percent goal required by EO 13514. The Agency already exceeded that goal with an FY 2013 waste diversion rate of 64.7 percent.

Electronic Stewardship and Data Centers

EPA's purchasing and IT policies require: energy-efficient and environmentally preferable features on electronic products; achieving a 100 percent power management enabling rate on computers and monitors; and reusing, donating, recycling, or disposing of electronic equipment in an environmentally sound manner. EPA plans to reduce its number of data centers as well.

Possible New Action Items

In addition to addressing its high-level vulnerabilities described previously, OARM will consider possible new action items to pursue as part of its climate adaptation plans, depending on funding and available resources (including personnel and other Agency resources).

Lead Office	Action Item	Priority & Timeframe
OA	**Make Adaptation Part of High Performance Sustainable Buildings** • *Consider Adaptation and Resiliency as Part of Building Management Plan Guidelines (BMPG):* As part of its efforts to meet the *Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings (Guiding Principles)*, EPA developed and is working to implement the BMPG in its owned facilities. OARM will review the BMPG for existing mitigation strategies and identify opportunities to address climate change adaptation and resiliency when assisting existing facilities in meeting the *Guiding Principles*. • *Work With GSA:* For facilities that EPA does not own, OARM will work with its counterparts at GSA to ensure climate change adaptation and resiliency are taken into account in procuring, renewing leases, and maintaining existing facilities, especially in communities where severe weather and other climate-related events could have the most impact. • *Update Best Practices (Environmental) Lease Provisions (BPLP):* EPA includes the BPLP with GSA's standard Solicitation for Offer template to facilitate inclusion of environmental provisions in new lease actions. EPA will identify potential impacts of several key climate stressors on leased facilities and will review the BPLP to determine if climate change resiliency requirements should be added in the future. • *Update Architecture and Engineering Guidelines (A&E Guidelines):* EPA's *A&E Guidelines* provide guidance for facilities management, engineering, planning, and architecture professionals in the design and construction of new EPA facilities and the evaluation of existing facilities. EPA will identify potential impacts of several key climate stressors and will review its *A&E Guidelines* to determine if climate change resiliency requirements should be added in the future. • *Incorporate Adaptation and Resiliency Into GreenCheck:* GreenCheck, OARM's process for evaluating new construction and renovation projects for various environmental initiatives and high performance sustainable building characteristics, will consider measures to ensure	**Medium/ Ongoing**

	building additions, construction, and other efforts take adaptation and resiliency to severe weather and other climate change-related effects into account when projects are undertaken.	
OA	**Conduct Pilot Facility Climate Resiliency Assessment** EPA will select a representative, mission-critical facility that is currently experiencing impacts from climate change and conduct a pilot assessment analyzing the climate stressors, vulnerabilities, adaptive responses, and lessons learned for that facility. Through the pilot study, EPA will "beta test" the proposed updates to its facility planning documents to improve resiliency for EPA facilities and contribute to the climate adaptation knowledge base for the federal community.	**Medium/ 2015**
OA	**Incorporate Adaptation Into Water Conservation Planning** As part of its ongoing work to reduce water intensity across all of its reporting facilities, EPA will revisit its existing Water Conservation Strategy to ensure that water is being used as efficiently as possible in its facilities, and that laboratories are prepared to respond in the event of a drought or other water shortage or quality event.	**Medium/ 2015**
OA	**Reduce Energy Reliance** EPA laboratories demand higher-than-average energy use to meet the Agency's research requirements. Because severe weather events and rising temperatures can impact the consistent delivery of power from the nation's electrical grid, EPA will continue to reduce its reliance on traditional energy sources through energy conservation measures, fleet efficiency, and onsite renewable energy generation.	**Medium/ Ongoing**
OAM	**Prepare for Contract Continuity** Federal Acquisition Regulation (FAR) Part 18 addresses emergency contracting policies at the federal regulatory level, and the Office of Federal Procurement Policy (OFPP) Emergency Acquisitions Guide provides supplemental guidelines, as does OARM's COOP.	**Low/2015**
OHR	**Educate Employees on the Impacts of Climate Change** Once the final Climate Adaptation Plan is published, OARM will integrate with other Agency-wide adaptation efforts to increase employee awareness of climate change effects that may affect their ability to implement effective programs. OARM will work with the EPA Office of Policy to provide the necessary data, information, training, and tools to employees to ensure continuity of operations.	**Low/2015**
OHR	**Redirect Personnel as Needed** Following severe weather and other events, EPA response personnel may need to be redirected to assist emergency management personnel, assess environmental damage, and test sites for air quality, water quality, and other environmental health concerns.	**As needed**

Monitoring and Evaluation

OARM recognizes that evaluating progress on climate change adaptation and resiliency is important. Much of the work described in this plan is evaluated annually as part of the SSPP, OMB Scorecard, and federal agency environmental compliance process. In addition, EPA will gather and review lessons learned over time as the Agency responds to severe weather events, addresses changing priorities, and mainstreams climate adaptation planning into personnel, facilities, and operations processes. We will use this information to continually improve our climate change adaptation and resiliency planning and response actions.

Looking ahead, OARM could track progress on climate change adaptation by incorporating new action items into future SSPP updates. As an existing, annually updated strategy that encompasses both climate change mitigation activities and EPA's progress on specific Agency-wide goals regarding facilities, personnel, and operations, the SSPP is the most appropriate way to track actions taken to adapt to climate change effects such as severe weather events that impact its facilities and operations and document EPA's efforts to build resiliency to such impacts.

Appendix: Potential Analysis Tools

Regional Climate Scenarios

In January 2013, the U.S. Global Change Research Program (USGRP) made available the first standardized set of regional climate scenarios and global sea level rise scenarios that all federal agencies can use in their adaptation planning efforts. The scenarios provide pictures of future climate and sea level rise that EPA can use as it anticipates and prepares for climate change.

OARM and each Region could, depending on funding availability, evaluate the potential impacts of climate change on their facilities, personnel, and operations using the Integrated Climate and Land Use Scenarios (ICLUS) (http://www.epa.gov/ncea/global/iclus/) developed by EPA's Office of Research and Development. These are nationwide housing-density scenarios consistent with climate change storylines. Combined with the USGCRP's regional climate scenarios, ICLUS can help answer the question, "What should we plan for?" They can help evaluate how interactions between climate and land-use changes may affect air and water quality, human health, and ecosystems.

EPA's Climate Resilience Evaluation and Awareness Tool

Version 2.0 of EPA's Climate Resilience Evaluation and Awareness Tool (CREAT) is now available for download at www.epa.gov/climatereadyutilities. The tool assists drinking water, wastewater, and stormwater utilities in identifying climate change threats, assessing potential consequences, and evaluating adaptation options.

Eight Regions Defined by the National Climate Assessment

Office of International and Tribal Affairs

Climate Change Adaptation Implementation Plan

Publication Number: EPA-100-K-14-001E

June 2014

This document has been prepared by the Office of International and Tribal Affairs, within the Environmental Protection Agency, as part of an Agency-wide effort to address climate change.

Disclaimer

To the extent this document mentions or discusses statutory or regulatory authority, it does so for informational purposes only. This document does not substitute for those statutes or regulations, and readers should consult the statutes or regulations to learn what they require. Neither this document, nor any part of it, is itself a rule or a regulation. Thus, it cannot change or impose legally binding requirements on EPA, States, the public, or the regulated community. Further, any expressed intention, suggestion or recommendation does not impose any legally binding requirements on EPA, States, tribes, the public, or the regulated community. Agency decision makers remain free to exercise their discretion in choosing to implement the actions described in this Plan. Such implementation is contingent upon availability of resources and is subject to change.

Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

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Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

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Bob Perciasepe

Deputy Administrator

September 2013

I. Background

Overview of OITA's Role
The role of the Office of International and Tribal Affairs (OITA) is to advance EPA's international environmental priorities and lead the Agency's Tribal Environmental Program tribal environmental program. To achieve this, OITA employs a multi-disciplinary approach.

Internationally, OITA staff works at the national, regional and multilateral levels to identify risks to human health and the environment and forge policy and programmatic responses. OITA works with other federal agencies to develop negotiating positions and represent the foreign policy interests of the United States.

OITA also leads EPA's efforts to protect human health and the environment of federally-recognized tribes by supporting implementation of federal environmental laws consistent with the federal trust responsibility, the government-to-government relationship, and EPA's 1984 Indian Policy.

While OITA is a small office, and thus limited in scope, it currently addresses climate change adaptation in several program areas and will continue to consider the effects of climate change when developing policies and implementing programs. OITA anticipates that requests for assistance to build climate adaptive capacity will increase over time.

II. Vulnerability Assessment for OITA

Vulnerable Populations
Certain parts of the population, such as children, pregnant women, the elderly, minorities, the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. A key principle guiding EPA's efforts to integrate climate adaptation into its programs, policies and rules calls for adaptation plans to prioritize helping people, places and infrastructure most vulnerable to climate impacts, designed to be implemented with meaningful involvement from all parts of society.

This Implementation Plan identifies key programmatic vulnerabilities and the priority actions that will be taken to address those vulnerabilities over time. As this Plan is implemented, special consideration will be given to communities and demographic groups most vulnerable to the impacts of climate change. The Agency will work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events (e.g. Hurricane Katrina and Superstorm Sandy) and subsequent efforts.

In general, since OITA views its programmatic and mission related vulnerabilities as largely arising from the potential climate vulnerabilities of partner organizations.

A. **International** – Addresses country, regional, and multilateral environmental engagements, typically driven by formal international processes and partnerships.

Approach

The international office engages international and regional organizations and governments in order to further international environmental priorities. In the context of international environmental policy development, reliable data, thorough analysis, and vetted approaches are important foundational elements. These foundational elements can be used by stakeholders at the local, national, and international levels to inform policy development. The development of virtual networks allows this information and policy guidance to be shared among relevant stakeholders, and facilitates recognition and sharing of best practices.

Examples of Potential Vulnerabilities

- Lack of basic data needed to make informed decisions about climate adaptation, especially for urban settings that anticipate dramatic increases in population in the coming decades.
- While the United States has an array of sophisticated analytical tools for assessing climate vulnerability, many partner countries do not possess this capacity.
- The United States has identified the Arctic as a region where the effects of climate change have been and will continue to be felt most acutely, with a high degree of certainty.[1]
- Lack of effective networking and information sharing mechanisms in many partnering developing countries to assess vulnerabilities, development effective action plans, and implement these plans, especially in urban settings.
- Based on specific climactic circumstances in countries and regions, vulnerabilities such as heat stress, sea level rise, droughts and floods are expected to have significant negative impacts, particularly in partner developing countries in Africa and Asia[3].

B. Tribal – The American Indian Environmental Office (AIEO)

Approach

EPA values its unique government-to-government relationship with 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 and the 2011 EPA Policy on Consultation and Coordination with Indian Tribes. These policies recognize and support the sovereign decision-making authority of tribal governments.

Supporting the development of adaptive capacity among tribes is a priority for the EPA. Tribes are particularly vulnerable to the impacts of climate change, due to the integral nature of the environment within their traditional lifeways and culture. Due to shrinking federal budgets, there is increased need to develop adaptation strategies that promote sustainability and reduce the impact of climate change on tribes.

EPA engaged tribes through a formal consultation process in the development of the Agency's Climate Change Adaptation Plan. Tribes identified some of the most pressing issues including erosion, temperature change, drought, and changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data; supporting baseline research to better track the effects of climate change;

developing community-level education and awareness materials; and providing financial and technical support. At the same time, tribes challenged EPA to coordinate climate change activities with other federal agencies so that resources are better leveraged and administrative burdens are reduced.

This Implementation Plan identifies specific steps that will be taken to partner with tribal governments on an ongoing basis to increase their adaptive capacity and address their adaptation-related priorities. These collaborative efforts will benefit from the expertise provided by our tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change and has been used by tribes for millennia as a valuable tool to adapt. Consistent with the principles of the 1984 Indian Policy, TEK is viewed as a complementary resource that can inform planning and decision-making.

AIEO will work with both its internal and external parts to advocate for the priorities detailed above.

Examples of Potential Vulnerabilities

- Among tribes, a lack of capacity among tribes to adapt to climate change.
- Limited access to data, training and resources to build adaptive capacity and monitor progress and effectiveness.
- A lack of community-level education and awareness materials to improve the understanding of climate change among tribal member and leaders.
- Limited financial and technical support to adapt to climate change.
- A lack of administrative capacity to understand and manage all of the information and programs coming to tribal governments from a variety of U.S. Government Agencies.
- Additionally, tribes have repeatedly noted the lack of Traditional Ecological Knowledge (TEK) used in EPA's decision-making and policymaking. One approach AIEO will support is to incorporate TEK into its Agency environmental projects and work. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change that has been used by tribes as a valuable tool to adapt to changing surroundings. As EPA develops a greater understanding of TEK alongside our tribal partners, AIEO will support the incorporation of TEK whenever possible.

III. Priority Actions Criteria

OITA is already addressing climate change adaptation in several international and tribal program areas and will continue to pursue opportunities for integrating the effects of climate change into our existing programs, including responding to climate change adaptation-related requests from our tribal partners – as resources and skills permit – especially in border regions.

To prioritize climate change adaptation needs, OITA has developed criteria unique to its mission to identify potential first steps. These criteria are based on a thorough examination of the potential vulnerabilities that face OITA and its mission, in the wake of climate change impacts. The highest priority will be given to those actions that meet several of the following criteria:

- Does the action involve existing partners?
- Does OITA have the necessary resources to meaningfully and effectively help address its partner vulnerabilities in some manner?
- Is this action required in order to enable other actions?
- Can the benefits of this action be measured or documented?
- How extreme is the vulnerability, as informed by relevant EPA, IPCC and USGCRP assessment reports?
- Do the climate vulnerabilities affect U.S. border regions?
- Is OITA the most appropriate lead for the intended action within EPA?

When receiving a request for cooperation in the area of climate adaptation, OITA will consider EPA experience and USG experience more broadly, and when appropriate, explore facilitating linkages with other U.S. agencies and relevant NGOs for implementation support.

IV. Priority Actions

International Priority Actions

- Explore with existing partners, especially along our borders, information needs related to climate literacy, climate vulnerability and climate adaptation options.
- Work with Durban Adaptation Charter cities and their international partners as a means of responding to urban and local government information needs and the need to share city and municipal government experiences, knowledge and best practices. Cities are first responders to climate/weather disasters and are projected to house about 70% of the world's population by 2050[5].
- The International Office will work with the Arctic Council and the International Maritime Organization to address the effects of climate change, including threats due to increased economic activity and shipping in the Arctic.
- Work with the Organization for Economic Cooperation and Development (OECD) member countries and the U.S. Agency for International Development on development of information, planning and assessment tools and guidelines for assessing vulnerabilities to climate change and sharing experiences and best practices.
- Work as a planning committee member on the annual Resilient Cities Congress, the largest international gathering of urban adaptation experts, policymakers, and local officials, for the purpose of exchanging experiences and knowledge.
- Play a lead role in the U.S. Government review of the Intergovernmental Panel on Climate Change (IPCC) climate assessments, which provide analyses of critical data that are made available to all countries.
- OITA seeks to help institute effective information sharing networks among international organizations and governments, especially among urban centers.

Tribal Priority Actions

- Support the Tribal Science Council's efforts to educate EPA scientists on the use of Traditional Ecological Knowledge (TEK) in EPA's work. For example, AIEO supported a

workshop in 2013 to train EPA staff on the value and applicability of TEK. TEK has been underutilized at the Agency, and is an important source of local, baseline information critical for deploying successful adaptation measures.

- Promote the use of Tribal ecoAmbassador funding to support projects related to climate change adaptation. This EPA program promotes collaborative research in partnership with tribal colleges and universities (TCUs). Professors from TCUs receive funding and technical support from EPA to solve the environmental problems most important to their tribal communities, and are then asked to share their findings with a variety of EPA and tribal audiences.
- Under new guidance issued for the Indian General Assistance Program (IGAP) in May 2013, tribes may use funding for climate change adaptation purposes. This has the potential to have an immediate impact on the adaptability of tribal governments, as every tribe is eligible to receive funding through the IGAP program. AIEO will work through the grants staff at EPA Regional Offices to ensure that tribal partners are aware of funding opportunities.
- Establish relationships with a variety of potential tribal partners, including tribal programs in other U.S. Government Agencies, climate-focused programs at Tribal Colleges and Universities (TCUs), and other Nongovernmental Organizations (NGOs) dedicated to the advancement of climate change adaptation for tribes.
- Host periodic stakeholder meetings on environmental issues, including climate change adaptation. These meetings will bring together a variety of tribal partners to both learn what resources are provided by EPA related to climate change, and also give tribal partners a chance to share their resources and experiences with EPA and other tribal partners.
- Update EPA's annual mandatory training, *Working Effectively with Tribal Governments*, to include information on the vulnerability of tribes to climate change adaptation as needed.
- AIEO will work with the Tribal Program Managers and IGAP Project Officers in each of the NPMs and Regional Offices to support any climate change adaptation efforts that benefit tribes.

V. Metrics and Evaluation

OITA, on a five-year basis, will review emerging scientific understanding on climate impacts and vulnerabilities, OITA programs and Agency practices, as well as its incorporation of traditional ecological knowledge, in the interest of maintaining an effective adaptation implementation strategy.

The international side of the Office of International and Tribal Affairs (OITA) established a Performance Measurement Framework to measure and analyze the results achieved from OITA's engagement with other countries and organizations to advance protection of human health and the domestic and global environment. Until now, EPA's international programs have only been able to collect, analyze, and report information about the results of its activities in a fragmented fashion. This framework has enabled OITA to describe its contributions toward characterizing and addressing environmental risks, improving environmental governance, and promoting environmental cooperation. As part of this framework OITA identified 26 measures that could be used to track, and evaluate progress and effectiveness in conducting our mission and achieving our goals.

OITA will evaluate the performance and effectiveness of its adaptation implementation strategy using measures such as the following:

- Number of partner engagements conducted
- EPA-based tools implemented by assisting organization
- Progress toward achieving identified policy goals
- Partnerships, alliances or networks established or enhanced

Additionally, with climate change adaptation now eligible as a use for Indian General Assistance Program (IGAP) grant funds, AIEO will:

- Monitor how tribes apply for and use funding for climate change adaptation
- Build these experiences into the program where appropriate
- Use these real world examples to improve our technical and financial support for tribes working to adapt to climate change

VI. Table of Examples of Potential Climate Vulnerabilities That May Affect OITA Programmatic Activities

Priority[a]	**Climate Change Impacts[b]**	**EPA Programmatic Impacts[c]**			
	Climate Change Impact[d]	Likelihood of Impact[e]	OITA Program and Focus	Likelihood OITA Program Will be Affected by Impact[f]	Examples of Risks if Program Were Impacted
Priority 1: Combating Climate Change by Limiting Pollutants	Coastal areas, especially heavily-populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and from rivers	Likely	**Asia Pacific Rim** - The Pacific Ports Clean Air Collaborative (PPCAC) is a voluntary group of domestic (U.S. West Coast) and international participants (Asia Pacific/Pacific Rim) from ports, industry,	High	Sea level rise, an increase in the frequency and magnitude of extreme weather events, and rising temperatures could affect critical infrastructure and port and vessel

	Coastal flooding in low-lying areas is very likely to become a greater risk than at present due to sea-level rise and more intense coastal storms, unless there is significant adaptation In new industrialized areas in Asia air quality trends will likely add to heat stress and smog	Very likely Likely	and environmental agencies that share expertise, technology, lessons learned to reduce environmental and sustainability impacts of marine goods movement		operation, as well as access to goods and shipping routes. Additional pollutant/greenhouse gas emissions from ports, ocean-going vessels, and other sources will continue to impact air quality and human health in port cities and in shipping lanes
	Increase in annual mean rainfall in East Africa Increase in runoff (and possibly floods) in East Africa Mean sea level rise will contribute to upward trends in extreme coastal high water levels as well as coastal erosion in the future	Likely High Confidence Very likely	**East Africa** - OITA is working with water utility companies in 10 East African countries, to improve planning for the delivery of water and water services	High	Climate projections for East Africa suggest an annual increase in rainfall and runoff, and more frequent extreme precipitation events, which could impact water management Sea level rise may create issues with salt water intrusion into existing aquifers, calling for different approaches to water resource planning
	Annually averaged Arctic sea-ice extent is projected to show a reduction of 22% - 33% by the end of the century	High confidence	**Arctic** - OITA and the USG play a leading role in Arctic Council deliberations on toxics and climate pollutants OITA plays a lead role as well in the Intl.	High	With increased access and economic activity in the Arctic, additional pollutants may exacerbate climate impacts, making emissions

	Over the next century there will be significant melting of Arctic glacial ice due to warming resulting in a substantial contribution to sea level rise For Arctic human communities, it is virtually certain that there will be negative and positive impacts on infrastructure and traditional lifestyles	Very high confidence High confidence	Maritime Organization's (IMO) development of standards and voluntary measures on polar shipping and pollution prevention and mitigation. OITA also contributes to USG engagement in black carbon assessment and mitigation work (AIEO) works with federally-recognized tribes on enforcement of environmental laws and standards		reductions more difficult Such trends will also affect IMO discussions on an emerging Polar Code, as sea level rises, sea ice retreats, and Arctic Ocean transit increases Projected climate trends in the Arctic will especially affect native peoples and AIEO's ability to enforce standards and laws in a rapidly changing setting

Footnotes for Summary Table of Examples of Potential Climate Change Vulnerabilities

[a] This table summarizes potential vulnerabilities according to the 5 goals or priorities in the EPA Strategic Plan.

[b] Climate change impacts/vulnerabilities are based upon the *IPCC Fourth Assessment Report: Climate Change 2007* (see Ref. 3 below).

[c] Programmatic Impacts are based upon EPA best professional judgment at this time.

[d] Statements on impacts are based upon the *IPCC Fourth Assessment Report: Climate Change 2007* (see Ref. 3 below).

[e] Expressions of confidence and likelihood cited in this table are adopted from the *IPCC Fourth Assessment Report: Climate Change 2007* (see Ref. 3 below) as follows:

Very high confidence – At least 9 out of 10 chance of occurring	Virtually Certain – >99% probability
High confidence – About 8 out of 10 chance of occurring	Very likely – >90% probability
Medium confidence – About 5 out of 10 chance of occurring	Likely – >66% probability
Low confidence – About 2 out of 10 chance of occurring	About as likely as not – 33-66% probability
Very low confidence – Less than 1 out of 10 chance of occurring	Unlikely – 0-33% probability
	Very unlikely – 0-10% probability
	Exceptionally unlikely – 0-1% probability

[f] Assessment of possible programmatic impact is based upon OITA's best professional judgment. **High** assumes that the program is very likely to be impacted; **Medium** assumes that the program has a moderate chance of being affected; **Low** assumes that there is a slight chance that the program will be impacted. This assessment is based on best professional judgment within OITA.

[1] U.S. Global Change Research Program, *Global Climate Change Impacts in the United States*, 2009.
[3] IPCC Contribution of Working Group II to the 4th Assessment Report, Summary for Policymakers, Cambridge Univ. Press, UK, 2007.
[4] EPA Climate Change Adaptation Plan, 2012.
[5]. World Bank, Cities and Climate Change: An Urgent Agenda, 2010.

VII. Conclusion

OITA is dedicated to advancing EPA's priorities of climate change adaptation and will work within its authorities to achieve these goals with our international and tribal partners.

Draft Climate Change Adaptation Implementation Plan
The Office of Chemical Safety and Pollution Prevention (OCSPP)

June 2014

Disclaimer

To the extent this document mentions or discusses statutory or regulatory authority, it does so for informational purposes only. This document does not substitute for those statutes or regulations, and readers should consult the statutes or regulations to learn what they require. Neither this document, nor any part of it, is itself a rule or a regulation. Thus, it cannot change or impose legally binding requirements on EPA, States, the public, or the regulated community. Further, any expressed intention, suggestion or recommendation does not impose any legally binding requirements on EPA, States, tribes, the public, or the regulated community. Agency decision makers remain free to exercise their discretion in choosing to implement the actions described in this Plan. Such implementation is contingent upon availability of resources and is subject to change.

Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Bob Perciasepe
Deputy Administrator

September 2013

Draft: Climate Change Adaptation Implementation Plan

The Office of Chemical Safety and Pollution Prevention (OCSPP)

June 4, 2013

Background

On October 5, 2009, the President signed Executive Order (EO) 13514 on Federal Leadership in Environmental, Energy and Economic Performance[1]. The EO established the Interagency Climate Change Adaptation Task Force and tasked it with delivering a report within a year with recommendations on policies and practices that Federal agencies can adopt that are compatible with and reinforce a national climate change adaptation strategy. The Task Force, co-chaired by the Council on Environmental Quality (CEQ), the National Oceanic and Atmospheric Administration (NOAA), and the Office of Science and Technology Policy (OSTP) delivered the report to the President on October 5, 2010[2]. One of its recommendations calls for all Agencies to develop a climate change adaptation plan. On March 4, 2011, the CEQ issued guidance for Federal agencies to implement climate change adaptation planning in accordance with EO 13514. That guidance sets a target for each agency to develop a policy statement and an adaptation plan.

On June 2, 2011, the EPA Administrator issued a policy statement on climate change adaptation[3]. The statement commits the Agency to develop an EPA Climate Change Adaptation Plan to integrate climate adaptation into the Agency's programs, policies, rules, and operations. The statement also directs all EPA program and regional offices to develop plans for implementing the Agency-wide Climate Change Adaptation Plan. The Agency

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[1] EO 13514, October 5, 2009. http://www.whitehouse.gov/administration/eop/ceq/sustainability

[2] White House Council on Environmental Quality, *Progress Report on the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy* (Washington, DC, October 5, 2010). http://www.whitehouse.gov/sites/default/files/microsites/ceq/Interagency-Climate-Change-Adaptation-Progress-Report.pdf

[3] U.S. Environmental Protection Agency, *Policy Statement on Climate-Change Adaptation*, June 2, 2011. http://epa.gov/climatechange/Downloads/impacts-adaptation/adaptation-statement.pdf.

provided its draft plan it to OMB and CEQ during the summer of 2012. The draft plan was publicly released on February 7, 2013[4].

Each program and regional office was asked to develop an implementation plan, contributing to the Agency's adaptation plan that addresses certain key elements in its implementation plans. The elements considered include: programmatic vulnerabilities, priority actions, role in the Agency's strategic measures, legal/enforcement, training/outreach, partnerships with tribes, impacts on vulnerable populations/locations, and evaluation to inform the organization's efforts to integrate climate adaptation into its activities.

Overview of OCSPP's Role in Implementing Agency Strategic Goals

Goal 4 of EPA's Strategic Plan is "Ensuring the Safety of Chemicals and Preventing Pollution". OCSPP has the primary responsibility in its day-to-day decisions to ensure the safety of chemicals. OCSPP also is responsible for managing the Agency's pollution prevention programs that are designed to prevent pollution at the source, promote the use of greener substances, and conserve natural resources.

Chemicals used to make our products, build our homes, protect property and crops, and support our way of life can end up in the environment and some may accumulate in our bodies. A changing climate can affect exposures to a wide range of chemicals. EPA's efforts to assess chemical safety, and to implement chemical management decisions and pollution prevention programs to minimize exposures could be impacted by changing environmental conditions related to extreme weather events (e.g., increasing run off can increase pollution in nearby streams) or changing chemical use patterns (e.g., changing pest pressure can affect the use of agricultural chemicals).

The regulatory framework that OCSPP uses to ensure chemical safety differs for pesticides and other industrial chemicals in commerce. Pesticides are regulated under the Federal Fungicide, Insecticide and Rodenticide Act (FIFRA) and under the Federal Food, Drug, and Cosmetic Act (FFDCA), which

[4] EPA's Draft Climate Change Adaptation Plan, February 7, 2013. http://www.epa.gov/climatechange/pdfs/EPA-climate-change-adaptation-plan-final-for-public-comment-2-7-13.pdfhttp://epa.gov

are managed by the Office of Pesticide Programs (OPP) within OCSPP. Other industrial chemicals in commerce are regulated under the Toxic Substances Control Act (TSCA), which is managed by the Office of Pollution Prevention and Toxics (OPPT) within OCSPP. OPPT also administers the Pollution Prevention Act through a series of programs that identify and leverage opportunities to prevent pollution.

Vulnerability Assessment

The effects on the environment resulting from climate change pose new challenges to EPA as it strives to fulfill its mission of protecting human health and the environment. Challenges resulting from a changing environment due to climate change that may inhibit the Agency's ability to fulfill its mission are referred to as vulnerabilities. Vulnerabilities can be a physical change in the environment causing increased exposure to chemicals or that may relate to programmatic processes or tools that may need to be adapted as a result of a changing environment. This section discusses potential vulnerabilities to the Agency's mission of ensuring chemical safety and preventing pollution. Overall, it is not likely the vulnerabilities discussed below will impede OCSPP's ability to carry out its core mission of ensuring chemical safety and preventing pollution because many of its programmatic processes can be readily adapted to address changing environmental conditions, including those resulting from climate change.

Changes in chemical exposure can result from the effects on the environment caused by a changing climate. For example, a changing climate can alter pest pressure or the location where crops are grown, which in turn may affect the rate, timing and/or frequency of chemical use. Changing environmental conditions may result in the introduction of new disease vectors or invasive species that could increase the demand for evaluating and making decisions regarding the safety of new chemicals or new uses of existing products to address public health threats.

To make decisions on the safety of chemicals, EPA relies on the best available science and assessment tools and when quality monitoring data are unavailable, it relies on models to estimate exposures to chemicals. The primary vulnerability OCSPP identified for its chemicals management programs is to ensure that the tools and methodologies it uses remain robust so that they reasonably reflect environmental changes, including those influenced by climate change.

OCSPP is examining the ways in which its models and tools may need updating to account for changing environmental conditions and the potential effects of climate change. OCSPP has begun to review the potential implications of climate change for its current approaches to evaluating pesticide/industrial chemicals exposures to the environment and people including children, agricultural workers, and other groups who may be disproportionally exposed or affected.

The role of OPP is to make pesticide licensing and re-licensing decisions and conduct additional program activities to ensure that pesticides are used in a manner that is protective of human health and the environment. OPPT assesses the potential safety of new and existing industrial chemicals in commerce on human health and the environment using the same or similar models and tools as used to evaluate pesticide exposures. The methodologies and tools used to assess pesticide risks have been peer reviewed and are the state of the art used throughout the world. To ensure that the underlying science is sound in light of climate change, OCSPP is evaluating its assessment tools to ensure that they address changes in important environmental factors resulting from climate change.

To assist with the evaluation of potential programmatic vulnerabilities, OPP consulted with the FIFRA Scientific Advisory Panel (SAP)[5] to seek advice on areas within pesticide assessment processes that may be vulnerable to changing climatic conditions. OPP asked the SAP to provide guidance on its model review and preliminary conclusions, and on sources of information that may help fill knowledge gaps. The SAP concluded that climate change would likely impact pest pressure, how and where pesticides are used, and the quantity of pesticides used. The SAP agreed with OPP's preliminary conclusion that since EPA reviews pesticide registrations at least every 15 years using assessment methodologies that are conservative and protective of human health and the environment, it is expected that the assessments, and decisions based on them, will remain protective.

One area of vulnerability identified by the SAP was the use of increasingly dated weather datasets in some models that estimate pesticide exposure. The SAP noted that the historical weather datasets might not fully reflect

[5] The SAP is a Federal Advisory Committee established under the law to provide advice on pesticide-related science issues.

recent changes in climate and current weather trends. OPPT has similar concerns, especially in the assessment of chemicals that have the potential for large releases to air and resulting exposures to the environment and people, including children. Some of EPA's exposure models that contain climate-related variables may need updating as weather patterns, temperatures, stream flow rates, air currents, precipitation rates, and other climate variables continue to change. With input from the SAP, OCSPP has begun to update its assessment approaches with the inclusion of current weather data to ensure that its assessments reflect current environmental conditions that could include factors affected by climate change. In the course of keeping its modeling capabilities current, as other information and resources become available, OCSPP may need to consider incorporating different assumptions or default environmental variables for physical-chemical properties that may vary with a changing climate and environmental conditions (pH, temperature, or flow rates).

Extreme weather events and impacts to energy production and use are important considerations in OCSPP's Pollution Prevention Program. Limited availability of water and other natural resources are changing the way manufacturers produce products, driving them to look for new ways to reduce and reuse water and materials. Increased demands on energy are pushing businesses to streamline production processes and minimize waste. The Pollution Prevention program did not identify additional vulnerabilities to its programmatic capabilities that could result from changing climatic conditions. The program's focus on water and energy conservation supports approaches and practices that businesses, communities, and state and local governments will need to employ in order to respond to climate change. Recognizing the critical role pollution prevention can play is an important environmental consideration within the context of climate change adaptation. The Pollution Prevention program did not identify specific vulnerabilities to its programmatic capabilities that could result from changing climatic conditions although they may present new challenges.

There may be other changes in environmental conditions that could impact chemical safety for which the Agency may need to consider. Rising sea levels and more frequent extreme weather events increase the vulnerability to flooding and destruction of structures in low lying areas. Chemical storage facilities may be located in low lying areas and could be at risk of increasing potential for chemical releases into the environment as a result of major weather events. Many farms are along major rivers, and storage facilities and businesses supplying pesticides can be in close proximity to the field

where pesticides are used. Similarly, industrial chemicals could be stored in low lying areas near ports along the seaboard, rivers, and other waterways. The Agency is not certain of the significance of this vulnerability; however, further study to determine the location of chemical facilities that may be at risk may be warranted.

Summary of Program Vulnerabilities to Climate Change Impacts on Chemical Safety

	Climate Change Impact	Likelihood of Impact	Focus of Associated EPA Program	Likelihood EPA Program will be Affected by Impact	Example of Risks if Program were Impacted
Goal 4: Ensuring Safety of Chemicals & Preventing Pollution	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very likely • Likely	• Protecting human health and ecosystems from chemical risks.	• Low	• Assure that chemical exposure models continue to be protective in light of changes in the environment • Changing in planting timing or location may affect the volume and timing of agricultural chemical use which could impact the appropriate risk management decisions. • Changing pest pressure in agriculture and public health may place additional demands on the new registration, special local need and emergency exemption processes. • Chemical storage facilities may be located in low lying areas that may be increasing at risk due to sea level increases or an increase in severe weather events.
			• Reduces pollution at sources	• Low	• Disruptions in energy or water supplies may increase demand for pollution prevention resources.

Priority Actions on Climate Change Adaptation

To determine which potential programmatic vulnerabilities may warrant closer attention, OCSPP considered a number of criteria. Factors considered included the ability to quickly mainstream climate change adaptation into core processes, the likelihood for affecting core program goals, the scale of the potential impact, the timing of the impact, and the severity of the impact. Vulnerabilities that can readily be incorporated into core processes generally are addressed in OCSPP current approaches. These actions involve little additional cost to the program. Some actions are currently underway, while others may be addressed without additional resources.

OCSPP is positioned to address the effects of climate change and changing environmental conditions on chemical safety and pollution prevention. The principal challenge to the program is to ensure that the tools and models it uses adequately reflect the changes in the environment that may affect human health and the environment.

This section discusses climate change adaptation-related activities and processes that OCSPP can readily mainstream into its programs so that it continues to meet its protection goals.

Public Health Pesticide Registration

- The spread or introduction of certain public health pests can be attributed, in part, to climate change. OPP has and will continue to work aggressively with companies and researchers to identify safe pest control products and strategies to minimize adverse effects on public health.

Tools and Models

- Volatilization – In the past, the FIFRA SAP raised concerns that OPP's current risk assessment approach does not consider off-site movement due to volatilization of pesticides. OPP now includes the potential for volatilization in its screening level assessments and will keep climate change in mind as it considers how to incorporate volatilization into its more refined assessments.

- Developing a spatial component to PRZM/EXAMS – The Pesticide Root Zone Model (PRZM) simulates chemical movement in unsaturated soil systems within and immediately below the plant root zone. PRZM is

often linked with the Exposure Analysis Modeling System (EXAMS), which simulates the processes that occur in a water body situated next to an agricultural field. The FIFRA SAP suggested that OPP consider the geographic changes in pesticide use that will likely occur as a result of climate change. OPP is currently developing a spatial component to PRZM/EXAMS that it expects to complete by 2014. This model development effort is expected to more fully account for regional differences in cropping, pesticide use, and environmental conditions. These changes will help ensure that pesticide environmental assessment methodology is resilient to changes in real-world conditions, including those caused by climate change.

- In the normal course of updating models and tools, OCSPP will consider new pathways and changes in chemical behavior resulting from a changing climate.
- OPPT also has developed a geospatial component for its web-based IGEMS (Internet Geographical Exposure Modeling System) model to advance its higher tier exposure modeling capability to assess exposure to chemicals, calculating environmental concentrations in air, soil, water, and ground water. As resources are available, OCSPP could consider updating modeling capabilities to address changing assumptions or default variables for other physical-chemical properties that may vary with changing environmental conditions (pH, temperature, or flow rates).

Pollution Prevention

- OPPT's Economy, Energy, Environment (E3) framework helps manufacturers reduce energy usage and conserve natural resources. Helping businesses to employ energy conservation techniques and discover new ways to reduce and reuse water and materials better positions them to respond to resource challenges that may result from climate change.

Specific information and data that would support OCSPP's mainstreaming efforts include:

- Acquiring current weather data to incorporate into risk assessment tools. This effort is underway.

- Acquiring, as the budget allows, up-to-date chemical use information.
- Acquiring information to improve our understanding of the location of existing facilities and the effect extreme weather events might have on facilities in low lying areas. Acquiring such information would be a part of an Agency-wide mapping effort lead by the Office of Research and Development.

Agency-wide Strategic Measures on Climate Change Adaptation

The Agency's Strategic Plan 2011-2015 includes a strategic goal to mainstream climate change adaptation into its programs. One specific mechanism for achieving the mainstreaming goal is through the development of scientifically sound decision tools. The primary mechanism by which the OCSPP will contribute to this goal is by ensuring that the tools used to assess chemical risks continue to provide robust estimates of potential risks in light of changing environmental conditions that may result from climate change.

Legal and Enforcement Issues

OCSPP believes that any changes in the conditions for regulating, approving, licensing or regulating chemicals can be accomplished in the current regulatory or enforcement structure.

Training and Outreach

Existing training and outreach programs within OCSPP can be used to communicate with, and educate the public about, any changes in the permitted use of chemicals that may result from changing environmental conditions. Internally, OCSPP will, as appropriate, encourage staff to participate in training developed across the Agency regarding mainstreaming of climate change adaptation into its programmatic work.

Partnerships with States and Tribes

OCSPP currently has existing mechanisms and strong partnerships with states and tribes which can be utilized to seek input and communicate programmatic activities related to climate change adaptation.

Vulnerable Populations and Places

Currently, OCSPP's assessment and decision making approaches take into consideration the identification of populations that may be disproportionately affected by chemical exposures. One area that may warrant further cross-agency discussion and investigation is the impact of the potential exposures to communities near chemical storage facilities in the event of a significant weather event.

Evaluation and Cross-Office Pilot Projects

Currently, OCSPP's key chemical assessment tools and science policies are peer reviewed by the FIFRA SAP for pesticides and by the Agency's Science Advisory Board (SAB) for other industrial chemicals. OCSPP would use independent peer review of any significant changes to assessment tools or models.

U.S. Environmental Protection Agency
Office of Research and Development

Climate Adaptation Implementation Plan

Prepared by the ORD Climate Adaptation Implementation Plan Team

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Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most

vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

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September 2013

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Chapter 1. Introduction

As the climate changes, it affects the ability of EPA to achieve its basic mission to protect human health and the environment. Many of the outcomes EPA is working to attain (e.g., clean air, safe drinking water) are sensitive to changes in weather and climate. Until recently, EPA has been able to assume that climate is relatively stable and future climate will mirror past climate. However, with climate changing more rapidly than society has experienced in the past, the past is no longer a good predictor of the future. Climate change is posing new challenges to EPA's ability to fulfill its mission.

To address these challenges, EPA developed its first Agency-wide plan for adapting to the changing climate in 2012. EPA was one of over 60 federal agencies that were required to develop climate adaptation plans under Executive Order 13514, signed by President Barack Obama in 2009.That order required each federal agency to "evaluate agency climate-change risks and vulnerabilities to manage the effects of climate change on the agency's operations and mission in both the short and long term…."[1]

On June 2, 2011, Administrator Lisa Jackson issued the "EPA Policy Statement on Climate-Change Adaptation." The Policy Statement recognizes that climate change can pose significant challenges to EPA's ability to fulfill its mission and calls for the Agency to anticipate and plan for future changes in climate and incorporate considerations of climate change into its activities. The first action called out in the Policy Statement is to "Develop and publish the EPA Climate-Change Adaptation Plan," which was completed and submitted to the Council on Environmental Quality (CEQ) in late June 2012.

The EPA Climate Change Adaptation Plan

The EPA Climate Change Adaptation Plan is the first step in meeting the requirements of Executive Order 13514 (Federal Leadership in Environmental, Energy, and Economic Performance) to implement climate change adaptation planning across the Agency. The Plan was developed by a cross-Agency working group led by the Office of Policy and including each national program and regional office, and it represents a true EPA-wide perspective on climate change adaptation, Agency vulnerabilities to climate change, and priority actions needed to ensure that EPA and its partners at the tribal, state, and local levels are able to fulfill EPA's mission to protect human health and the environment even as we face the impacts of a changing climate.

The EPA Climate Change Adaptation Plan calls for each office to develop an office-specific plan for implementing the priority actions as appropriate for that office. These implementation plans have been developed in coordination across EPA to enable adequate flexibility to address the challenges and situations faced by each office without losing the strength of collaboration to address common vulnerabilities.

The Adaptation Plan outlines the known vulnerabilities of EPA carrying out its mission due to climate change, identifies approaches to "mainstreaming" climate change adaptation in EPA through a series of ten priority actions (see text box), and describes measures to evaluate performance.

[1] Executive Order 13514, "Federal Leadership in Environmental, Energy, and Economic Performance," October 5, 2009.

Among the Agency priorities for implementing measures to adapt to climate change is partnering with tribes. EPA works with federally recognized tribes on a government-to-government basis to protect the land, air, and water in Indian country.

Supporting the development of adaptive capacity among tribes is a priority for the EPA. Tribes are particularly vulnerable to the impacts of climate change due to the integral nature of the environment within their traditional life ways and culture. There is a strong need to develop adaptation strategies that promote sustainability and reduce the impact of climate change on tribes and tribal lands.

Agency-wide Climate Change Adaptation Priorities

1. Fulfill Strategic Measures in FY 2011-2015 EPA Strategic Plan
2. Protect Agency facilities and operations
3. Factor legal considerations into adaptation efforts
4. Strengthen adaptive capacity of EPA staff and partners through training
5. Develop decision-support tools that enable EPA staff and partners to integrate climate adaptation planning into their work
6. Identify cross-EPA science needs related to climate adaptation
7. Partner with tribes to increase adaptive capacity
8. Focus on most vulnerable people and places
9. Measure and evaluate performance
10. Develop program and regional office Implementation Plans

EPA engaged tribes through a formal consultation process in the development of the Agency's Climate Change Adaptation Plan. Tribes identified some of the most pressing issues as erosion, temperature change, drought and various changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. At the same time, tribes challenged EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative burdens are reduced.

This Implementation Plan identifies specific steps that will be taken to partner with tribes on an ongoing basis to understand, increase, and address their adaptive capacity and adaptation-related priorities. These collaborative efforts will benefit from the expertise provided by our tribal partners and Traditional Ecological Knowledge (TEK). TEK can be a valuable body of knowledge in assessing the current and future impacts of climate change and has been used by tribes to adapt to changing surroundings. Consistent with the principles in the 1984 Indian Policy, TEK is viewed as a complementary resource that can inform planning and decision-making.

Networks and partnerships already in place will be used to assist tribes with climate change issues, including the National Tribal Caucus of EPA's National Tribal Operations Committee, Regional Tribal Operations Committees, and EPA-tribal partnership groups. EPA can also use funding through the Indian General Assistance Program (IGAP) to support climate change capacity-building efforts. Additionally,

efforts will be made to coordinate with other regional and program offices in EPA, since climate change has many impacts that transcend media and regional boundaries. Transparency and information sharing will be a focus, in order to leverage activities already taking place within EPA offices and tribal governments.

An additional priority for all regional and program offices is the need to focus on vulnerable populations and locations. Certain parts of the population, such as children, the elderly, minorities, the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most vulnerable to climate impacts and to be designed and implemented with meaningful involvement from all parts of society.

This Implementation 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 Plan is conducted, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events (e.g., Hurricane Katrina and Superstore Sandy) and the subsequent recovery efforts.

The Adaptation Plan also includes a list of comment areas of focus for the office-specific implementation plans, which will be addressed in the text below. The EPA Adaptation Plan sets the stage for the implementation plans for each office, including ORD.

ORD's Mission and Adapting to Climate Change

ORD's mission is to provide the solid underpinning of science and technology for the Agency. ORD has been involved in climate change research for over 20 years, with a strong focus on conducting research to inform the Agency regarding the impacts of climate change on air quality, water quality, and human and ecosystem health. These efforts, at their core, have been designed to inform EPA's program and regional offices as they set and implement policies that will remain effective in a changing climate.

The pace and scale at which climate impacts are occurring create a challenge for ORD by increasing the rate at which new issues arise and new scientific and technical information is needed by the Agency. The impacts of climate change are now illustrating the need to address impacts that the Agency is likely to face in the future, while maintaining flexibility to respond to issues that may arise as climate change impacts occur in unexpected ways.

Relationship of climate adaptation to ORD's Research Programs

ORD's research must be conducted in the context of a changing climate. Such changes will occur across all of ORD's research programs as we learn more about environmental conditions and as we respond to EPA programs and regions and their needs to address those changing conditions.

The recent restructuring of ORD's research programs places ORD in a good position to effectively adapt to climate change and maintain our ability to provide the scientific and technical information needed by our program and regional office partners. The expanded and on-going interactions with our EPA partners form a good foundation for understanding their concerns regarding climate adaptation and enable us to communicate new research needs as they develop. The current program structure also provides a strong means for developing research that cuts across the ORD research programs to bring to bear the right mix of expertise needed to address issues identified by our partners.

Components of the Implementation Plan

This implementation plan has three main components: (1) an assessment of ORD's vulnerabilities to climate change impacts; (2) priority actions for ORD to take to adapt to climate change and reduce its vulnerabilities; and (3) a discussion of performance measures to be developed to evaluate progress toward meeting key goals.

Chapter 2. Assessment of ORD Vulnerabilities and Challenges to Climate Change

In the context of the EPA Climate Change Adaptation Plan, ORD seeks to understand the climate-related vulnerabilities and challenges to providing needed scientific and technical support to EPA's program and regional offices, and how to adapt to those vulnerabilities and challenges. EPA's program and regional offices have developed initial vulnerability assessments of their programs to climate change, which will inform ORD's vulnerabilities. ORD's vulnerabilities refer to the degree to which ORD's capacity to carry out its mission is susceptible to the impacts of climate change, including climate variability and extremes. These could include damage or limited access to facilities, worker safety or security, or lack of fundamental resources such as water or energy. To effectively support the EPA programs and regions, climate change presents ORD with numerous challenges that do not pose physical, climate-related constraints on our ability to conduct and deliver research, but could require changes in our research portfolio to address climate change impacts, compared to what we would have done in the absence of those impacts. ORD's challenge is to be flexible and responsive to the changing science needs of our EPA partners as they work to maintain and improve environmental protection in the face of a changing climate.

> Vulnerabilities refer to the degree to which ORD's capacity to carry out its mission is susceptible to the impacts of climate change, including climate variability and extremes.
>
> Challenges do not pose physical, climate-related constraints on our ability to conduct and deliver research, but could require changes in our research portfolio to address climate change impacts.

Operational Vulnerabilities

OARM has primary responsibility for operation and maintenance of the research facilities used by ORD, including addressing the vulnerability of these facilities to the impacts of climate change. The key operational vulnerabilities are listed in Table 1 below (with OARM's assessment of the level of vulnerability). Given ORD's knowledge of these facilities, ORD staff will work collaboratively with OARM to identify potential problems and develop proactive adaptation measures for facilities and those who use them. Even though OARM has primary responsibility for facility protection and response, ORD will carry significant responsibility for unique research equipment, continuity of experiments, archived samples, and historical data within those facilities which may be vulnerable to climate change impacts. Coordination between on-site ORD staff and OARM will substantially improve the evaluation of vulnerabilities, particularly climate-related environmental changes such as temperature and extreme precipitation events, and the possible approaches to mitigate them.

ORD will also have responsibility for those systems that may be vulnerable to the impacts of climate change, such as field sampling systems, that do not fall under the heading of "facility." Such systems may be vulnerable to temperature or precipitation extremes or other climate-associated impacts.

Table 1. Key operational vulnerabilities posed by climate change

Area of Vulnerability	OARM Estimated Level of Vulnerability
Energy Security	High
Water Quality and Supply	High
Severe Weather or Flooding Damage	Medium (Will vary with location. Gulf Breeze, Edison, and Narragansett are likely to face higher levels of vulnerability to severe weather and flooding than other ORD locations.)
Safety of Field Workers	Medium
Security Operations, Emergency Communications	Medium
Personal Property	Low
Real Property	Low
Shift in Emergency Response Personnel	Low
Continuity of Operations Plan (includes training of essential personnel)	Low

Scientific Challenges

Understand partner needs and regional differences

The scientific challenges, to a large degree, have been well communicated to ORD, partly as a consequence of the increasing interactions with EPA program and regional offices during the development of ORD's program-focused research portfolios. A primary focus of the consolidation of ORD's research into six national research programs has been to expand the opportunities for program and regional offices to identify their needs for scientific and technical information and support, which is then incorporated into the development of ORD's research agenda. Such interactions are not new in the area of climate change and adaptation – discussions to identify partner office needs related to climate adaptation have long been a core component of ORD's Global Change Research Program (now part of the Air, Climate, and Energy Research Program) and the Water Quality and Drinking Water research programs (now incorporated into the Safe and Sustainable Water Research Program).

The climate adaptation research needs identified in past and current discussions are consistent with the vulnerabilities to EPA's mission identified by EPA's program and regional offices in the development of their Adaptation Implementation Plans. The on-going interactions between ORD and the program and regional offices have provided ORD with a head start toward meeting the scientific challenges posed by our partners' programmatic vulnerabilities. Examples of research results that address vulnerabilities to climate change include the assessment of air quality impacts associated with climate change[2] and development and release of scenarios for land use change under different possible future conditions, including climate change.[3]

[2]Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone, U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-07/094F, 2009.
[3]ICLUS Tools and Datasets. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-09/143F, 2010.

The key programmatic vulnerabilities identified by the program and regional offices are listed below in Table 2, with the understanding that this list will very likely change as EPA's adaptation planning efforts progress and our understanding of the science of climate change and its impacts expands.

Given the dynamic nature of the scientific needs across the Agency, one of ORD's challenges will be to develop the flexibility to respond quickly to emerging adaptation issues that may not now be seen as priorities.

Table 2. Key programmatic vulnerabilities identified by program and regional offices, with ORD capacity to provide relevant information related to those vulnerabilities. The order of the list does not necessarily reflect the program or regional office priority.

Programmatic adaptation vulnerabilities that may pose scientific challenges	Primary Office[a]	Current ORD capacity[b]
Tropospheric ozone (OAR Tier I[c])	OAR	High
Particulate matter (OAR Tier II)		High
Indoor air quality (OAR Tier I)		Medium
Biogeochemical Cycling (Tier III)		Medium (nutrients), Low (carbon and water)
Impact of more intense extreme weather events on OAR disaster response planning (potential)		Medium
Environmental justice implications (potential)		Medium
Stratospheric Ozone (Tier II)		Low
Effect on energy efficiency programs of climate-driven changes in energy demand and supply (potential)		Low
Changes in chemical use patterns (fracking, oil spill dispersants, water purification and desalinization, wastewater treatment or antimicrobial and disease prevention)	OCSPP	High
Changing weather trends (including weather extremes) in pesticide exposure models and tools		Low
Increased demand for climate adaptation information applicable to developing countries that are at greatest risk for climate-related disasters; technical support is likely to be needed for both rural areas and urban centers	OITA	High
Programmatic adaptation vulnerabilities that may pose scientific challenges	Primary Office[a]	Current ORD capacity[b]
Increased vulnerability to diseases (waste disposal, clean water, changing disease geographies)	OITA	High
Invasive species and ocean acidification		Medium
International risk assessment, including SLR, weather extremes, cookstoves, glaciers and snow cover, clean water supply		Medium
Arctic Council participation		Medium
Traditional ecological knowledge (TEK)		Low

Impacts to cultural resources, including traditional food resources (fishing, hunting)		Low
Arctic impacts (loss of sea ice and potential village abandonment, mobilization of POPs)		Low
Transport of hazardous substances due to flooding from more intense and frequent storm events	OSWER	High
Changes in groundwater processes and impact to hydrogeological remediation		High
Change in liner permeability due to saltwater intrusion and increased groundwater salinity in coastal aquifers		High
Temperature-driven changes in contaminant volatility		High
Impacts to phytoremediation and ecological revitalization due to changes in plant growth		Medium
Inundation and vulnerability to storm surge		Medium
Potential need for increased emergency preparedness due to impacts from severe weather events		Medium
Drying of the landscape		Low
Contamination risk due to melting of permafrost		Low
Air and water temperature increases	OW	High
Storm intensity (impacts to stormwater infrastructure)		High
Rainfall/snowfall levels and distribution		Medium
Sea level rise		Medium
Changes in energy generation		Medium
Coastal/ocean characteristics		Low

a. Regional offices are not listed separately. The issues identified by the program offices are repeated in regional office vulnerability assessments as appropriate to regional needs.
b. ORD Capacity refers to the internal expertise and facilities available to ORD to conduct research in the specific area.
c. OAR described vulnerabilities in terms of tiers according to their estimate of scientific understanding. Tier I: impact is well established in the literature and has clear implications for the Program's success; Tier II: impacts are being or have been explored by the research community, but significant uncertainties remain; Tier III: the literature is evolving and program implications are uncertain

Although the purpose of this plan is to ensure that EPA is able to carry out its mission as the climate changes, the broader and longer-term need is to ensure that the nation is able to adapt to the impacts of climate change. While this broader scope is closely related to the vulnerabilities identified by EPA's program and regional offices, ORD must also remain cognizant of the adaptation needs of various external partners in local, state, and tribal governments; other federal agencies; international institutions; industries; the research community; and, the public at large. Many of the issues identified in this section are applicable to this broader set of partners and will require their active participation. This broader scope will also require incorporation of research results developed by other science partners in the US Global Change Research Program, the academic community, industry, and research carried out at the tribal, state, and local levels.

Incorporate climate science, strengthen climate adaptation science, and develop cross-Agency research priorities

The issues listed above highlight the need to continue to develop the scientific and technical information to support adaptation. This will require an on-going effort to incorporate the latest understanding of climate science into the development of ORD's research planning to ensure that the adaptation research efforts are focused on understanding how to adapt to conditions that are likely to be experienced in the future. It will also require that ORD conduct research, incorporate the results of others, and work with others to identify the issues that are likely to pose the most serious threats to human health and the environment and to the Agency's ability to continue to protect them. This will require that ORD work with EPA program and regional offices to identify Agency-wide research priorities, as opposed to a set of office-specific priorities. The existing ORD programmatic structure and the EPA Adaptation Working Group provide the means through which such priorities can be developed. Even so, further discussions will be needed to clearly define the approach needed to identify priorities that cut across partner and ORD program boundaries.

Improve flexibility to address emerging and unexpected problems

There are likely to be issues related to climate impacts and adaptation that arise more rapidly than the normal planning cycle, and which may require relatively rapid response from ORD. Where the magnitude of such issues is significant enough, it may be necessary to divert resources (whether staff or funds) to address the emerging or unexpected problem. More generally, however, ORD will need to continue its close interactions with program and regional partners to ensure close communication is maintained so that such issues are quickly identified in the context of the Agency's needs. In addition, ORD will need to continue to provide expert perspectives on emerging issues. This requires that ORD continue development of the staff's scientific and technical capabilities across a broad spectrum of climate-related topics.

Communicate climate, adaptation, and mitigation science

One need that has been identified by program and regional office partners is to develop the ability to communicate current, relevant scientific information about climate change across EPA. For example, given the rapidly growing volume of research on climate change, its impacts, and responses, one of ORD's challenges related to climate adaptation will be to effectively identify and communicate key scientific results that impact EPA's ability to effectively adapt to climate change and support climate change adaptation across the country. The critical need for such information has been identified as a priority by the U.S. Global Change Research Program. This interagency group is in the process of developing a Global Change Information System (GCIS), which is intended to provide a single source of up-to-date information on science and technology related to climate change, climate impacts and adaptation, and mitigation.

Even with the development and deployment of the GCIS, communications across all EPA offices on climate science issues needs to be enhanced to ensure quick and effective sharing of key information, identification of science needs, and understanding of stakeholder perspectives and needs. To the extent that new databases or information systems are needed, ORD will need to remain closely involved in how such approaches are developed and implemented.

Chapter 3. ORD's Priority Actions for Climate Adaptation

ORD's priority actions are derived from the vulnerabilities and challenges discussed in the previous section and, to a significant extent, from the Agency-level adaptation priorities presented above. ORD has already made considerable progress toward meeting many of the key adaptation priorities identified in EPA's 2012 Climate Change Adaptation Plan. Although many of these priorities have been an integral part of our research planning, conduct, and communication for the past several years, there are still opportunities for developing a more explicit and robust response to the impacts of climate change, as outlined in the priority actions below.

Identify vulnerable research resources and develop response plans

ORD makes use of various research resources to accomplish its mission, e.g. laboratories, pilot-scale equipment, measurement instruments, and animal care facilities. The first priority action is to assess the potential vulnerabilities of ORD research systems to the impacts of climate change and to develop approaches, in collaboration with OARM, to minimize those and other facilities vulnerabilities. For example, it will be critical to ORD's delivery of high quality research and data--in the face of extreme temperatures and precipitation events as a result of climate change--to maintain continuity of measurements and experiments, and protect archived samples, data repositories, and monitoring networks that may be located at sites remote from ORD facilities. A "self-assessment" of the vulnerabilities of ORD research resources can result in adaptation approaches that are designed to protect not only the facilities themselves, but also the research capabilities associated with the facility and its integrated research systems.

Develop an approach to identify Agency-wide research priorities

Because of the broad implications of climate change, there is a need to "identify cross-EPA science needs related to climate adaptation." Therefore, an ORD priority action is to coordinate discussions between ORD's Deputy Associate Administrator for Science and National Research Program Directors and cross-agency program and regional management to identify and incorporate input on climate adaptation research priorities.

Work with EPA partners to develop effective venues to communicate advances in climate impact and adaptation research

It will be important to effectively identify and communicate advances in the science of climate change and adaptation. One of ORD's priority actions is to play a key role in developing approaches to consolidating and communicating climate change and adaptation research, particularly by engaging at the interagency level, such as with the development of the Global Change Information System by the U.S. Global Change Research Program.

Design extramural research efforts that appropriately incorporate climate change adaptation questions and measures

In October 2011, the Office of Policy and the Office of Grants and Debarment sent a memo[4] to Senior Resource Officials across the agency directing them to incorporate criteria for climate change adaptation into the grant development process. ORD's National Center for Environmental Research (NCER) has already made this directive a standard component of their process for developing requests for application (RFAs).

ORD will consider how to incorporate criteria for climate adaptation into other major financial mechanisms.

[4] "Incorporating Climate Change Adaptation Considerations into Applicable Assistance Agreement Competitive Funding Opportunity Announcements," Memo from J.D. Scheraga and B.S. Binder to Grants Customer Relations Council and Agency Senior Resource Officials, October 18, 2011.

Chapter 4. Measuring and Evaluating Performance

ORD's performance in effectively adapting to climate change should consider two primary areas: (1) identifying Agency-wide research priorities for climate adaptation and (2) incorporating climate change into extramural research efforts.

Agency science priorities

Priority 3.3.6 of the EPA Climate Change Adaptation Plan is to "identify cross-EPA science needs related to climate adaptation," which is one of ORD's Priority Actions for climate adaptation discussed above. Performance will be evaluated and measured by degree of participation from each affected EPA office, identification of cross-agency priorities in a timely manner, and dissemination of consensus priorities. ORD will also continue its efforts to develop decision support tools useful to decision makers at federal, state, and local levels.

Incorporating climate adaptation into extramural research

ORD is already incorporating climate adaptation as a required factor for consideration by extramural research grant applicants if appropriate. One possible metric of evaluation could be to quantify the number of requests for applications (RFAs) that include climate adaptation as a review criterion, or to demonstrate consistent use of climate adaptation review criteria for appropriate solicitations.

Office of Solid Waste and Emergency Response
Climate Change Adaptation
Implementation Plan

June 2014

Disclaimer

To the extent this document mentions or discusses statutory or regulatory authority, it does so for informational purposes only. This document does not substitute for those statutes or regulations, and readers should consult the statutes or regulations to learn what they require. Neither this document, nor any part of it, is itself a rule or a regulation. Thus, it cannot change or impose legally binding requirements on EPA, States, the public, or the regulated community. Further, any expressed intention, suggestion or recommendation does not impose any legally binding requirements on EPA, States, tribes, the public, or the regulated community. Agency decision makers remain free to exercise their discretion in choosing to implement the actions described in this Plan. Such implementation is contingent upon availability of resources and is subject to change.

Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

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I. Climate Change Impacts to OSWER Programs

What We Do

Climate change is posing new challenges to the Environmental Protection Agency's (EPA's) ability to fulfill its mission. The Office of Solid Waste and Emergency Response's (OSWER's) mission is to protect human health and the environment, and preserve and restore land resources. OSWER strives to protect the land from contamination through sustainable materials management and the proper management of waste and petroleum products. When contamination does occur, OSWER and its partners clean up communities to create a safer environment for all Americans. In addition, OSWER prepares for and responds to environmental emergencies and promotes redevelopment of contaminated areas and emergency preparedness and recovery planning.

Without proper protections and effective restoration, the presence of uncontrolled hazardous substances in surface water, ground water, air, soil and sediment can cause human health concerns, threaten healthy ecosystems, and inhibit economic opportunities on and adjacent to contaminated properties. Waste on the land can also migrate to ground water and surface water, contaminating drinking water supplies. There are multiple benefits associated with cleaning up contaminated sites: reducing mortality and morbidity risk; preventing and reducing human exposure to contaminants; reducing impacts to ecosystems; making land available for commercial, residential, industrial, or recreational reuse; and promoting community economic development. In addition, materials management and sustainable land management practices can significantly reduce greenhouse gas emissions.

Impact of Climate Change

Changes in climate and its impacts may test OSWER's ability to serve these important functions. OSWER recognizes that anticipating and planning for future changes in the climate and incorporating climate considerations into its programs and operations is critical for OSWER to continue to achieve its mission and fulfill its statutory, regulatory, and programmatic requirements. There is some uncertainty, however, as to how and when these changes to the climate will occur. OSWER will act prudently to ensure its actions address pressing needs and will review its vulnerabilities, actions and the state of climate science to make adjustments in the future.

> Vision
>
> OSWER will continue to achieve its mission to protect human health and the environment, and preserve and restore land resources, even as the climate changes.

Purpose of this Document

In June 2011, EPA issued a *Policy Statement on Climate-Change Adaptation* which recognized that climate change can pose significant challenges to EPA's ability to fulfill its mission. It calls for the agency to anticipate and plan for future changes in climate and incorporate considerations of climate change into its activities. The *Policy Statement* also requires the development of an agencywide adaptation strategy that would integrate climate adaptation into the agency's programs, policies, rules and operations. OSWER participated in the cross-agency workgroup that developed EPA's Climate Change Adaptation Plan, which was released for public review February 2013. In addition to the Agency Plan, the *Policy Statement* also directed every EPA program and regional office to develop an Implementation Plan that provides more detail on how it will meet the priorities and carry out the work called for in the agencywide plan.

The purpose of this document is to describe OSWER's process for identifying climate change impacts to its programs and the plan for integrating consideration of climate change impacts into the office's work. OSWER will monitor the status of climate science, particularly as it relates to known or anticipated impacts on OSWER's program areas, as well as the effectiveness of its program activities under changing conditions, and update or adjust its direction as necessary. As its knowledge evolves, OSWER will continue to refine its approach to climate change adaptation and build on the current plan.

Process for Developing this Document

OSWER's Climate Change Adaptation Implementation Plan was created by a workgroup of EPA employees located throughout the United States representing each of OSWER's headquarters and regional offices. Descriptions of OSWER offices and programs are listed in Table 2.

There were three primary stages in the development of OSWER's Climate Change Adaptation Implementation Plan. First, a comprehensive set of vulnerabilities was developed, as described in Section II. Next, evaluation criteria were applied to each vulnerability to guide the development of actions. These scores are shown in Appendix C. Finally, specific actions were developed to address the vulnerabilities that were identified as most critical, as described in Section III.

This plan also includes sections on vulnerable populations, working with tribes, legal and enforcement issues, and measurement of progress.

Definition of Key Terms

Adapt, Adaptation: Adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects.

Adaptive capacity: The ability of a human or natural system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Mitigation: An intervention to reduce the causes of changes in climate, such as through reducing emissions of greenhouse gases to the atmosphere.

Resilience: A capability to anticipate, prepare for, respond to, and recover, from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.

Risk: A combination of the magnitude of the potential consequence(s) of climate change impact(s) and the likelihood that the consequence(s) will occur.

Vulnerability: The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Source: NRC. (2010). *America's Climate Choices: Adapting to the Impacts of Climate Change*. National Research Council.

II. Vulnerability Assessment

Climate Change Impacts

The global climate is changing and the impacts of this change are being felt across the United States and the world. Many of these impacts will directly affect OSWER programs and activities. Listed below are several climate change trends described by the U.S. Global Change Research Program [1] and their potential impacts on OSWER programs.[2]

- *"One of the clearest precipitation trends in the United States is the increasing frequency and intensity of heavy downpours. The amount of rain falling in the heaviest downpours has increased approximately 20 percent in the last century."* Flooding and inundation from more intense and frequent storms may lead to contaminant releases through surface soils, ground water, surface waters, sediments, and/or coastal waters at OSWER sites.
- *"During the past 50 years, sea level has risen up to 8 inches or more along some coastal areas of the United States, and has fallen in other locations."* Rising sea level may inundate OSWER sites in coastal areas and increase flooding from storm surge, both of which could damage cleanups and increase human and ecological exposures to contaminants.
- *"The power and frequency of Atlantic hurricanes have increased substantially in recent decades."* More powerful hurricanes may increase the area affected by these storms, putting sites and communities that had not been previously impacted by flooding and storm surge in the past at risk. More powerful storms may also increase storm debris that will need to be appropriately managed.
- *"United States average temperature has risen more than 2°F during the last 50 years."* Increased average temperature and increased extreme temperatures may result in more frequent and longer lasting heat waves, increasing the risk of wildfires capable of spreading to OSWER sites and affecting the performance of remedies.
- *"Over the past 50 years, Alaska has warmed at twice the rate of the United States' average. The higher temperatures are already contributing to . . . permafrost warming."* The melting of permafrost may allow contaminants at OSWER sites in Alaska to migrate and may cause land shifting and subsidence.

[1] USGCRP. (2009). *Global Climate Change Impacts in the United States*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (Eds.). Cambridge University Press.
[2] This list is not intended to be exhaustive. A more complete list is included in subsequent parts of this section and Appendix A.

- *"In much of the Southeast and large parts of the West, the frequency of drought has increased coincident with rising temperatures."* Decreased precipitation and increased frequency of drought may impact water-intensive remedies and site stability, as well as increase the risk of wildfires.
- *"Wildfires in the United States are already increasing due to warming. In the West, there has been a nearly fourfold increase in large wildfires in recent decades, with greater fire frequency, longer fire durations, and longer wildfire seasons."* Wildfires at contaminated sites could promote the spread of contamination or impact remedies. Wildfire in the upland areas above contaminated sites could reduce vegetative cover, thereby increasing surface water runoff and resulting in catastrophic flooding that spreads contamination or impacts remedies.

In order for OSWER to fulfill its mission to protect human health and the environment, it is critical that OSWER anticipate and plan for future climatic conditions. OSWER must appropriately integrate consideration of climate into its program activities, policies, and regulations. Through adaptation planning, OSWER can continue to protect human health and the environment but in a way that accounts for effects of climate change.

Identification of Vulnerabilities

The first step in the development of OSWER's Climate Change Adaptation Implementation Plan was the identification of OSWER's vulnerabilities to climate change. A vulnerability in this context reflects the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Using expert professional judgement and information from peer-reviewed scientific literature, the OSWER workgroup used the aforementioned climate change impacts as an initial screening tool to determine vulnerabilities to OSWER's processes, activities, and functions. OSWER did not conduct a detailed quantitative assessment of vulnerabilities. In total, 27 unique vulnerabilities were identified (Table 1).

Table 1. OSWER Climate Change Vulnerabilities

Preserving Land	Proper Management of Hazardous and Non-Hazardous Wastes	Design and placement of RCRA Treatment, Storage and Disposal facilities, non-hazardous Subtitle D landfills, Superfund remedies and municipal recycling facilities may need to change to accommodate climate change impacts.
		Hazardous waste permitting requirements may need to be updated to reflect climate change impacts.
		Current waste management capacity may be insufficient to handle surges in necessary treatment and disposal of hazardous and municipal wastes, as well as mixed wastes generated from climate events.
		Levels of necessary financial assurance at RCRA and CERCLA facilities may need to adjust for increased risks/liabilities at specific facilities that may be directly affected by climate change impacts.
	Reducing Chemical Risks and Releases	Remediation and containment strategies and materials used in construction may need to be strengthened to reflect changing climate conditions.
		Current equipment, scientific monitoring and sampling protocols on sites may no longer be effective and therefore may require adjustments due to climate change impacts.
		Current assumptions regarding protectiveness of remediation and containment methods may not reflect changing climate impacts.
		Spill Prevention Plans may need to be updated due to the significant increases in the incidence of flooding and storm events.
	Restoring Land	Site characterization and design of cleanups may not reflect changing climate conditions.
		Risk factors and rankings for risk-based cleanup strategies may need to be reassessed based on changing climate conditions.
		Changing climate conditions may impact continued remedy effectiveness.
		Remedies that are "complete" or are long-term actions may no longer be protective and resilient as climate conditions change at site.
		Increased contaminant migration may lead to boundary changes at current sites or creation of new sites.
		Changes in climate conditions may alter assumptions about contaminant form/volatility.
		Current scientific monitoring and sampling protocols on sites may no longer be effective.
		Safety procedures on sites may not reflect likelihood or intensity of surrounding conditions.
		Availability of utilities and transportation infrastructure may be limited as a result of increased impacts to those systems.
		Current assumptions regarding protectiveness of remediation and containment methods may not reflect changing climate impacts.
		Periodic evaluations of implemented remedies may not incorporate all climate change impacts, including changes in frequency and intensity that may impact remedy effectiveness.
		Use of natural resources impacted by sites may change as a result of increased need, resource scarcity, or compromised resources.
	Emergency Response	Current levels of administrative, enforcement, and emergency response staff may be insufficient to cover needs if number of extreme events increase.
		Sufficient capability and capacity for conducting necessary lab analysis following significant weather events may not be available.
		Current waste management capacity, including interim capacity, may be insufficient to handle surges in necessary treatment and disposal of hazardous and municipal wastes, as well as mixed wastes generated from climate events.
		Training needs (both current and future) are likely to increase in order to meet the increase demand for response actions.
		Existing emergency planning currently required or employed by OSWER may not sufficiently consider elevated risks from multiple climate impacts.
	Tools, Data, Training and Outreach	Outreach and educational materials may need to be developed for owners and operators with facilities in areas of changing environmental conditions.
		Revised training protocols and SOPs that take into account climate change impacts and what to look for may need to be developed.
		Reliable data sources to use in site-specific analyses may need to be identified
		Models, decision tools, site environmental data and information feeds may need to be updated to reflect changing climate conditions

Each vulnerability is linked to at least one climate change impact, however most vulnerabilities are linked to multiple impacts (Appendix A). For example, increased contaminant spread could occur because of the greater incidence of flooding at contaminated sites from heavy precipitation, hurricanes, and sea level rise, as well as, melting permafrost or wildfires. Several vulnerabilities, such as data collection for mapping and training are linked to all the impacts of climate change.

As the vulnerabilities were identified, they were organized by four critical OSWER programmatic focus areas and a cross-cutting category:

- Preserving Land –Proper Management of Hazardous and Non-Hazardous Wastes;
- Preserving Land –Reducing Chemical Risks and Releases;
- Restoring Land;
- Emergency Response;
- Tools, Data, Training and Outreach.

Under each focus area a vulnerability may apply to more than one OSWER program office. For example, five different OSWER offices identified contaminant migration from sites as a vulnerability for their program. In addition, there were several vulnerabilities related to training and data needs that cut across all program offices in OSWER, as well as across EPA.

Table 2. OSWER Programs

Office of Superfund Remediation and Technology Innovation and Federal Facilities Restoration and Reuse Office
The **Superfund Remedial and Federal Facilities Program** addresses long-term risks to human health and the environment resulting from releases of hazardous substances at the nation's highest priority sites. Superfund sites are found throughout the country. The Federal Facilities Program works with federal entities to ensure fast and effective cleanup at federally-owned sites, and facilitates partnerships between the other federal agencies and the surrounding communities. The Superfund Remedial Program works on non-federally owned sites.
Office of Brownfields and Land Revitalization
The **Brownfields Program** addresses environmental site assessment and cleanup of abandoned and potentially contaminated sites through grants, cooperative agreements, and technical assistance to communities, states, and tribes. Brownfields' sites have potential contamination that needs to be assessed and in some instances cleaned up before redevelopment and reuse can occur. These sites generally are much less contaminated than Superfund and RCRA Corrective Action sites. Funding to states and tribes helps develop and enhance their voluntary cleanup programs for these sites.
Office of Emergency Management
The **Superfund Emergency Response and Removal Program** functions as the backbone federal response to many emergency events; provides response support to state, local, tribal and potentially responsible parties when their response capabilities are exceeded; and manages risks to human health and the environment. Removal actions are typically responses intended to protect people from threats posed by hazardous waste sites.
The **Oil Spill Program** protects U.S. waters by preventing, preparing for and responding to oil spills. Section 311 of the Clean Water Act and the Oil Pollution Act of 1990 provide EPA with the authority to establish a regulatory program for preventing, preparing for and responding to oil spills that occur in navigable waters of the United States.
The **EPA Chemical Emergency Preparedness and Prevention Program** is the national regulatory framework to prevent, prepare for and respond to catastrophic accidental chemical releases at industrial facilities throughout the United States.
Office of Resource Conservation and Recovery
The **Resource Conservation and Recovery Act (RCRA) Solid Waste Program** encourages states to develop comprehensive plans to manage nonhazardous industrial solid waste and municipal solid waste, sets criteria for municipal solid waste landfills and other solid waste disposal facilities, and prohibits the open dumping of solid waste. A core function of this program is to look for and incentivize more sustainable ways to manage our materials, prolonging the life of materials as usable commodities for as long as possible.
The **RCRA Hazardous Waste Program** issues comprehensive, national regulations, defines solid and hazardous wastes, and imposes standards on anyone who generates, recycles, transports, treats, stores or disposes of hazardous waste. This program also monitors the movement of hazardous waste in and out of U.S. borders and works to help ensure the waste that is exported is properly recycled or disposed of.
The **RCRA Corrective Action Program** directly implements the corrective action (CA) program in 13 states and territories, and performs as lead regulator at an increasingly significant number of facilities undergoing CAs in 42 states across the country that are authorized for the RCRA CA Program. An essential element of EPA's hazardous waste management program is the statutory requirement that facilities managing hazardous wastes must clean up releases of hazardous constituents that could adversely impact human health and the environment. The CA program is critical to preventing future Superfund sites and the associated resources and expenditures.
Office of Underground Storage Tanks
The **Underground Storage Tanks (UST) Prevention Program** works with state, tribal and inter-agency partners to set and implement standards which prevent and detect releases from underground storage tanks. EPA provides resources to support the infrastructure of state and tribal UST programs and provides regulations, guidance and policies to support program implementation. An essential element of the UST program is full implementation of the Energy Policy Act of 2005.
The **Leaking Underground Storage Tank (LUST) Cleanup Program** works with state and tribal partners to clean up releases from LUST sites, many of which impact ground water resources. Cleaning up LUSTs is a key part of protecting our environment. EPA provides resources to support the infrastructure of state LUST programs so that private and state resources can directly finance the field work necessary to address contamination at federally-regulated tank releases. EPA also provides regulations, guidance and policy to support cleanup of tank releases.

III. Addressing Impacts of Climate Change

Focusing on Specific Vulnerabilities

In a resource-constrained environment, in order to prioritize and focus OSWER's efforts to address the impacts of climate change, each vulnerability was evaluated based on a set of criteria. Together, these criteria allowed each OSWER office to use its best professional judgment to evaluate the areas that needed the most or immediate attention and where its contribution would be most effective.

The first two criteria, referred to as the "Characterization Criteria", were designed to enhance the understanding of the overall impact of a particular vulnerability. Because climate change is a long-term problem, both the scale and timing of adaptation actions are important.

Characterization Criteria:

- Scale of impact to human health, the environment or vulnerable communities because of the vulnerability – The scores for this criterion reflect the potential for harm to human health, the environment, or a vulnerable community, if the vulnerability is not addressed.
- Likelihood of occurrence because of the vulnerability – This criterion is a reflection of what impacts have already occurred at OSWER sites and programs.

The second set of criteria reflect EPA roles in addressing the impacts of these vulnerabilities and are collectively referred to as "Opportunities for OSWER to make a difference". These criteria are intended to identify those vulnerabilities for which action by OSWER would significantly advance adaptation efforts and ones in which OSWER is more directly responsible for addressing.

Opportunities for OSWER to make a difference:

- Does EPA have a unique or lead role or technical expertise in this area?
- To what extent are climate impacts currently not considered in this area?
- To what extent could additional EPA involvement build momentum or leverage current activities?
- Is there an opportunity to incorporate climate change into an ongoing effort (e.g., rulemaking, changes to grant criteria, updates to guidance and training)?

Each OSWER office determined which vulnerabilities were applicable to its work and developed a score for the vulnerability. When applying the criteria, offices did not rank vulnerabilities in relation to each

other, but instead considered each vulnerability independently. These scores were used to aid OSWER offices in determining which vulnerabilities were most critical to focus actions.

The score sheet with the criteria is shown in Appendix B. To maintain transparency OSWER has included all identified vulnerabilities regardless of the final score.

Developing Priority Actions

Using the vulnerability criteria as a guide, the following OSWER offices developed priority actions:

- CPA – Center for Program Analysis
- FFRRO –Federal Facilities Restoration and Reuse Office
- OBLR – Office of Brownfields and Land Revitalization
- OEM – Office of Emergency Management
- ORCR – Office of Resource Conservation and Recovery
- OSRTI – Office of Superfund Remediation and Technology Innovation
- OUST – Office of Underground Storage Tanks

In addition, EPA regional offices play a central role in implementing OSWER programs. Regions work closely with states, tribes, and other stakeholders to protect the environment and human health at a more localized, geographically focused level than the OSWER national program. OSWER reviewed actions proposed by Regional offices in their climate change adaptation plans and supports them as a crucial element to advancing climate change. OSWER regional actions were primarily in support of EPA's Strategic Goal 3: Cleaning Up Communities and Advancing Sustainable Development.

Continued Actions to Lessen Climate Change Impacts

While preparing for the potential impacts of climate change, leveraging materials and land management programs to achieve measurable greenhouse gas (GHG) reductions remains a focus of OSWER programs. It is estimated that approximately 42% of GHG emissions are attributable to materials management activities and approximately 16% are related to land management choices. To promote continued GHG reductions, OSWER is increasing efforts for the advancement of life-cycle-analyses, the promotion of sustainable production and material management, as well as promoting the use of green remediation principles that reduce emissions during cleanups.

Source: USEPA. (2009). Opportunities to Reduce or Avoid Greenhouse Gas Emissions through Materials and Land Management Practices.

Priority Actions

OSWER has identified 26 priority actions to begin over the next 3 years. These actions are in one or more of the four programmatic focus areas and one cross-cutting category. The actions are found in a summary chart in Appendix C and are listed below by programmatic focus area and office.

Preserving Land – Proper Management of Hazardous & Non-Hazardous Wastes

Proper treatment, storage, and disposal of hazardous waste protect the environment from harmful contamination. To ensure these materials are properly managed, OSWER supports prevention by activities such as permitting and inspections. Non-hazardous waste must also be properly managed, both routinely and in times of emergency.

In the "Proper Management of Hazardous and Non-Hazardous Wastes" focus area, the vulnerability that ranked the highest was the management of surges in waste, particularly from the impacts of extreme events. ORCR is already involved in several efforts in this area and has identified several actions to respond to this vulnerability. These actions are also applicable in the "Emergency Response" focus area.

As a crucial part of the RCRA program, ORCR has also identified a long-term action that will begin to look at issues related to climate change and permitting programs. Even though, vulnerabilities related to permitting did not receive high criteria scores, particularly in terms of likelihood of occurrence and potential impacts.

Actions:

ORCR

- Based on outreach to states and tribes, develop recommendations for these stakeholders to incorporate climate change into RCRA Permitting Programs as appropriate (e.g., through robust implementation of technical standards for facility location and design).

ORCR (also in the Emergency Response section)

- Prepare Fact Sheets on proper management of wastes/debris associated with large natural disasters (e.g., electronic, household hazardous wastes, white goods, etc.).
- Continue collaborative development with the Office of Homeland Security, on an interactive electronic waste management planning tool to aid federal, state and local emergency planners and managers in development of waste/debris management plans.
- Finalize a document describing the "4 Step Process for Waste Management Planning."
- Update ORCR Homeland Security Website with updated waste management planning information.

Preserving Land – Reducing Chemical Risks and Releases

EPA has several programs in place to prevent contamination from chemical releases. Prevention is accomplished through effective operation and maintenance activities, containment strategies, as well as inspection and monitoring of facilities that deal with hazardous materials.

The actions in this programmatic focus area address activities that prevent contamination from occurring. Other vulnerabilities with high scores in this focus area will benefit from the actions to address remediation and containment approaches as described in "Restoring Land".

Actions:

OEM

- Incorporate sensitivity for climate change vulnerabilities into oil Spill Prevention, Control, and Countermeasure (SPCC) and Facility Response Plan (FRP) [3] inspector training.
- Incorporate into SPCC and FRP guidance the statement of potential vulnerabilities to oil facilities from catastrophic weather events due to climate change.
- Incorporate sensitivity for climate change vulnerabilities in risk management plan (RMP) [4] inspector training and guidelines.

Restoring Land

Accidents, spills, leaks and past improper disposal and handling of hazardous materials and wastes have resulted in tens of thousands of contaminated sites in the United States. Contaminated land can threaten human health and the environment, impact our water and air quality, and potentially hamper economic growth and the vitality of local communities. Numerous activities address the contamination, reduce risk to human health and the environment, and move the contaminated site along the cleanup process to return the site to use or reuse.

Two primary types of vulnerabilities were identified as the most critical in the "Restoring Land" focus area. First, several offices identified increased contaminant migration as having a high potential impact,

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[3] The Spill Prevention, Control, and Countermeasure (SPCC) rule includes requirements for oil spill prevention, preparedness, and response to prevent oil discharges to navigable waters and adjoining shorelines. The rule requires specific facilities to prepare, amend, and implement SPCC Plans. The SPCC rule is part of the Oil Pollution Prevention regulation, which also includes the Facility Response Plan (FRP) rule. A Facility Response Plan (FRP) demonstrates a facility's preparedness to respond to a worst case oil discharge. Under the Clean Water Act, as amended by the Oil Pollution Act, certain facilities that store and use oil are required to prepare and submit these plans.

[4] Under the authority of section 112(r) of the Clean Air Act, the Chemical Accident Prevention Provisions require facilities that produce, handle, process, distribute, or store certain chemicals to develop a Risk Management Program, prepare a Risk Management Plan (RMP), and submit the RMP to EPA.

high probability of occurrence, and often under the control of EPA programs. Second, remedy effectiveness, which includes three separate vulnerabilities representing various stages of the cleanup process (remedy selection, remedy effectiveness during cleanup, and remedy effectiveness after a cleanup is complete), was also identified by several offices as having a high vulnerability score and a role for EPA involvement.

Numerous OSWER offices involved in cleanup activities identified either a short- or long-term action related to the vulnerabilities mentioned above. Due to the differences in how OSWER cleanup programs are implemented, whether at the headquarters office, in partnerships with states, or through grants, the actions differ across offices. There may, however, be areas where offices can share resources and knowledge, for example, as we learn more about the effectiveness of particular remedies under extreme climate conditions.

Actions:

ORCR

- Develop recommendations for states and tribes to encourage climate change considerations be incorporated into all of their RCRA Corrective Action Programs (e.g., regarding remedy selection, etc.).

OUST

- Work with the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) to gather information on if and how states currently:
    - alter remediation plans in response to changing climate impacts;
    - alter site assessments in response to flooding or drought conditions;
    - alter risk factors and rankings in response to flooding or drought conditions.
- Share information among states, tribes, and EPA regions regarding:
    - new or modified investigation strategies and remediation techniques;
    - new or modified assessment techniques;
    - how climate conditions may impact risk-based cleanup factors and rankings.

OBLR

- Work with regional staff to update the Analysis of Brownfields Cleanup Alternatives (ABCA) language in the brownfield grant Terms and Conditions to include language that requires recipients take potential changing climate conditions into consideration when evaluating cleanup alternatives.

- Develop an outreach strategy to promote the importance of climate change adaptation and mitigation, explaining how it will affect all communities at varying degrees and why it is important to consider when developing revitalization plans in their community.

OSRTI and FFRRO

- Share vulnerability screening protocol for regional application.
    - Develop criteria to identify remedies where performance may be impacted by climate change.
    - Develop a methodology to evaluate and ensure remedy protectiveness.
- Prepare remedy-specific climate change adaptation fact sheets for remedies most likely to be impacted and identify potential vulnerabilities and adaptation recommendations.
- Identify existing Superfund program processes (Remedial Investigation/Feasibility Study, Record of Decision, Remedial Design/Remedial Action, Five Year reviews, etc.) for implementation of climate change adaptation protocols to ensure continuing protectiveness of current and future remedies.
- Prepare training materials, coordinate with the National Association of Regional Project Managers (NARPM) co-chairs and Superfund forums to integrate the training into future NARPM events, and provide web-based content and training.
- Participate with OSWER and other EPA programs to initiate conversations as appropriate regarding approaches for handling remedy impacts from climate change.

Emergency Response

OSWER responds to a variety of emergencies, varying greatly in size, nature, and location, including natural disasters. OSWER staff act as response coordinators and on-site responders. In all cases, prompt action is crucial and the first priority is to eliminate dangers to the public; dangers include contamination from chemical releases in the air, water or soil and large amounts of waste. In addition to the responsibilities of OSWER's Office of Emergency Management, many other OSWER and EPA program offices play a role in addressing the impacts of emergency events.

The management of debris was a highly ranked vulnerability in this category, as well as in the "Proper Management of Hazardous and Non-Hazardous Waste" focus area. Several actions are identified to address this vulnerability.

The Emergency Operations Center (EOC) is a vital part of OSWER's response program. Actions are identified to ensure EOC staff are provided with the most accurate and comprehensive information that takes into consideration changes in climate.

Actions:

OUST

- Work with ASTSWMO to gather information on if and how states currently respond to climate-related emergencies (e.g., use of GIS mapping in flood-prone areas).
- Analyze lessons learned from Hurricanes Katrina (2005) and Sandy (2012) to identify how EPA can help states respond to UST-related hurricane impacts.
- Share information among states, tribes, and EPA regions regarding emergency response and preparedness (e.g., OUST's Flood Guide).

ORCR (also in the Proper Management of Hazardous and Non-Hazardous Wastes section)

- Prepare Fact Sheets on proper management of wastes/debris associated with large natural disasters (e.g., electronic, household hazardous wastes, white goods, etc.).
- Continue collaborative development with the Office of Homeland Security, on an interactive electronic waste management planning tool to aid federal, state and local emergency planners and managers in development of waste/debris management plans.
- Finalize a document describing the "4 Step Process for Waste Management Planning."
- Update ORCR Homeland Security Website to incorporate facts sheets, 4 Step Process, and updated waste management planning information.

OEM

- Utilize the National Response Team multi-agency membership (e.g., National Oceanic and Atmospheric Administration, Federal Emergency Management Agency, U.S. Coast Guard) to monitor the state of preparedness. Based on these meetings, evaluate if additional resources and planning exercises will be needed to address the impacts from changes in the frequency and/or severity of extreme weather events.
- Incorporate the use of FlexViewer technology as a preparedness tool for climate change impacts.
    - The EOC will build on-going development and use of FlexViewer technology to graphically display information on notifications and incidents in headquarters and all 10 regional EOCs. This technology will allow for improved and up-to-date Geographic Information System (GIS) mapping of watersheds and coastal areas impacted by climate change.
- Incorporate materials on the impacts of climate change as EOC training materials are updated and exercises are planned.

Tools, Data, Training and Outreach

In order to make informed decisions about program direction, design, and implementation, OSWER must use the best available data. As a result of climate change, assumptions about ecosystem conditions are shifting more rapidly, affecting the ability to predict potential weather patterns and map the geographic conditions at and around its sites.

Several vulnerabilities, including data collection and training, were identified as applicable and important to all OSWER offices. One of the primary challenges to incorporating climate change into its activities will be obtaining reliable projections of sea level rise, flooding zones, and other impacts of climate change. These projections will help guide decisions such as remedy selection. Access to this data is needed by all programs. In addition, training is a vital component of information dissemination and use; therefore, OSWER must appropriately consider relevant training. To best address these vulnerabilities it will be necessary for OSWER to work with regions and other EPA offices, including the Office of Research and Development, to ensure consistency across the agency.

Actions:

CPA

- Provide recommended data sources and parameters to OSWER offices and regions to ensure consistent mapping data and protocols. Develop these recommendations by working with the agency's climate change workgroup and EPA's Office of Research and Development.
- Participate in agency climate change adaptation training development, as well as develop specific training as needed for OSWER staff.
- Work with EPA partners and external experts to monitor evolving assumptions related to climate science. Develop a method for disseminating this information to OSWER offices that ensures consistent assumptions are used across all activities.

IV. Disproportionately Affected Populations

Disproportionate Impact

While climate change will affect all parts of society, it will have disproportionate effects on particular communities, demographic groups and geographic locations.[5] Certain parts of the population, such as children, the elderly, minorities, the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations can be especially vulnerable to the impacts of climate change. These disproportionately affected groups may have less ability to cope with or adapt to climate change due to economic, social, physical, or health constraints. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas.

Populations that are already overburdened by environmental contamination, poverty, and environmental health issues, may face greater adaptation challenges.[6] Though Hurricane Sandy was not necessarily due to climate change, the impacts resulting from associated flooding are similar to what could occur in a climate related flooding or storm surge event. Many of the elderly and poor in New York and New Jersey suffered significantly from flooding-associated power and heat loss, scarcity of food and supplies, and difficulty in accessing medical care.[7] These populations may have lacked the resources to evacuate outside the affected areas and as a result could not as readily avoid the adverse conditions resulting from the storm. During the recovery and reconstruction phases, vulnerable populations may also have a more difficult time due to underlying factors such as economic and social resource base and health status that can limit their access to resources as well as their ability to take action.

In addition, a community's location near a vulnerable ecosystem or a contaminated site may also result in differential impacts depending on how that ecosystem or site is impacted by climate change. Degraded ecosystems or those changed from human activities may place communities near them at higher risk for the effects of climate change. The ecosystems that may have served as a natural buffer against storm surge or may have provided valuable cultural, recreational, or other resources can no longer serve this purpose due to their altered state.[8] For example, an environmental justice community's resilience and ability to adapt to climate change may be complicated by their location both near a hazardous waste site

[5] USEPA. (2012). *Climate Change Adaptation Plan: Public Review Draft.*
[6] ibid.
[7] USEPA. (2012). Region 2 Adaptation Plan.
[8] USGCRP. (2009). *Global Climate Change Impacts in the United States*, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (Eds.). Cambridge University Press.

and in an area prone to increased climate-related storm surge. It is important to recognize the factors that may compound a community's vulnerability to climate change in order to implement effective strategies to increase adaptive capacity.

Climate change may also pose unique challenges to tribes and other indigenous populations. Tribes are particularly vulnerable to the impacts of climate change, due to the integral nature of the environment within their traditional lifestyles and culture. Partly due to their dependence upon a specific area for their livelihood, the degree to which those geographic areas embody climate-sensitive environments, and their unique cultural, economic, or political characteristics and contexts, tribes and indigenous groups may be especially sensitive to climate change related shifts in their environment.[9] Their ability to cope with climate-related hazards is further restricted by limited access to preparedness, response, and recovery resources.[10] While tribes and indigenous populations will likely be disproportionately vulnerable to climate change, they are uniquely positioned to provide valuable community level, culturally relevant data, information on climate change impacts, and relevant solutions.

For instance, Alaskan Natives are one population that is experiencing disproportionate impacts from climate change. Temperature increases associated with climate change have led to the melting of permafrost. In some cases, permafrost acts as a barrier to the transport of contaminants. With increased temperatures, thawing could allow contaminants to migrate more freely to adjoining areas and those effects would only accelerate with continued changes in the climate.[11] In several Alaskan coastal communities, melting ice and erosion have caused landfills to fall into the ocean, affecting environmental and human health.[12]

Partnerships

States, tribes, and local communities share responsibility for protecting human health and the environment, and partnerships with EPA are at the heart of the country's environmental protection system. These partnerships will be critical for efficient, effective, and equitable implementation of climate adaptation strategies. Strong partnerships make the most effective use of partners' respective bodies of knowledge, resources, and talents. Below is a summary of how OSWER currently works with underserved populations and tribes.

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[9] USEPA. (2012). *Climate Change Adaptation Plan: Public Review Draft*.
[10] Cutter, S.L. and C. Finch. (2008). "Temporal and spatial changes in social vulnerability to natural hazards." *Proceedings of the National Academy of Science* 105(7): 2301-2306.
[11] USGCRP. (2009). *Global Climate Change Impacts in the United States*, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (Eds.). Cambridge University Press.
[12] The National Climate Assessment and Development Advisory Committee Report (Draft for public comment)

Ongoing Partnerships to Address Vulnerable Populations and Places

OSWER has identified three focus areas to address environmental justice (EJ) in its programs. These focus areas are designed to integrate ongoing EJ activities and produce tangible outcomes in overburdened and underserved communities impacted by OSWER programs. These focus area activities listed below are designed to meaningfully advance EJ in OSWER programs, have EJ as the central focus, and can produce meaningful, measurable outcomes in low income and minority communities.

- **Focus Area #1:** Incorporate EJ considerations into OSWER programs, policies, and activities by addressing disproportionately high, adverse human health and environmental impacts on overburdened and underserved populations to the greatest extent practicable and permitted by law
- **Focus Area #2:** Institute a continual learning process through training and the use of agency environmental justice tools to help OSWER staff better serve overburdened and underserved communities
- **Focus Area #3**: Expand community engagement approaches and increase partnership building which allows overburdened and underserved communities to meaningfully participate in decision making activities and address local environmental concerns.

Ongoing Partnerships with Tribes

EPA values its unique government-to-government relationship with Indian 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* and the *2011 Policy on Consultation and Coordination with Indian Tribes*. These policies recognize and support the sovereign decision-making authority of tribal governments. OSWER works as a partner with many Tribal Nations to implement OSWER programs. OSWER's partnership with tribes is based on its tribal strategy.[13] The long-term goal of the tribal strategy is to support and provide direction for OSWER's Indian program, enhance outreach efforts with tribes on environmental protection in Indian country, and maintain consistency with EPA's Indian Policy. OSWER short-term strategies include:

- Ensure appropriate government-to-government consultation and communication with tribal leaders in accordance with EPA's *2011 Policy*.
- Build tribal capacity. OSWER provides support through training, financial support, and technical assistance to tribes to build capacity in assuming regulatory and program management responsibilities. Additionally, OSWER develops guidance and provides for research in

[13] USEPA, Office of Solid Waste and Emergency Response. (2008). *Tribal Strategy: EPA & Tribal Partnership to Preserve and Restore Land in Indian Country*.

cooperation with tribes to clarify key issues and/or obtain relevant information for addressing issues potentially affecting tribal health and the environment.

- Facilitate meaningful communication, coordination, and cooperation within OSWER on tribal issues and cultural awareness.

EPA engaged tribes through a formal consultation process in the development of the agency's *Climate Adaptation Plan.* Tribes identified erosion, temperature change, drought, and various changes in access to and quality of water as some of the most pressing issues. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. At the same time, tribes challenged EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative burdens are reduced.

Priority Actions

Community Engagement

One of the principles guiding OSWER's efforts to integrate climate adaptation into its programs, policies, and rules calls for its adaptation plans to prioritize helping people, places, and infrastructure that are most vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society. Within OSWER, community engagement is a critical component to how the office does its job of protecting human health and the environment. Effective community engagement is about a process of interactions that builds relationships over time and recognizes and emphasizes the community's role in identifying concerns and participating in formulating solutions. It establishes a framework for collaboration and deliberation. In the broadest sense, community engagement in environmental decision-making is the inclusion of the community in the process of defining the problem and developing solutions and alternatives.

For climate change decision-making processes to be effective they must be transparent and accessible and communities must be well informed and engaged. Communities should therefore have access to clear and understandable information. The local knowledge and input gained from meaningful engagement with the full diversity of the community will help to strengthen OSWER's decisions about climate change adaptation and the actions developed to address vulnerabilities, ensuring that these activities are well suited to the community's particular needs and circumstances. OSWER will work in partnership with communities to increase their adaptive capacity and resilience to climate change impacts. These efforts

will be informed by experiences with the impacts of previous extreme weather events (*e.g.*, Hurricane Katrina and Superstorm Sandy) and the subsequent recovery efforts.

Adaptation actions must recognize and be tailored to the specific issues at the regional, state, local, and community levels.[14] OSWER can provide federal leadership, guidance, information, and support which are vital to planning for and implementing adaptive actions, however, adaptation planning must include collaboration between multiple stakeholders including state and local governments, tribes, communities, non-governmental organizations and others.

Vulnerable Population Actions

OSWER will give special attention to populations and places that are most vulnerable to climate related impacts to its sites. OSWER will also continue to work to better understand the populations that surround these sites in order to expand its knowledge on potential impacts and better protect vulnerable communities and places.

Actions:

- Work with the agency's climate change workgroup and EPA's Office of Research and Development to ensure consistent mapping data and protocols to better understand the intersections of climate impacts and population vulnerability and help to inform future policy and office activities and ensure they take evolving climate science into account.
- Review and update as necessary, existing community engagement tools and training to incorporate climate change concerns in how we partner with communities, based on new knowledge relating to climate change.

In addition, the Community Engagement Network being created by OSWER may provide a valuable internal forum for sharing and gathering information about best practices for engaging communities in climate change conversations.

Tribal Actions

Supporting the development of adaptive capacity among tribes is a priority for the EPA. Networks and partnerships already in place will be used to assist tribes with climate change issues, including Regional Tribal Operations Committees, the Institute for Tribal Environmental Professionals and the Indian General Assistance Program. Transparency and information sharing will be a focus, in order to leverage activities already taking place within EPA offices and tribal governments.

[14] USGCRP. (2009). *Global Climate Change Impacts in the United States*, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (Eds.). Cambridge University Press.

Actions:

- Work with the agency's climate change workgroup and EPA's Office of Research and Development to share mapping data and protocols with its partners, including tribes to help inform their adaptation activities.
- Assist the Institute for Environmental Tribal Professionals (ITEP) in developing adaptation into their normal climate change training.

Collaborative efforts on climate change will benefit from the expertise provided by tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change and has been used by tribes for millennia as a valuable tool to adapt to changing surroundings. Consistent with the principles in EPA's Indian Policy, TEK should be viewed as a complementary resource that can inform planning and decision making.

Supporting Regions

While OSWER headquarters program offices are taking actions to address climate change adaptation, much of the work with tribes and vulnerable populations will occur within the EPA regions, since climate change has many impacts that transcend media and regional boundaries. OSWER plans to coordinate with and support regional and program office actions by working to ensure that they have access to evolving climate science and standardized data to inform policy and other activities. For instance, data could be used for mapping impacts relating to vulnerable populations and tribes. Data driven mapping will help ensure that adaptation actions can be prioritized and tailored to those populations who are most at risk for disproportionate impact from climate change. Data can also be shared with tribes to help them create adaptation strategies to address their climate change impacts.

V. Measures and Evaluation

The actions proposed in this plan expand OSWER's efforts to mainstream and integrate climate change adaptation into its programs. OSWER will monitor the status of climate science, particularly as it relates to known or anticipated impacts on OSWER's program areas, as well as the effectiveness of its program activities under changing conditions, and update or adjust its direction as necessary. OSWER commits to periodically publicly reporting on progress implementing these actions and what it has accomplished in website updates or factsheets.

To measure and evaluate progress toward completing actions, the workgroup that developed this document will continue to meet to discuss progress implementing actions and share information that may assist other offices in their efforts. Collaborative tools may also be utilized to facilitate the discussion.

VI. Legal and Enforcement Issues

OSWER works closely with the Office of General Counsel (OGC) to ensure that its actions are legally supported and in compliance with all applicable laws. OSWER will continue to work with OGC as it plans for and develops programming related to adaptation and the impacts of climate change.

OSWER will partner with the Office of Site Remediation Enforcement (OSRE) to address enforcement concerns related to climate change issues. OSWER and OSRE will work together to develop tools that address climate change policy questions as well as site-specific issues.

Appendix A – Effect of Climate Change Impacts on OSWER Program Vulnerabilities

The ✸ symbol indicates climate change impacts that are expected to significantly contribute to the identified program vulnerabilities. Note: The likelihood of occurrence for each climate change impact is taken from EPA's Climate Change Adaptation Plan. Additional sources are found at the end of the table.

	Climate Change Impact								
	Increased extreme temps[1]	Sustained changes in average temp[1]	Sea level rise[2]	Decreased permafrost[3]	Decreased precipitation increasing drought[4]	Increased heavy precipitation events[1]	Increased flood risk[4]	Increased frequency & intensity of wildfires[5]	Increased intensity of hurricanes[1]
Program Vulnerability	**Very Likely**			**Likely**					
Preserving Land – Proper Management of Hazardous and Non-Hazardous Wastes									
Design and placement of RCRA Treatment, Storage and Disposal facilities, non-hazardous Subtitle D landfills, Superfund remedies and municipal recycling facilities may need to change to accommodate climate change impacts.						✸	✸	✸	✸
Hazardous waste permitting requirements may need to be updated to reflect climate change impacts.	✸	✸	✸	✸		✸	✸	✸	✸
Current waste management capacity, including interim capacity, may be insufficient to handle surges in necessary treatment and disposal of hazardous and municipal wastes, as well as mixed wastes generated from climate events.						✸	✸	✸	✸
Levels of necessary financial assurance at RCRA and CERCLA facilities may need to adjust for increased risks/liabilities at specific facilities that may be directly affected by climate change impacts.	✸	✸	✸	✸	✸	✸	✸	✸	✸
Preserving Land – Reducing Chemical Risks and Releases									
Remediation and containment strategies and materials used in construction may need to be strengthened to reflect changing climate conditions.	✸	✸	✸	✸		✸	✸	✸	✸
Current equipment, scientific monitoring and sampling protocols on sites may no longer be effective and therefore may require adjustments due to climate change impacts.	✸	✸			✸	✸	✸	✸	✸
Current assumptions regarding protectiveness of remediation and containment methods may not reflect changing climate impacts.	✸	✸	✸	✸	✸	✸	✸	✸	✸
Spill Prevention Plans may need to be updated due to the significant increases in the incidence of flooding and storm events.			✸			✸	✸	✸	✸

Program Vulnerability	Climate Change Impact								
	Increased extreme temps[1]	Sustained changes in average temp[1]	Sea level rise[2]	Decreased permafrost[3]	Decreased precipitation increasing drought[4]	Increased heavy precipitation events[1]	Increased flood risk[4]	Increased frequency & intensity of wildfires[5]	Increased intensity of hurricanes[1]
	Very Likely			Likely					
Restoring Land									
Site characterization and design of cleanups may not reflect changing climate conditions.	✸	✸	✸		✸	✸	✸	✸	✸
Risk factors and rankings for risk-based cleanup strategies may need to be reassessed based on changing climate conditions.			✸			✸	✸	✸	✸
Changing climate conditions may impact continued remedy effectiveness.	✸	✸	✸	✸	✸	✸	✸	✸	✸
Remedies that are "complete" or are long-term actions may no longer be protective and resilient as climate conditions change at site.	✸	✸	✸	✸	✸	✸	✸	✸	✸
Increased contaminant migration may lead to boundary changes at current sites or creation of new sites.			✸	✸		✸	✸	✸	✸
Changes in climate conditions may alter assumptions about contaminant form/volatility.	✸	✸	✸	✸	✸	✸	✸	✸	✸
Current scientific monitoring and sampling protocols on sites may no longer be effective.	✸	✸			✸	✸	✸	✸	✸
Safety procedures on sites may not reflect likelihood or intensity of surrounding conditions.	✸	✸	✸			✸	✸	✸	✸
Availability of utilities and transportation infrastructure may be limited as a result of increased impacts to those systems.	✸		✸	✸		✸	✸	✸	✸
Current assumptions regarding protectiveness of remediation and containment methods may not reflect changing climate impacts.	✸	✸	✸	✸	✸	✸	✸	✸	✸
Periodic evaluations of implemented remedies may not incorporate all climate change impacts, including changes in frequency and intensity that may impact remedy effectiveness.	✸	✸	✸	✸	✸	✸	✸	✸	✸
Use of natural resources impacted by sites may change as a result of increased need, resource scarcity, or compromised resources.			✸		✸	✸	✸	✸	✸

Program Vulnerability	Climate Change Impact								
	Increased extreme temps[1]	Sustained changes in average temp[1]	Sea level rise[1]	Decreased permafrost[2]	Decreased precipitation increasing drought [3]	Increased heavy precipitation events[1]	Increased flood risk[3]	Increased frequency & intensity of wildfires[4]	Increased intensity of hurricanes[1]
	Very Likely			Likely					
Emergency Response									
Current levels of administrative, enforcement, and emergency response staff may be insufficient to cover needs if number of extreme events increase.						✸	✸	✸	✸
Sufficient capability and capacity for conducting necessary lab analysis following significant weather events may not be available.						✸	✸	✸	✸
Current waste management capacity, including interim capacity, may be insufficient to handle surges in necessary treatment and disposal of hazardous and municipal wastes, as well as mixed wastes generated from climate events.						✸	✸	✸	✸
Training needs (both current and future) are likely to increase in order to meet the increase demand for response actions.						✸	✸	✸	✸
Existing emergency planning currently required or employed by OSWER may not sufficiently consider elevated risks from multiple climate impacts.	✸		✸			✸	✸	✸	✸

1. IPCC. (2012). "Summary for Policymakers." In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. C.B. Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea,K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (Eds.). *A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge, UK, and New York, NY, USA.

2. IPCC. (2008). *Climate Change and Water: Technical Paper of the Intergovernmental Panel on Climate Change*. B.C. Bates, Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds. IPCC Secretariat, Geneva.

3. USGCRP. (2009). *Global Climate Change Impacts in the United States*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (Eds.). Cambridge University Press.

4. IPCC. (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E.Hanson (Eds.), Cambridge, UK : Cambridge University Press.

Appendix B – Vulnerability Scorecard[1]

Program Vulnerability	Office	Characterization Criteria: Total Score	Scale of impact (Scale 1-10 10(High) -1(Low))	Likelihood of occurrence (Scale 1-10 10(High) -1(Low))	Opportunities for OSWER to Make a Difference: Total Score	Role for EPA technical expertise? (Scale 1-5 5(Yes)-1(No))	Are climate impacts currently considered? (Scale 1-5 5(Not) – 1(Fully))	Would build momentum or leverage current activities. (Scale 1-5 5(Very Likely)-1(Not Likely))	Can incorporate into ongoing effort? (Scale 1-5 5(Very Likely)-1(Not Likely))
Preserving Land – Proper Management of Hazardous and Non-Hazardous Wastes									
Design and placement of RCRA Treatment, Storage and Disposal facilities, non-hazardous Subtitle D landfills, Superfund remedies and municipal recycling facilities may need to change to accommodate climate change impacts.	FFRRO	6	**5**	1	12	4	2	3	3
	ORCR	6	**5**	1	10	2	3	4	1
	OSRTI	6	**5**	1	18	5	3	5	5
Hazardous waste permitting requirements may need to be updated to reflect climate change impacts.	FFRRO	15	10	5	14	5	2	4	3
	ORCR	6	5	1	13	5	3	4	1
Current waste management capacity may be insufficient to handle surges in necessary treatment and disposal of hazardous and municipal wastes, as well as mixed wastes generated from climate events.	FFRRO	20	10	10	8	1	3	3	1
	ORCR	15	5	10	15	4	3	4	4
	OSRTI	15	5	10	18	5	3	5	5
Levels of necessary financial assurance at RCRA and CERCLA facilities may need to adjust for increased risks/liabilities at specific facilities that may be directly affected by climate change impacts.	FFRRO	10	**5**	5	12	4	2	3	3
	ORCR	10	5	5	8	3	3	1	1
	OSRTI	10	5	5	15	5	3	4	3
Preserving Land – Reducing Chemical Risks and Releases									
Remediation and containment strategies and materials used in construction may need to be strengthened to reflect changing climate conditions.	FFRRO	15	8	7	8	1	2	3	2
	ORCR	10	5	5	14	5	3	4	2
	OSRTI	10	5	5	18	5	3	5	5
Current equipment, scientific monitoring and sampling protocols on sites may no longer be effective and therefore may require adjustments due to climate change impacts.	FFRRO	12	5	7	10	1	3	3	3
	ORCR	2	1	1	9	4	3	1	1
	OSRTI	2	1	1	18	5	3	5	5
Current assumptions regarding protectiveness of remediation and containment methods may not reflect changing climate impacts.	FFRRO	10	5	5	8	1	2	4	1
	ORCR	15	5	10	6	3		2	1
	OSRTI	16	8	8	8	2	3	1	2
Spill Prevention Plans may need to be updated due to the significant increases in the incidence of flooding and storm events.	OEM	4	2	2	6	2	1	2	1

Program Vulnerability	Office	Characterization Criteria: Total Score	Scale of impact (Scale 1-10 10(High) -1(Low))	Likelihood of occurrence (Scale 1-10 10(High) -1(Low))	Opportunities for OSWER to Make a Difference: Total Score	Role or technical expertise? (Scale 1-5 5(Yes)-1(No))	Currently considered? (Scale 1-5 5(Not) – 1(Fully))	Build momentum or leverage current activities. (Scale 1-5 5(Very Likely)-1(Not Likely))	Ongoing effort? (Scale 1-5 5(Very Likely)-1(Not Likely))
Restoring Land									
Site characterization and design of cleanups may not reflect changing climate conditions.	FFRRO	11	6	5	7	1	2	3	1
	ORCR	10	5	5	13	3	2	4	4
	OSRTI	10	5	5	18	5	3	5	5
	OBLR	10	5	5	13	2	4	4	3
Risk factors and rankings for risk-based cleanup strategies may need to be reassessed based on changing climate conditions.	FFRRO	15	10	5	13	4	3	3	3
	ORCR	10	5	5	14	3	3	4	4
	OSRTI	10	5	5	18	5	3	5	5
	OBLR	10	5	5	11	2	4	3	2
	OUST	6	1	5	7	1	3	1	2
Changing climate conditions may impact continued remedy effectiveness.	FFRRO	17	10	7	14	3	4	5	2
	ORCR	15	10	5	15	4	3	4	4
	OSRTI	12	7	5	18	5	3	5	5
	OBLR	15	10	5	11	2	4	3	2
Remedies that are “complete” or are long-term actions may no longer be protective and resilient as climate conditions change at site.	FFRRO	18	10	8	14	3	4	4	3
	ORCR	10	5	5	15	4	3	4	4
	OSRTI	18	8	10	18	5	3	5	5
	OBLR	10	5	5	12	2	4	3	3
Increased contaminant migration may lead to boundary changes at current sites or creation of new sites.	FFRRO	17	10	7	12	4	3	3	2
	ORCR	20	10	10	13	3	2	4	4
	OSRTI	20	10	10	18	5	3	5	5
	OBLR	20	10	10	10	2	4	2	2
	OUST	15	5	10	7	1	3	1	2
Changes in climate conditions may alter assumptions about contaminant form/volatility.	FFRRO	16	8	8	14	4	4	3	3
	ORCR	6	5	1	10	3	5	1	1
	OSRTI	6	5	1	14	3	3	3	5
	OBLR	6	5	1	8	1	3	2	2

Program Vulnerability	Office	Characterization Criteria: Total Score	Scale of impact (Scale 1-10 10(High) -1(Low))	Likelihood of occurrence (Scale 1-10 10(High) -1(Low))	Opportunities for OSWER to Make a Difference: Total Score	Role or technical expertise? (Scale 1-5 5(Yes)-1(No))	Currently considered? (Scale 1-5 5(Not) – 1(Fully))	Build momentum or leverage current activities (Scale 1-5 5(Very Likely)-1(Not Likely))	Ongoing effort? (Scale 1-5 5(Very Likely)-1(Not Likely))
Restoring Land (continued)									
Current scientific monitoring and sampling protocols on sites may no longer be effective.	FFRRO	15	7	8	14	4	4	3	3
	ORCR	2	1	1	16	5	5	3	3
	OSRTI	2	1	1	16	3	3	5	5
	OBLR	2	1	1	9	1	4	2	2
Safety procedures on sites may not reflect likelihood or intensity of surrounding conditions.	FFRRO	6	5	1	15	3	5	3	4
	OSRTI	6	5	1	17	4	3	5	5
	OBLR	6	5	1	8	1	3	2	2
Availability of utilities and transportation infrastructure may be limited as a result of increased impacts to those systems.	FFRRO	10	5	5	12	3	3	3	3
	OSRTI	15	10	5	13	2	3	5	3
	OBLR	15	10	5	11	2	3	3	3
Current assumptions regarding protectiveness of remediation and containment methods may not reflect changing climate impacts.	FFRRO	17	7	10	10	4	2	4	-
	ORCR	15	5	10	15	4	3	4	4
	OSRTI	15	5	10	16	5	3	3	5
	OBLR	15	5	10	12	2	4	3	3
	OUST	15	5	10	7	1	3	1	2
Periodic evaluations of implemented remedies may not incorporate all climate change impacts, including changes in frequency and intensity that may impact remedy effectiveness.	FFRRO	10	5	5	14	3	3	4	4
	ORCR	10	5	5	16	4	4	4	4
	OSRTI	10	5	5	18	5	3	5	5
	OBLR	10	5	5	8	1	4	2	1
Use of natural resources impacted by sites may change as a result of increased need, resource scarcity, or compromised resources.	FFRRO	10	5	5	12	3	3	3	3
	OBLR	6	5	1	9	2	4	2	1

Program Vulnerability	Office	Characterization Criteria: Total Score	Scale of impact (Scale 1-10 10(High) -1(Low))	Likelihood of occurrence (Scale 1-10 10(High) -1(Low))	Opportunities for OSWER to Make a Difference: Total Score	Role or technical expertise? (Scale 1-5 5(Yes)-1(No))	Currently considered? (Scale 1-5 5(Not) – 1(Fully))	Build momentum or leverage current activities. (Scale 1-5 5(Very Likely)-1(Not Likely))	Ongoing effort? (Scale 1-5 5(Very Likely)-1(Not Likely))
Emergency Response									
Current levels of administrative, enforcement, and emergency response staff may be insufficient to cover needs if number of extreme events increase.	OEM	4	3	1	5	2	1	1	1
	ORCR	20	10	10	9	1	4	2	2
Sufficient capability and capacity for conducting necessary lab analysis following significant weather events may not be available.	FFRRO	10	5	5	-	-	-	-	-
	ORCR	10	5	5	9	1	4	2	2
Current waste management capacity, including interim capacity, may be insufficient to handle surges in necessary treatment and disposal of hazardous and municipal wastes, as well as mixed wastes generated from climate events.	FFRRO	15	7	8	-	-	-	-	-
	ORCR	15	5	10	18	5	3	5	5
Training needs (both current and future) are likely to increase in order to meet the increase demand for response actions.	ORCR	15	5	10	12	3	4	3	2
Existing emergency planning currently required or employed by OSWER may not sufficiently consider elevated risks from multiple climate impacts.	OUST	10	5	5	10	3	3	2	2

1. OSWER did not conduct a detailed quantitative assessment of vulnerabilities to determine scores. Using best professional judgement and information from peer-reviewed scientific literature, the OSWER workgroup members determined values for each criteria. When applying the criteria, offices did not evaluate vulnerabilities in relation to each other, but instead considered each vulnerability independently. These tables are not intended to be a ranking, but rather as a useful and informative guide for OSWER offices as they determine which vulnerabilities to focus activities.

Characterization Criteria:

Scale of impact to human health, the environment or vulnerable communities because of the vulnerability.

Likelihood of occurrence because of the vulnerability.

Opportunities for OSWER to Make a Difference:

Does EPA have a unique or lead role or technical expertise in this area?

To what extent are climate impacts currently not considered in this area?

To what extent could additional EPA involvement build momentum or leverage current activities?

Is there an opportunity to incorporate climate change into an ongoing effort (e.g., rulemaking, changes to grant criteria, updates to guidance and training)?

Appendix C – OSWER Actions

Theme		Vulnerability	Office	Action	Timing
Preserving Land	Proper Management of Hazardous and Non-Hazardous Waste	Design and placement of RCRA Treatment, Storage and Disposal facilities may need to change to accommodate climate change impacts.	ORCR		L
		Current waste management capacity may be insufficient to handle surges in necessary treatment and disposal of hazardous and municipal wastes, as well as mixed waste events. *(Actions also in Emergency Response)*		Prepare Fact Sheets on the proper management of wastes/debris associated with large natural disasters (e.g., electronic, household hazardous wastes, white goods, etc.)	S
				Continue collaborative development with the Office of Homeland Security on an interactive electronic waste management planning tool to aid federal, state and local emergency planners and managers in development of waste/debris management plans.	L
				Finalize a document describing the "4 Step Process for Waste Managment Planning."	M
				Update the ORCR Homeland Security Website with updated waste management planning information.	M
	Reducing Chemical Risks and Releases	Spill Prevention Plans may need to be updated due to the significant increases in the incidence of flooding and storm events.	OEM	Incorporate sensitivity for climate change vulnerabilities in oil Spill Prevention, Control, and Countermeasure (SPCC) and Facility Response Plan (FRP) inspector training (e.g., reminding inspectors to consider vulnerabilities at the subject facility during catastrophic weather events).	M
				Incorporate in SPCC and FRP guidance the statement of potential vulnerabilities to oil facilities from catastrophic weather events due to climate change.	M
				Incorporate sensitivity for climate change vulnerabilities in risk management plan (RMP) inspector training and guidelines. (e.g., example, reminding inspectors to consider vulnerabilities at the subject facility during catastrophic weather events).	M

Theme	Vulnerability	Office	Action	Timing
Restoring Land	Increased contaminant migration may lead to boundary changes at current sites or creation of new sites. Current assumptions regarding protectiveness of remediation and containment methods may not reflect changing climate impacts. Changing climate conditions may impact continued remedy effectiveness. Remedies that are "complete" or are long-term actions may no longer be protective and resilient as climate conditions change at site.	ORCR	Develop recommendations for states and tribes to encourage that climate change considerations be incorporated into all of their RCRA Corrective Action Programs (e.g., regarding remedy selection, etc.)	L
		OSRTI/ FFRRO	Share vulnerability screening protocol for regional application. - Develop criteria to identify remedies where performance may be impacted by climate change. - Develop a methodology to evaluate and ensure remedy protectiveness.	M
			Prepare remedy-specific climate change adaptation fact sheets for remedies most likely to be impacted and identify potential vulnerabilities and adaptation recommendations.	M
			Identify existing Superfund program processes (RI/FS, ROD, RD/RA, Five Year reviews, etc.) for implementation of climate change adaptation protocols to ensure continuing protectiveness of current and future remedies.	S
			Prepare training materials, coordinate with NARPM co-chairs and Superfund forums to integrate the training into future NARPM events, and provide web-based content and training.	M
			Participate with OSWER and other EPA programs to initiate conversations as appropriate regarding approaches for handling remedy impacts from climate change.	M
			Work with ASTSWMO to gather information on if and how states currently alter remediation plans in response to changing climate impacts.	L
			Share information among states, tribes and EPA regions regarding new or modified investigation strategies and remediation techniques.	L
			Work with ASTSWMO to gather information on if and how states currently alter site assessments in response to flooding or drought conditions.	L
			Share information among states, tribes and EPA Regions regarding new or modified assessment techniques.	L
	Risk factors and rankings for risk-based cleanup strategies may need to be reassessed based on changing climate conditions.		Work with ASTSWMO to gather information on if and how states currently alter risk factors and rankings in response to flooding or drought conditions.	L
			Share information among states, tribes and EPA regions regarding how climate conditions may impact risk-based cleanup factors and rankings.	L
	Site characterization and design of cleanups may not reflect changing climate conditions.	OBLR	Work with regional staff to update the Analysis of Brownfields Cleanup Alternatives (ABCA) language in the brownfield grant T&Cs to include language that requires recipients take potential changing climate conditions into consideration when evaluating cleanup alternatives.	S
			Develop an outreach strategy to promote the importance of climate change adaptation and mitigation, explaining how it will affect all communities at varying degrees and why it's important to consider when developing revitalization plans in their community.	S

Theme	Vulnerability	Office	Action	Timing
Emergency Response	Existing emergency planning currently required or employed by OSWER may not sufficiently consider elevated risks from multiple climate impacts.	OUST	Work with ASTSWMO to gather information on if and how states currently respond to climate-related emergencies (e.g., use of GIS mapping in flood-prone areas).	M
			Analyze lessons learned from Hurricanes Katrina (2005) and Sandy (2012) to identify how EPA can help states respond to UST-related hurricane impacts.	M
			Share information among states, tribes and EPA regions regarding emergency response and preparedness (e.g., OUST's Flood Guide).	M
	Current waste management capacity may be insufficient to handle surges in necessary treatment and disposal of hazardous and municipal wastes, as well as mixed waste events. *(Actions also in Proper Management of Hazardous and Non-Hazardous Waste)*		Prepare fact sheets on the proper management of wastes/debris associated with large natural disasters (e.g., electronic, household hazardous wastes, white goods, etc.)	S
			Continue collaborative development with the Office of Homeland Security, on an interactive electronic waste management planning tool to aid federal, state and local emergency planners and managers in development of waste/debris management plans.	L
			Finalize a document describing the "4 Step Process for Waste Managment Planning."	M
			Update the ORCR Homeland Security Website with updated waste management planning information.	M
	Current levels of administrative, enforcement, and emergency response staff may be insufficient to cover needs if number of extreme events increase.	OEM	Utilize the National Response Team multi-agency membership (e.g., NOAA, FEMA, U.S. Coast Guard) to monitor the state of preparedness. Based on these meetings, evaluate if additional resources and planning exercises will be needed to address the impacts from changes in the frequency and/or severity of extreme weather events.	S
	Existing emergency planning currently required or employed by OSWER may not sufficiently consider elevated risks from multiple climate impacts.		Incorporate the use of FlexViewer technology as a preparedness tool for climate change impacts. -The EOC will build on-going development and use of FlexViewer technology to graphically display information on notifications and incidents in headquarters and all 10 regional EOCs. This technology will allow for improved and up-to-date GIS mapping of watersheds and coastal areas impacted by climate change.	S
	Training needs (both current and future) are likely to increase in order to meet the increase demand for response actions.		Incorporate materials on the impacts of climate change as EOC training materials are updated and exercises are planned.	M
Tools, Data, Training and Outreach	Identification of reliable data sources to use in site-specific analyses may need to be identified.	CPA	Provide recommended data sources and parameters to OSWER offices and Regions to ensure consistent mapping data and protocols. Develop these recommendations by working with the agency's climate change workgroup and EPA's Office of Research and Development.	S
	Revised training protocols and SOPs that take into account climate change impacts and what to look for may need to be developed.		Participate in agency climate change adaptation training development, as well as develop specific training as needed for OSWER staff.	S
	Models, decision tools, site environmental data and information feeds may need to be updated to reflect changing climate conditions.		Work with EPA partners and external experts to monitor evolving assumptions related to climate science. Develop a method for disseminating this information to OSWER offices that ensures consistent assumptions are used across all activities.	S

Theme	Vulnerability	Office	Action	Timing
Vulnerable Populations and Tribes	All vulnerabilities should include consideration of potential impacts to vulnerable populations and tribes. To emphasize the importance of this, consideration of impacts to vulnerable populations was included in the characterization criteria.	All OSWER Offices	Work with the agency's climate change workgroup and EPA's Office of Research and Development to ensure consistent mapping data and protocols to better understand the intersections of climate impacts and population vulnerability and help to inform future policy and office activities and ensure they take evolving climate science into account.	S
			Review and update as necessary, existing community engagement tools and training to incorporate climate change concerns in how we partner with communities, based on new knowledge relating to climate change.	M
			Work with the agency's climate change workgroup and EPA's Office of Research and Development to ensure consistent mapping data and protocols that can be share with its partners, including tribes to help inform their adaptation activities.	S
			Assist the Institute for Environmental Tribal Professionals (ITEP) in developing adaptation into their normal climate change training.	M

Key:

Timing:
S: Short-term, initiated within one year
M: Medium-term, initiated within two years
L: Long-term, initiated after 3 years

Offices:
CPA—Center for Program Analysis; FFRRO –Federal Facilities Restoration and Reuse Office; OBLR – Office of Brownfields and Land Revitalization; OEM—Office of Emergency Management; ORCR – Office of Resource Conservation and Recovery; OSRTI – Office of Superfund Remediation and Technology Innovation; OUST – Office of Underground Storage Tanks

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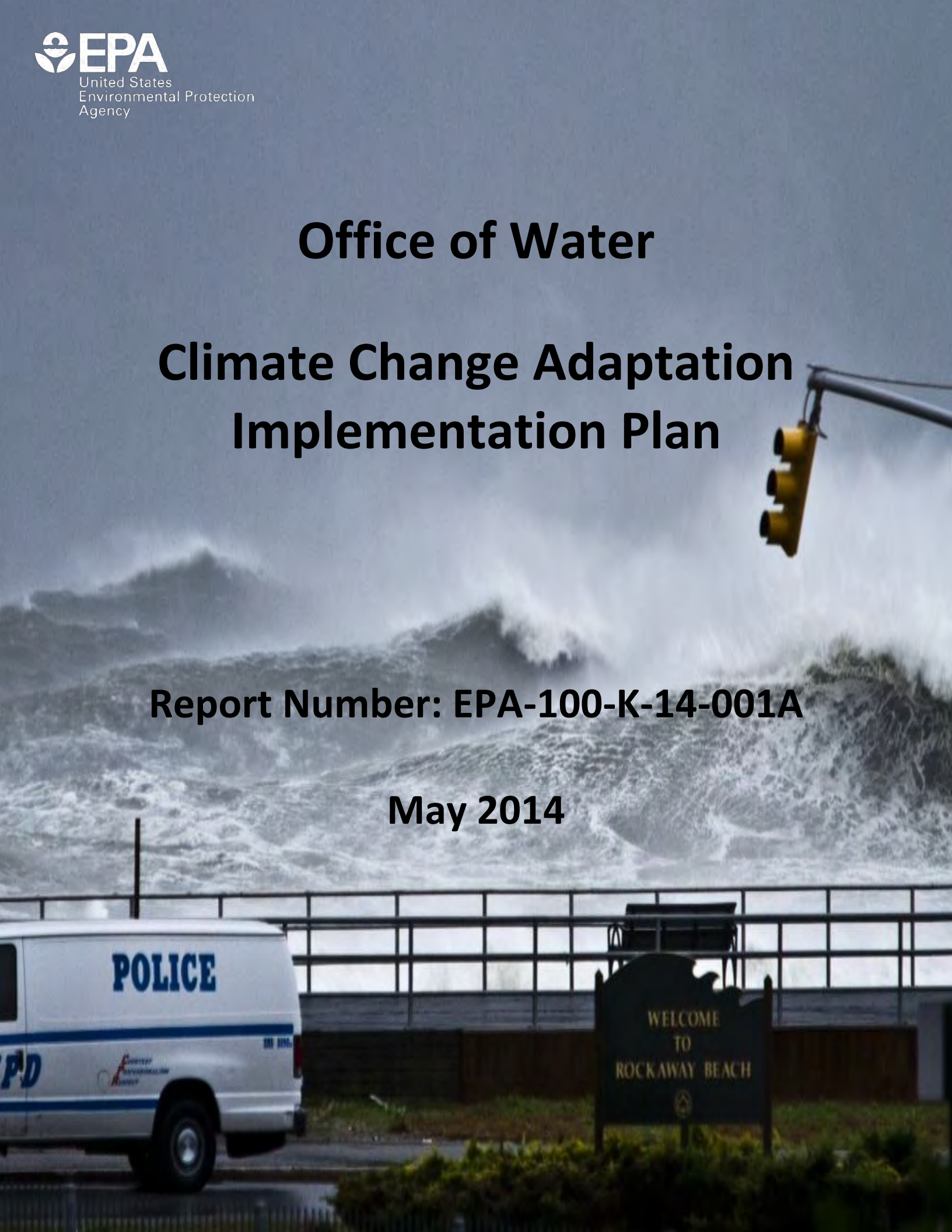
United States Environmental Protection Agency

Office of Water

Climate Change Adaptation Implementation Plan



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Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Bob Perciasepe

Deputy Administrator

September 2013

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Appendices

1. Table of Vision Areas, Goals and Strategic Actions from EPA *National Water Program 2012 Strategy: Response to Climate Change*
2. Graphic Illustrating the Organizational Framework for Climate Change work by the EPA National Water Program
3. EPA National Water Program Climate Change Workgroup: Principal Members
4. Table Illustrating the Climate Change Impacts on Clean Water and Drinking Water Program Components

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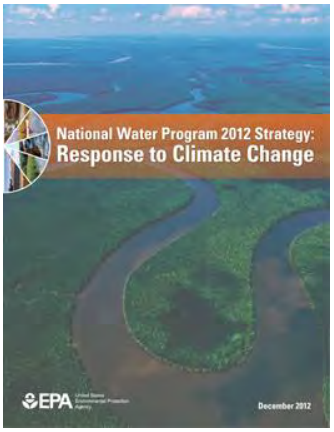

INTRODUCTION

This *Implementation Plan* provides an overview of the opportunities available to the Office of Water within the U.S. Environmental Protection Agency (EPA) to respond to the challenges that a changing climate poses for the successful operation of national programs to protect the quality of the national water resources and drinking water.

This *Plan* is organized using the framework adopted by the EPA for each of its major national offices and regional offices. Key elements of the *Plan* address:

- Vulnerability of water resources, including clean water and drinking water programs, to climate change;
- Priority actions for water program response to climate change;
- Office of Water contribution to meeting EPA strategic measures on climate change;
- Legal and enforcement issues;
- Training and outreach for climate change adaptation;
- Partnerships with Tribes;
- Populations and places vulnerable to a changing climate; and
- Program evaluation and cross-Agency pilot projects.

This *Plan* draws on, and is intended to help implement, the EPA *National Water Program 2012 Strategy: Response to Climate Change* published in December 2012. *The 2012 Strategy* describes long-term goals for the management of sustainable water resources in light of climate change and is intended to be a roadmap to guide future programmatic planning and inform decision makers during the Agency's annual planning process. The *2012 Strategy* is available at http://www.epa.gov/water/climatechange. Some initial steps by EPA national water programs and regional offices are described in *the 2012 Highlights of Progress* Report (available at the website above).

> "Many of the programs and activities already underway throughout the National Water Program…are even more important to do in light of climate change. However, climate change poses such significant challenges to the nation's water resources, that more **transformative approaches will be necessary**."
>
> *National Water Program 2012 Strategy: Response to Climate Change*; EPA; 2012; p. 1

The *2012 Strategy* identifies five long-term programmatic vision areas:

1. water infrastructure;
2. watersheds and wetlands;
3. coastal and ocean waters;
4. water quality; and
5. working with Tribes.

Climate Change Vision:

The National Water Program's overarching vision for responding to climate change is:

Despite the ongoing effects of climate change, the National Water Program intends to continue to achieve its mission to protect and restore our waters so that drinking water is safe; and aquatic ecosystems sustain fish, plants, and wildlife, as well as economic, recreational, and subsistence activities.

Each of these programmatic vision areas is supported by more specific goals and strategic actions. Additional goals and actions address "cross-cutting program support" topics. A table providing a brief summary of the 5 vision areas, 19 goals, and 53 strategic actions described in the *2012 Strategy* is provided in Appendix 1. Climate change issues and actions in climate regions across the country are also described in the *2012 Strategy*.

The National Water Program, including both EPA Headquarters offices and EPA Regional offices, has taken several steps to implement the new *2012 Strategy* including*:*

- Developing this *Implementation Plan* as part of the Agency-wide work to prepare EPA climate change adaptation implementation plans;

- Preparing internal workplans for 2013 and 2014 describing specific implementation actions that EPA Headquarters and Regional offices plan to implement;

- Committing to the continued operation of the EPA National Water Program State and Tribal Climate Change Council made up of representatives of States and Tribes to provide advice and guidance to the National Water Program in addressing issues related to climate change and water;

- Identifying future directions for the work on climate change issues in the EPA *FY 2015 Addendum* to the EPA *FY 2014 National Water Program Guidance for FY 2014;* and

- Committing to leadership of cooperative efforts with other organizations to address climate change and water issues including serving as co-chair of the Interagency Climate Change and Water Workgroup (made up of Federal agencies) and the Climate Change Workgroup of the Advisory Committee on Water Information (ACWI) made up of 40 stakeholder organizations and Federal agencies.

A graphic illustrating the organizational framework for the climate change work by the National Water Program is provided in Appendix 2. Appendix 3 provides a list of the principal members of the National Water Program Climate Change Workgroup that developed this *Plan.*

II. Vulnerability of Water Resources to Climate Change

The many impacts that a changing climate is likely to have on water resources, both freshwater and coastal resources, include:

1. Increases in water pollution problems as air and water warm;
2. More extreme weather events;
3. Changes to water availability (rain and snow level and distribution);
4. Sea level rise/storm surge and waterbody boundary movement and displacement;
5. Collective impacts on coastal areas; and
6. Indirect impacts resulting from changes in energy and fuel production.

The nature and extent of these impacts is described in greater detail below, together with the relationship of these impacts to clean water and drinking water program components. The association of climate change impacts on water with clean water and drinking water programs is illustrated using a chart of the full range of programs (see sample chart below). For each of the six climate change impacts identified above, the specific programs identified in the chart affected by the impacts are highlighted. This chart format illustrates both the programs expected to be affected by the specific type of climate change impacts and the programs expected to be less affected.

Clean Water and Drinking Water Program Template

Drinking Water Standards	Surface Water Standards	Technology Based Standards	Emergency Planning
Drinking Water Planning	Clean Water Planning	Water Monitoring	Water Restoration/ Total Maximum Daily Loads (TMDLs)
Underground Injection Control Permits	Discharge Permits	Storm Water Permits	Wetlands Permits
Source Water Protection	Nonpoint Pollution Control	Coastal Zone	National Estuaries Program
Drinking Water SRF (State Revolving Funds)	Clean Water SRF (State Revolving Funds)	Ocean Protection	Combined Sewer Overflow Plans

A table illustrating the collective climate change impacts on clean water and drinking water program components is provided in Appendix 4.

1) Increases in Water Pollution Problems as Air and Water Warm:

Warmer air temperatures will result in warmer water. Warmer water holds less dissolved oxygen making instances of low oxygen levels or "hypoxia" more likely (which is detrimental to the aquatic ecosystem); foster harmful algal blooms; and alter the toxicity of some pollutants. For further details on these impacts see pages 41-51, 56, 81, 87, 96, 122, 150, 151 in Karl et al., 2009.

Vulnerability Citations: Descriptions of vulnerabilities provided in this section are drawn from: *Global Climate Change Impacts in the United States,* Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.) Cambridge University Press, 2009 (Karl et al 2009). Connections of climate impacts to water programs are the assessment of water program managers.

As air and water warm, water resource managers will likely face significant challenges:

- increased pollutant concentrations and lower dissolved oxygen levels will result in higher incidences of impaired water quality; (Karl et al.; p. 46)
- increased growth of algae and microbes will affect drinking water quality; (Ibid; p. 46, 96)
- some aquatic taxa will be replaced by other taxa better adapted to warmer water (i.e., cold water fish will be replaced by cool water fish), and this process will likely occur at an uneven pace disrupting aquatic system health and allowing non-native and/or invasive species to become established; (Ibid; p. 81, 87, 122)
- warmer air temperatures will increase demand for cooling and for power production, resulting in increased discharges of warm water from power plants; (Ibid; p. 49, 56)
- increased water use will put stress on water infrastructure and demands on the clean water and drinking water State Revolving Funds; (Ibid; p. 48, 49) and
- increased evapotranspiration rates resulting from temperature increases may result in water losses for which drinking water and wetlands managers will need to account (Ibid; p. 49).

Pollution Problems Related to Warmer Air and Water: Effects on Water Programs
(Shaded areas reflect programs most affected by air and water temperature increases)

Drinking Water Standards	Surface Water Standards	Technology Based Standards	Emergency Planning
Drinking Water Planning	Clean Water Planning	Water Monitoring	Water Restoration/ TMDLs
Underground Injection Control Permits	Discharge Permits	Storm Water Permits	Wetlands Permits
Source Water Protection	Nonpoint Pollution Control	Coastal Zone	National Estuaries Program
Drinking Water SRF	Clean Water SRF	Ocean Protection	Combined Sewer Overflow Plans

2) More Extreme Weather Events:

Heavier precipitation from tropical and inland storms will increase flood risk, expand flood hazard areas, increase the variability of stream flows (i.e., higher high flows and lower low flows) and increase the velocity of water during high flow periods, thereby increasing erosion. These changes will have adverse effects on water quality, drinking water sources, and aquatic ecosystem health. For example, increases in intense rainfall may result in more nutrients, sediments, pathogens, and toxins being washed into waterbodies. For further details on these impacts, see pages 18, 25, 34-36, 41, 44, 88, 94, 95, 102 in Karl et al., 2009.

Water resource managers will face significant challenges as storm intensity increases:

- although there is uncertainty with respect to climate models addressing storm intensity and frequency, emergency plans for drinking water and wastewater infrastructure need to recognize the possibility of increased risk of high flow and high velocity events due to intense storms and potential low flow periods; (Ibid; p. 25, 34-36, 44)
- damage from intense storms may increase the demand for public infrastructure funding and may require re-prioritizing of infrastructure projects; (Ibid; p. 47)
- floodplains may expand along major rivers requiring protection or relocation of drinking water and wastewater infrastructure facilities and coordination with local planning efforts; (Ibid; p. 44)
- in urban areas, stormwater collection and management systems may need to be redesigned to increase capacity; (Ibid; p. 47, 48)
- combined storm and sanitary sewer systems may need to be redesigned because an increase in storm event frequency and intensity can result in more combined sewer overflows causing increased pollutant and pathogen loading to receiving waterbodies; (Ibid; p. 48, 94, 95)
- changes in precipitation patterns and intensity may increase the demand for watershed management that mitigates the impacts of intense storms and build resilience into water management through increased water retention (e.g., green infrastructure, smart growth, and source water protection practices); (Ibid; p. 41, 44, 45) and
- the management of wetlands for stormwater control purposes and to buffer the impacts of intense storms will be increasingly important. (Ibid; p. 88, 102)

Extreme Weather: Effects on Water Programs

(Shaded areas reflect programs most affected by storm intensity)

Drinking Water Standards	Surface Water Standards	Technology Based Standards	Emergency Planning
Drinking Water Planning	Clean Water Planning	Water Monitoring	Water Restoration/ TMDLs
Underground Injection Control Permits	Discharge Permits	Storm Water Permits	Wetlands Permits
Source Water Protection	Nonpoint Pollution Control	Coastal Zone	National Estuaries Program
Drinking Water SRF	Clean Water SRF	Ocean Protection	Combined Sewer Overflow Plans

3) Changes to Water Availability (Rain and Snow Level and Distribution):

In some parts of the country, droughts, changing patterns of precipitation and snowmelt, and increased water loss due to evaporation as a result of warmer temperatures, will result in changes to the availability of water for drinking and for use for agriculture, industry, and energy production, as well as fire protection. In other areas, sea level rise and salt water intrusion will have the same effect. Warmer air temperatures may also result in increased demands on water supplies, and the water needs for agriculture, industry, and energy production are likely to increase. For further details on these impacts see pages 44-46, 48, 82, 94, 95, 113, 124, 129 in Karl et al., 2009.

Changing precipitation patterns pose several challenges for water program managers:

- increased rainfall, especially more intense rainfall, will result in increased stormwater runoff and may make overflows of sanitary sewers and combined sewers more frequent, putting new demands on discharge permit and nonpoint pollution programs; (Ibid; p. 44, 45, 48, 94, 95)
- increased storm water runoff will wash sediment and other contaminants into drinking water sources, requiring additional treatment; (Ibid; p. 44-46)
- additional investments in water infrastructure may be needed to manage both decreases and increases in rainfall and these demands could increase demand for water financing generally, including from the State Revolving Funds; (Ibid; p. 44-46)
- limited water availability and drought in some regions will require drinking water providers to reassess supply facility plans and consider alternative pricing, allocation, water conservation, and water reuse options; (Ibid; p. 44, 48, 113, 129)
- in areas with less precipitation or reduced snowpack, demand for water may shift to underground aquifers and prompt water recycling and reuse, development of new reservoirs, or underground injection of treated water for storage; (Ibid; p. 44, 45, 124)
- in areas with less precipitation, reduced stream flow may make meeting water quality goals more challenging; (Ibid; p. 44, 45, 46) and
- increased incidence of wildfire as a result of higher temperatures and drought may increase soil erosion and sedimentation, increase water pollution, increase risk of flooding, and pose a threat to aquatic habitats and water infrastructure. (Ibid; p. 82)

Changes in Rainfall and Snowfall Levels/Distribution: Effects on Water Programs

(Shaded areas reflect programs most affected by rainfall and snowfall levels)

Drinking Water Standards	Surface Water Standards	Technology Based Standards	Emergency Planning
Drinking Water Planning	Clean Water Planning	Water Monitoring	Water Restoration/ TMDLs
Underground Injection Control Permits	Discharge Permits	Storm Water Permits	Wetlands Permits
Source Water Protection	Nonpoint Pollution Control	Coastal Zone	National Estuaries Program
Drinking Water SRF	Clean Water SRF	Ocean Protection	Combined Sewer Overflow Plans

4) Sea Level Rise/Storm Surge and Waterbody Boundary Movement and Displacement:

Rising sea levels will move ocean and estuarine shorelines by inundating lowlands, displacing wetlands, and altering the tidal range in rivers and bays. Storm surges resulting from more extreme weather events will increase the areas subject to periodic inundation. Changing water flow to lakes and streams, increased evaporation, and changed precipitation in some areas will affect the extent of wetlands and lakes. Water levels in the Great Lakes are expected to fall. For further details on these impacts, see pages 12, 25, 34, 47, 48, 84, 109, 114, 138, 152 in Karl et al., 2009.

Sea level rise, storm surges, and waterbody movement will affect a range of water programs and pose significant challenges for water program managers:

- emergency plans for drinking water and wastewater infrastructure need to account for long-term projections for rising sea levels; (Ibid; p. 12, 25, 34, 47, 114)
- drinking water systems will need to consider relocating intakes as sea levels rise and salt water intrudes into freshwater aquifers used for drinking water supply and protecting or relocating some treatment facilities; (Ibid; p. 47, 138)
- wastewater utilities will need to consider hardening facilities against storm surge, protecting facilities with natural or man-made barriers, and relocation of some treatment facilities and discharge outfalls as a result of sea level rise; (Ibid; p. 12, 109, 152) and
- watershed-level planning will need to incorporate an integrated approach to coastal management in light of sea level rise including land use planning, building codes, land acquisition and easements, shoreline protection structures (e.g., seawalls and channels), beach nourishment, wetlands management, and underground injection to control salt water intrusion to fresh water supplies. (Ibid; p. 12, 49, 84, 114)

Sea Level Rise/Storm Surge: Effects on Water Programs
(Shaded areas reflect programs most affected by sea level rise)

Drinking Water Standards	Surface Water Standards	Technology Based Standards	Emergency Planning
Drinking Water Planning	Clean Water Planning	Water Monitoring	Water Restoration/ TMDLs
Underground Injection Control Permits	Discharge Permits	Storm Water Permits	Wetlands Permits
Source Water Protection	Nonpoint Pollution Control	Coastal Zone	National Estuaries Program
Drinking Water SRF	Clean Water SRF	Ocean Protection	Combined Sewer Overflow Plans

5) Collective Impacts on Coastal Areas:

Coastal areas are likely to see multiple impacts associated with climate change including: sea level rise, increased damage from floods and storm surges, coastal erosion, changes in drinking water supplies, and increasing temperature and acidification of the oceans (e.g., decreases in pH, decreases in carbonate ion availability for calcifying organisms). These overlapping impacts make protecting water resources in coastal areas especially challenging. For further details on these impacts, see pages 17, 43, 47, 84, 85, 148, 151 in Karl et al., 2009.

Changes in ocean characteristics pose several challenges for water program managers including:

- watershed-level protection programs may need to be revised to account for changes in natural systems as salinity and pH levels change; (Ibid; p. 17, 43, 47, 151)
- climate change and ocean acidification may exacerbate existing stresses on coral reefs such that programs to protect coral reefs, including temperate and cold water corals, from land-based pollution and impacts may need to be reassessed to provide enhanced protection; (Ibid; p. 84, 85, 148) and
- wetlands programs may need to be adjusted to account for changing salinity levels and impacts on wetlands health. (Ibid; p. 47, 84)

Changing Ocean Characteristics: Effects on Water Programs
(Shaded areas reflect programs most affected by changing ocean characteristics)

Drinking Water Standards	Surface Water Standards	Technology Based Standards	Emergency Planning
Drinking Water Planning	Clean Water Planning	Water Monitoring	Water Restoration/ TMDLs
Underground Injection Control Permits	Discharge Permits	Storm Water Permits	Wetlands Permits
Source Water Protection	Nonpoint Pollution Control	Coastal Zone	National Estuaries Program
Drinking Water SRF	Clean Water SRF	Ocean Protection	Combined Sewer Overflow Plans

6) Indirect Impacts Resulting from Changes in Energy and Fuel Production:

Possible responses to climate change include development of alternative methods of energy and fuel production that reduce emissions of greenhouse gases, as well as development of carbon sequestration technology. Alternative methods of both energy production and sequestration can have impacts on water resources including: increased water use and withdrawals from surface waters and groundwater, potential nonpoint pollution impacts of expanded agricultural production, increased water temperatures due to discharge of process cooling waters and reduced assimilative capacity of warmer waters, increased pollution concentration due to low flows, and effects of carbon sequestration on groundwater or ocean environments. For further details on these impacts, see pages 48, 49, 56, 59, 60, 74 in Karl et al., 2009.

Changing energy generation methods poses several challenges for water program managers including:

- increased water use and withdrawals will require expanded efforts to ensure water supply availability; (Ibid; p. 48, 49, 56)
- increased water supply demands and more variable water supplies will have effects on water resource management and reservoir operation; (Ibid; p. 48, 49, 59, 60) and
- need for increased attention to discharge permit conditions to address increased temperature and concentration of pollutants due to low flows. (Ibid; p. 49, 56)

Energy Generation Shifts: Effects on Water Programs

(Shaded areas reflect programs most affected by energy generation shifts)

Drinking Water Standards	Surface Water Standards	Technology Based Standards	Emergency Planning
Drinking Water Planning	Clean Water Planning	Water Monitoring	Water Restoration/ TMDLs
Underground Injection Control Permits	Discharge Permits	Storm Water Permits	Wetlands Permits
Source Water Protection	Nonpoint Pollution Control	Coastal Zone	National Estuaries Program
Drinking Water SRF	Clean Water SRF	Ocean Protection	Combined Sewer Overflow Plans

III. Priority Actions

Recognizing the impacts that a changing climate is likely to have on water resources generally, and clean water and drinking water programs more specifically, the Office of Water identified criteria to consider in defining "priority actions" to respond to these impacts and make the water programs more "climate ready." These criteria, and the "priority actions" defined based on the criteria, are described below. The Office of Water commitment to "mainstreaming" climate considerations into the full range of core clean water and drinking water programs is also described. Some specific core programs that, although designed for other purposes, have clear benefits in responding to a changing climate, are identified.

In addition, EPA Regional offices play a central role in implementing clean water and drinking water programs and are especially important because they are in a position to tailor implementation actions to the varied climate change and water adaptation challenges that exist across the country. Additionally, EPA Regional offices are able to work closely with States, Tribes, and other stakeholders to advance these activities. The Office of Water and Regional office water programs have identified a set of nine "common" activities that water programs in each Regional office will attempt to implement to build their capability to respond to climate change challenges related to water resources. These common climate change and water actions are described at the end of this section.

Criteria to Identify Priority Actions

Since resources to implement climate change response actions are limited, it is important to consider the significance of the impacts and to allocate scarce resources to response actions that address the most pressing and critical threats.

Some key criteria to consider when linking climate change impacts to potential response actions include:

- **Urgency:** What is the timing of the impact? How urgent is it that it be addressed?
- **Risk:** How significant is the risk to public health, infrastructure, or aquatic ecosystems?
- **Geographic Scale:** What is the geographic/demographic scale of the impact?
- **Programmatic Scale:** What is the scale of the programmatic impact?
- **Probability of Occurrence:** What is the likelihood the impact will actually occur?

Office of Water Priority Actions

Based on consideration of the criteria identified above, the Office of Water has identified ten "priority actions". These actions were identified from a larger group of national program office and regional water program actions developed as part internal work planning processes.

1. Encourage water utilities to use the **Climate Resiliency Evaluation and Awareness Tool** (CREAT) and develop Version 3.0 of this tool.

2. Promote use of an **Extreme Events Workshop Planner** designed to provide everything a water sector utility needs to plan, customize, and conduct a workshop focused on planning for extreme events including flooding, drought, sea level rise and storm surges, wildfire, and reduced snowpack.

3. In cooperation with EPA Regional offices, **expand the number of WaterSense partners** nationally and in each Region, with a goal of a 150 additional partners annually.

4. Encourage the **Clean Water and Drinking Water State Revolving Funds** to incorporate climate change considerations into their processes.

5. Encourage the National Estuary Programs and other watershed managers at the state and local level to use the **Watershed Climate Change Adaptation Planning Workbook** developed by the EPA National Estuary Program.

6. Complete development of initial screening criteria to identify **water and wastewater facilities on the Atlantic and Gulf Coasts that may be at risk of inundation** in the event of a storm surge comparable to Hurricane Sandy and work with utilities to address risks.

7. Complete **technical development of the Climate Change Extension within the Stormwater Calculator** and identify and implement enhancements to improve its utility.

8. Work with EPA Regional office counterparts to identify ways to **better integrate climate change considerations into water quality management planning projects and processes** and develop an initial report.

9. Draft a white paper providing information States and Tribes can use to **protect aquatic life from negative effects associated with alteration of hydrologic conditions**, including potential effects from climate change.

10. Engage key stakeholders in climate change adaptation work by continuing to support the EPA **State and Tribal Climate Change Council** that advises the National Water Program and engaging additional stakeholders using a range of forums and mechanisms.

It is important to note that a key objective of the *2012 Strategy* is to integrate climate change considerations and awareness into day-to-day management decisions for clean water and drinking water programs at national, regional, state, tribal, and local levels. The National Water program is facilitating this "mainstreaming" of climate change into core water programs by providing information and training to water program managers on climate change issues and prompting discussions of opportunities to recognize climate change in program management wherever possible. The Office of Water is also working with water programs in the ten EPA Regions to address climate change and water issues generally, as well as specific challenges that occur in each Region (see common EPA regional climate change actions below).

In addition to the specific "priority actions" identified above, the National Water Program conducts a range of programs that, although not designed to directly or uniquely address the impacts of a changing climate, make important contributions to making water resources more resilient to the impacts of a changing climate. Some examples of climate change-supporting programs include:

- Wetlands programs that help protect and restore wetlands that serve as sponges to retain water from more intense storm events, increased precipitation, and more rapid snowmelt;

- Stormwater permit programs that reduce pollution levels and the rate of runoff of rainfall in developed areas with large percentages of impervious surfaces and programs that promote improved stormwater management through implementation of "green infrastructure" practices;

- Healthy watershed programs that help maintain the quality of healthy watersheds and supportive habitat corridor networks across the country that provide resilience to climate change impacts;

- The National Estuary Program supports development and implementation of Comprehensive Conservation and Management Plans (CCMPs) in 28 estuaries around the country and had supported the development of a range of projects to address climate change challenges faced in these estuaries;

- Infrastructure management programs to expand the use of management practices that make water and wastewater treatment facilities more sustainable, including practices that improve resilience to climate change; and

- Monitoring programs, such as the *National Coastal Condition Report*, that can provide benchmarks of progress in addressing key climate change impacts.

Common Climate Change Actions for Regional Water Programs

Each regional water program will attempt to carry out the following common climate change related activities in 2013:

1. **Participate in the National Water Program Climate Change Workgroup:** Maintain current participation in the National Water Program Climate Change Workgroup, including identifying a single point of contact for the regional water program.

2. **Support the EPA Office of Water Climate Change Adaptation Implementation Plan:** Help to develop and implement the EPA-wide Climate Change Adaptation Implementation Plan (and coordinate between the National Water Program *2012 Strategy* and the EPA regional climate change adaptation implementation plans.

3. **Build Internal Climate Change Communications:** After the completion of the EPA Climate Change Adaptation Implementation Plan, draw on materials developed by the Office of Water to provide training for regional water program staff on the challenges that climate change poses for water programs and familiarize them with the National Water Program *2012 Strategy* and regional climate adaptation plans through a variety of means such as "all hands" meetings, webinars, seminars, and dissemination of the plans.

4. **Build External Climate Change Communications:** Support national program efforts to inform and educate water program managers in the public and private sectors on climate change and water issues through a variety of means such as identifying key stakeholders and expanding professional networks, improving educational outreach efforts on national and regional EPA climate change websites and in other media, and disseminating clear and credible messaging on climate change science and impacts.

5. **Address Climate Change in Meetings with States and Tribes:** In program meetings with States and Tribes in 2014, include discussion of ongoing Agency and regional climate change adaptation planning, the National Water Program *2012 Strategy*, and climate change activities related to State water programs as appropriate.

6. **Support Coordination among Federal Agency Regional Offices:** Coordinate with the Regional offices of other Federal agencies on climate change adaptation matters and participate, where appropriate, with related interagency cooperative and collaborative efforts to address climate change challenges on a regional scale.

7. **Promote Use of Tools from the Climate Ready Water Utilities (CRWU) and Climate Ready Estuaries (CRE) Programs:** Work with municipal and private water and wastewater utilities to promote use of the Climate Resilience, Evaluation and Awareness Tool (CREAT) to recognize and respond to climate change risks and promote with

National Estuary Program partners the use of the new Climate Ready Estuaries workbook to develop local climate vulnerability assessments and resilience plans.

8. **Develop Regional WaterSense Partners:** Work with States, Tribes, municipalities, non-profit organizations and businesses to promote the WaterSense Program in the region.

9. **Work with State Revolving Loan Fund Programs to recognize climate change impacts.**

IV. Office of Water Contribution to Meeting EPA Strategic Measures on Climate Change

The EPA *Strategic Plan* identifies several objectives for strengthening the Agency response to a changing climate by 2015. The Office of Water is committed to contributing to the Agency work to meet these objectives. The Agency objective and the Office of Water contribution to meeting the objective are identified below. Implementation plans from other offices within EPA address additional steps to be taken to meet these objectives.

- **Save energy and conserve resources:** The Office of Water will support this objective through measures to reduce energy use at wastewater treatment plants and through the WaterSense program.

- **Integrate climate change science into five major models and/or decision support tools:** The Office of Water supported this objective through publication of Version 2.0 of the Climate Resilience Evaluation and Awareness Tool (CREAT) for water utilities.

- **Integrate climate change science or trend information into five major rulemaking processes:** The Office of Water will support this objective through the development of a water program regulation prior to 2015. The specific regulation is not yet determined.

- **Integrate climate change considerations into five major grant, loan, or technical assistance programs:** The Office of Water is meeting this objective through integrating climate change in the National Estuary Program grant program.

The Office of Water will monitor progress in supporting these Agency objectives annually and will adjust programs and activities as needed to assure that the water program contributions to meeting the goals are achieved by the 2015 due date.

V. Legal and Enforcement Issues

The Office of Water works closely with the EPA Office of General Counsel and matters related to climate change and water resources and will continue this working relationship in the future. To date, water program actions to respond to a changing climate have not faced significant legal issues.

As noted in Section IX of this Plan, the Office of Water is interested in initiating a pilot project for collaboration with the EPA Office of Enforcement and Compliance Assurance addressing inclusion of climate change considerations in compliance and enforcement activities.

VI. Training and Outreach

The Office of Water will continue and expand current work to provide training to water program managers on climate change issues and to ensure strong communication and coordination among EPA water program offices, regional offices, other Federal agencies, and stakeholders. These training and outreach materials are addressed in Goal 17 of the *2012 Strategy.*

Training

The Office of Water will continue to work to provide training on climate change impacts on water resources, and especially on the impacts on clean water and drinking water programs. Some key actions the Office of Water will take include:

- Update the **Climate Change and Water training module** included as part of the EPA Watershed Academy online training program and promote this climate change and water training with EPA water program staff in national and regional offices;

- Continue the monthly **Climate Change and Water Seminar Series** which invites experts in climate change and water issues to speak to EPA Headquarters and Regional staff;

- Continue to support the **Climate Change Module** at the EPA Water Quality Standards Academy that presents an overview of climate change impacts on water resources and climate change vulnerability considerations for managers;

- Participate in the Agency workgroup tasked with **developing a general training tool for EPA staff addressing climate change adaptation challenges**;

- Work with Regions to develop a **model presentation** that EPA regional water programs can use to describe the climate change and water issues generally, with a focus on the implementation of the *National Water Program 2012 Strategy: Response to Climate Change;* and

- Sponsor an **all-hands meeting** of the Office of Water after the completion of the EPA *Climate Change Adaptation Implementation Plan t*o generally familiarize all staff with the challenges that climate change poses and to describe the new Agency Implementation Plan with special emphasis on the *2012 Strategy* for the National Water Program and this Office of Water *Implementation Plan.*

Outreach

The Office of Water will support several activities to cooperate with other EPA offices, Federal agencies, and other organizations interested in addressing the impacts of a changing climate on water resources including:

- Continue to support the **National Water Program Climate Change Workgroup and provide oversight and management of National Water Program climate change actions,** including implementation of the *National Water Program 2012 Strategy: Response to Climate Change* (this Workgroup includes staff from national program offices, other EPA offices, EPA regional offices, and Great Waterbody offices);

- Continue to support the EPA National Water Program **State and Tribal Climate Change Council** that advises the National Water Program on a full range of climate change adaptation issues, including implementation of the *National Water Program 2012 Strategy: Response to Climate Change,* and engaging additional stakeholders using a range of forums and mechanisms.

- Continue to serve as **co-chair of the Interagency Water Resources Workgroup** that supports the Interagency Council on Climate Resilience and Preparedness and provide staff support to this Workgroup that oversees the implementation of the *National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate;*

- Serve as the **Federal Agency co-chair of the Climate Change Workgroup of the Advisory Committee on Water Information** (ACWI) in cooperation with the non-Federal co-chair from the Water Environment Federation;

- Continue to manage the EPA climate change and water **website** providing information and materials on a range of climate change and water topics;

- Continue to publish the EPA **Climate Change and Water News electronic newsletter** and consider options to expand the number of subscribers (currently approximately 2,700 email addresses) with a goal of doubling that number;

- Work with EPA Regions to support efforts to link and **coordinate Office of Water climate change website content** with climate change content provided on regional water program websites;

- Work with the U.S. Army Corps of Engineers in the effective operation and management of the **Water Resources Toolbox website** which provides a one stop website of information on a range of water resources management issues, including climate change;

- Work with EPA Region 10, the National Oceanic and Atmospheric Administration, the State of Washington, and other interested agencies and Tribes on issues related to assessing water quality criteria relevant to ocean and coastal acidification (e.g., aragonite saturation state (calcium carbonate availability for calcareous organisms' shell building); and

- Work with the U.S. Department of Energy to accelerate progress in understanding and developing innovative technologies and processes that lead to improved management of both water resources and energy production including topics such as:

    - Integrated water resource management;
    - Water and energy efficiency and conservation;
    - Water quality;
    - Use and reuse of wastewater for power generation;
    - Emergency response and recovery; and
    - Thermoelectric generation.

VII. Partnerships with Tribes

EPA values its unique government-to-government relationship with Indian Tribes in planning and decision making. Supporting the development of capacity to adapt to climate change among Tribes is a priority for the EPA. 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 to develop adaptation strategies that promote sustainability and reduce the impact of climate change on Tribes.

EPA engaged Tribes through a formal consultation process in the development of the Agency's *Climate Change Adaptation Plan*. Tribes identified some of the most pressing issues as erosion, temperature change, drought, and various changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. These collaborative efforts will benefit from the expertise provide by our tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change and has been used by Tribes for millennia as a valuable tool to adapt to changing surroundings.

The Office of Water has a strong partnership with Tribes and works closely with Tribes in the implementation of clean water and drinking water programs. This partnership extends to work on issues relating to climate change and water.

The *2012 Strategy* addresses cooperation with Tribes on climate change and water matters in Goals 15 and 16. Some key objectives of these goals include:

- Strategic Action 47: Through formal consultation and other mechanisms, incorporate climate change as a key consideration in the revised National Water Program Tribal Strategy and subsequent implementation of Clean Water Act (CWA), Safe Drinking Water Act (SDWA), and other core programs;

- Strategic Action 48: Incorporate adaptation into tribal funding mechanisms, and collaborate with other EPA and federal funding programs to support sustainability and adaptation in tribal communities;

- Strategic Action 49: Collaborate to explore and develop climate change science, information, and tools for Tribes, and incorporate local knowledge; and

- Strategic Action 50: Collaborate to develop communication materials relevant for tribal uses and tribal audiences.

Some key actions that the Office of Water will implement to advance the goal of supporting Tribes in responding to the water-related impacts of climate change include:

- Continue to support the EPA National Water Program **State and Tribal Climate Change Council** as a vehicle for sharing information and hearing the views of Tribes on climate change issues;

- Include a presentation addressing tribal climate change recommendations at the next Office of Water **tribal water quality conference**, planned for 2015;

- Continue to support sustainability and adaptation in tribal communities in coordination with the EPA-Tribal Science Council (TSC), as the TSC implements its tribal science priorities for climate change and Traditional Ecological Knowledge (TEK) (e.g. the Office of Water will develop and incorporate **water-resource specific information into materials, presentations, and training related to TEK);**

- Collaborate with the EPA American Indian Environmental Office (AIEO) to **incorporate climate change adaptation into the tribal General Assistance Program (GAP) grant guidance**;

- Work with Tribes to identify the most **pressing and significant impacts that a changing climate poses for tribal management of water resources** and support actions to respond to climate change related vulnerabilities; and

- Partner with tribal stakeholders to develop and pilot the **Tribal-Focused Environmental Risk Screening Tool (Tribal-FERST)**, a web-based geospatial and information access tool to support tribal environmental decision making that provides access to relevant science and information that can be used to help identify, prioritize, and manage environmental and public health issues.

VIII. Vulnerable Populations and Places

Certain parts of the population, such as children, the elderly, minorities, the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies, and rules calls for its adaptation plans to prioritize helping people, places, and infrastructure that are most vulnerable to climate impacts and to be designed and implemented with meaningful involvement from all parts of society.

The Office of Water is giving special attention to populations and places that are most vulnerable to the water related impacts of a changing climate. As noted above, the Office of Water is working closely with Tribes to respond to climate change impacts on water resources.

In the case of vulnerable places, the Office of Water is supporting national program initiatives that address places that are especially vulnerable to a changing climate. For example, the Climate Ready Estuaries program advances climate adaptation work in many of the 28 estuaries that participate in the National Estuary Program.

In addition, the Office of Water will work with EPA Regional offices to support climate change adaptation work by Great Waterbody offices (e.g., the Chesapeake Bay Program Office and the Great Lakes National Program Office) as well as other large ecosystem programs. Some examples of actions planned in this area are provided below.

- The Chesapeake Bay Program Office will develop a **research coordination and support program to address climate change issues in the Chesapeake Bay.**

- The **Great Lakes National Program Office will initiate the Climate Change Impacts Annex Subcommittee** to the newly formed Great Lakes Executive Committee under the Great Lakes Water Quality Agreement with Canada and develop and implement a bi-national workplan to undertake activities over the next three years to fulfill the commitments in the annex.

- EPA Region 10 will address **climate change in grants to support protection and restoration of Puget Sound** consistent with the Puget Sound Action Agenda including:

    - conduct an erosion survey to evaluate sea level rise threat in San Juan County;
    - map habitat and infrastructure vulnerability in Puget Sound and restoration potential for reducing vulnerability;
    - Tribes and counties will incorporate climate change in their plans and/or analyses.

Puget Sound Grant partners include: Puget Sound Partnership, Friends of the San Juans, The Nature Conservancy, Snohomish County, Washington Department of Ecology, Samish Indian Nation, Swinomish Tribe, Nooksack Tribe, Suquamish Tribe, and Port Gamble Indian Commission.

- EPA Regions 1 and 2 will revise the **Lake Champlain TMDL,** including an analysis of potential effects of climate change on phosphorous loads to the Lake.

- EPA Regions 2 and 3 will support the **Partnership for the Delaware Estuary** efforts toward climate change adaption planning by expanding upon the work of the climate change adaptation plan of 2010 including:

    - creating a **living shorelines process document** that combines their knowledge of the Delaware Estuary Living Shorelines Initiative planning, installation, and outreach processes and best practices; and

    - continue recruiting communities to the **Weathering Change** program in which agencies work with the community to help them understand the weather-related changes that are beginning to happen in their community.

- EPA Regions 1 and 2 are supporting the **Long Island Sound** program in implementing the **"Sentinels of Climate Change: Coastal Indicators of Wildlife and Ecosystem Change"** project in Long Island Sound. The project will address several of the key climate change sentinels identified by the Sentinel Monitoring program, including the responses of critical and sensitive habitats, such as salt marsh and tidal flats, and how changes in these ecosystems impact the population and behavior patterns of key bird species inhabiting them.

- EPA Regions 1, 2, 3, and 4 are working with other Federal agencies (e.g., the U.S. Department of the Interior, National Oceanic and Atmospheric Administration, and Army Corps of Engineers) and States **to manage development of off-shore renewable energy facilities, including identify areas best suited for wind energy production**. EPA will have significant National Environmental Policy Act (NEPA) responsibilities once projects are proposed and, to a lesser degree, Clean Water Act and Clean Air Act permitting responsibilities.

IX. Evaluation and Cross-Office Pilot Projects

Work is underway within the Office of Water to develop strong program evaluation practices for assessing progress in responding to climate change impacts and to develop effective collaborations with other EPA national program offices are described below.

Evaluation of Progress

The National Water Program initiated a new process in 2012 to track progress in implementing climate change response programs based on assessing the stage or phase of development of efforts to implement each of the 19 major Goals identified in the *2012 Strategy*. Progress toward each of the 19 Goals was assessed by program staff in the context of one of seven phases of development. The seven developmental phases are:

1. **Initiation**; conduct a screening assessment of potential implications of climate change to mission, programs, and operations;

2. **Assessment**; conduct a broader review to understand how climate change affects the resources in question;

3. **Response Development**; identify changes necessary to continue to reach program mission and goals and develop initial action plan;

4. **Initial Implementation**; initiate actions in selected priority programs or projects

5. **Robust Implementation**; programs are underway and lessons learned are being applied to additional programs and projects;

6. **Mainstreaming;** climate is an embedded, component of the program; and

7. **Monitor Outcomes and Adaptive Management;** continue to monitor and integrate performance, new information, and lessons learned into programs and plans.

In the 2012 *Highlights of Progress* (see http://www.epa.gov/water/climatechange), the Office of Water identified the status of work on each of the Goals in the *2012 Strategy* (see Appendix 1) as of December 2012. This 2012 baseline assessment has a total numeric value of 43 out of a total possible score of 133 (i.e., 19 Goals times a score of 7 for each action = 133). This combined score indicates that many actions are in the early stages of implementation. Future annual progress reports will identify the cumulative progress toward full implementation of the *2012 Strategy* in both narrative and numeric terms.

In the future, the Office of Water will work to develop metrics that assess the readiness of clean water programs in the face of a changing climate and the contribution that water programs make toward reducing releases of greenhouse gases (e.g., reducing water use which reduces energy use, or generating energy from wastewater treatment to lower carbon footprints of these facilities).

Cross-Organization Projects

The EPA Office of Water is engaged in two major cross-organization projects related to climate change adaptation:

- **Collaboration on National Estuaries Program**: The Office of Water, in collaboration with the EPA Office of Air and Radiation (OAR) has funded 37 projects with 23 National Estuary Programs (NEPs) in six EPA Regions through the Climate Ready Estuaries Program. In 2012, the program completed the first Climate Ready Water Utilities pilot project, held a lessons learned workshop with NEPs in EPA Region 1, held a joint stakeholder meeting with the National Oceanic and Atmospheric Administration, and promoted Fall 2011 king tide sea level rise education campaigns with 10 NEPs. In addition, two NEPs collaborated with the EPA Office of Research and Development to pilot test an expert elicitation approach to address climate change vulnerability assessments. In 2013, the Office of Water will continue to work with OAR to help National Estuary Programs respond to a changing climate.

- **Collaboration on Evaluation:** The Office of Water has undertaken a measurement and evaluation project through the EPA Office of Policy's Evaluation Support Division to guide implementation of *National Water Program 2012 Strategy: Response to Climate Change* (*2012 Strategy*). The purpose of this project is to:

  - develop a robust performance measurement approach for the *2012 Strategy; and*
  - identify lessons learned from previous climate change planning efforts that can inform implementation of the new strategy.

  The Office of Water views measurement in general, and this project specifically, as critical for the long-term success of the *2012 Strategy.*

- **Collaboration on Climate and Water Research:** The Office of Water has a longstanding collaboration with the EPA Office of Research and Development (ORD) to ensure that climate change issues are addressed to the extent possible in water research supported by the Agency. In 2013, the Office of Water and ORD will begin quarterly meetings to review progress and set directions for research related to climate change and water and will organize research projects from different parts of ORD according to the specific goals identified in the *2012 Strategy.*

Potential future collaborations with other EPA Offices include:

- **Collaboration on Enforcement Issues:** The Office of Water is interested in working with the EPA Office of Enforcement and Compliance Assurance to identify opportunities to recognize the impacts of a changing climate on water resources in the context of compliance and enforcement activities and actions through the use of green infrastructure, climate resilient approaches, and other measures.

- **Collaboration on Storm Surge Screening Criteria:** The Office of Water is working with Regions 1, 2, 3, 4, and 6 to begin development of initial screening criteria that could be used to identify water and wastewater facilities that may be at risk from inundation as a result of a storm surge event comparable to that generated by Hurricane Sandy.

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APPENDICES

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Appendix 1:
Visions, Goals and Strategic Actions of the
National Water Program 2012 Strategy: Response to Climate Change
Including 2012 Baseline Assessment Scores

Visions and Goals	***Strategic Actions (SA)***	***2012 Development Phase / Score***
<u>Infrastructure:</u> In the face of a changing climate, resilient and adaptable drinking water, wastewater and stormwater utilities (water sector) ensure clean and safe water to protect the nation's public health and environment by making smart investment decisions to improve the sustainability of their infrastructure and operations and the communities they serve, while reducing greenhouse gas emissions through greater energy efficiency.		
Goal 1: Build the body of information and tools needed to incorporate climate change into planning and decision making.	SA1: Improve access to vetted climate and hydrological science, modeling, and assessment tools through the Climate Ready Water Utilities Initiative.	Phase: Response Development Score: 3
	SA2: Assist wastewater and water utilities to reduce greenhouse gas emissions and increase long-term sustainability with a combination of energy efficiency, co-generation, and increased use of renewable energy resources.	
	SA3: Work with the States and public water systems, particularly small water systems, to identify and plan for climate change challenges to drinking water safety and to assist in meeting health based drinking water standards.	
	SA4: Promote sustainable design approaches to provide for the long-term sustainability of infrastructure and operations.	
Goal 2: Support Integrated Water Resources Management (IWRM) to sustainably manage water resources.	SA5: Understand and promote through technical assistance the use of water supply management strategies.	Phase: Assessment Score: 2
	SA6: Evaluate and provide technical assistance on the use of water demand management strategies.	
	SA7: Increase cross-sector knowledge of water supply climate challenges and develop watershed specific information to inform decision making.	

Visions and Goals	*Strategic Actions*	*2012 Development Phase / Score*
<u>Watersheds & Wetlands</u>: Watersheds are protected, maintained and restored to ensure climate resilience and to preserve the social and economic benefits they provide; and the nation's wetlands are maintained and improved using integrated approaches that recognize their inherent value as well as their role in reducing the impacts of climate change.		
Goal 3: Identify, protect, and maintain a network of healthy watersheds and supportive habitat corridor networks.	SA8: Develop a national framework and support efforts to protect remaining healthy watersheds and aquatic ecosystems.	Phase: Response Development Score: 3
	SA9: Collaborate with partners on terrestrial ecosystems and hydrology so that effects on water quality and aquatic ecosystems are considered.	
	SA10: Integrate protection of healthy watersheds throughout the National Water Program core programs.	
	SA11: Increase public awareness of the role and importance of healthy watersheds in reducing the impacts of climate change.	
Goal 4: Incorporate climate resilience into watershed restoration and floodplain management.	SA12: Consider a means of accounting for climate change in EPA funded and other watershed restoration projects.	Phase: Response Development Score: 3
	SA13: Work with federal, state, interstate, tribal, and local partners to protect and restore the natural resources and functions of riverine and coastal floodplains as a means of building resiliency and protecting water quality.	
Goal 5: Watershed protection practices incorporate Source Water Protection to protect drinking water supplies.	SA14: Encourage States to update their source water delineations, assessments or protection plans to address anticipated climate change impacts.	Phase: Assessment Score: 2
	SA15: Continue to support collaborative efforts to increase state and local awareness of source water protection needs and opportunities, and encourage inclusion of source water protection areas in local climate change adaptation initiatives.	

Visions and Goals	*Strategic Actions*	*2012 Baseline Assessment*
Watersheds & Wetlands (continued)		
Goal 6: Incorporate climate change considerations into the Clean Water Act (CWA) 404 regulatory program as they relate to permit reviews and compensatory mitigation.	SA16: Consider the effects of climate change, as appropriate, when making significant degradation determinations in the CWA Section 404 wetlands permitting and enforcement program	Phase: Initiation Score: 1
	SA17: Evaluate, in conjunction with the U.S. Army Corps of Engineers, how wetland and stream compensation projects could be selected, designed, and sited to aid in reducing the effects of climate change.	
Goal 7: Improve baseline information on wetland extent, condition and performance to inform effective adaptation to climate change.	SA18: Expand wetland mapping by supporting wetland mapping coalitions and training on use of the new federal Wetland Mapping Standard.	Phase: Initiation Score: 1
	SA19: Produce a statistically valid, ecological condition assessment of the nation's wetlands.	
	SA20: Work with partners and stakeholders to develop information and tools to support long term planning and priority setting for wetland restoration projects.	

Visions and Goals	*Strategic Actions*	*2012 Baseline Assessment*
<u>Coastal and Ocean Waters</u>: Adverse effects of climate change and unintended adverse consequences of responses to climate change have been successfully prevented or reduced in the ocean and coastal environment. Federal, tribal, state, and local agencies, organizations, and institutions are working cooperatively; and information necessary to integrate climate change considerations into ocean and coastal management is produced, readily available, and used.		
Goal 8: Collaborate to ensure information and methodologies for ocean and coastal areas are collected, produced, analyzed, and easily available.	SA21: Collaborate to ensure that synergy occurs, lessons learned are transferred, federal efforts effectively help local communities, and efforts are not duplicative or at cross-purposes.	Phase: Response Development Score: 3
	SA22: Work within EPA and with the U.S. Global Change Research Program and other federal, tribal, and state agencies to collect, produce, analyze, and format knowledge and information needed to protect ocean and coastal areas and make it easily available.	
Goal 9: EPA geographically targeted programs support and build networks of local, tribal, state, regional and federal collaborators to take effective adaptation measures for coastal and ocean environments.	SA23: Work with the National Water Program's larger geographic programs to incorporate climate change considerations, focusing on both the natural and built environments.	Phase: Assessment Score: 2
	SA24: Address climate change adaptation and build stakeholder capacity when implementing National Estuary Program Comprehensive Conservation and Management Plans and through the Climate Ready Estuaries Program.	
	SA25: Conduct outreach and education, and provide technical assistance to state and local watershed organizations and communities to build adaptive capacity in coastal areas outside the National Estuary Program and Large Aquatic Ecosystem programs.	

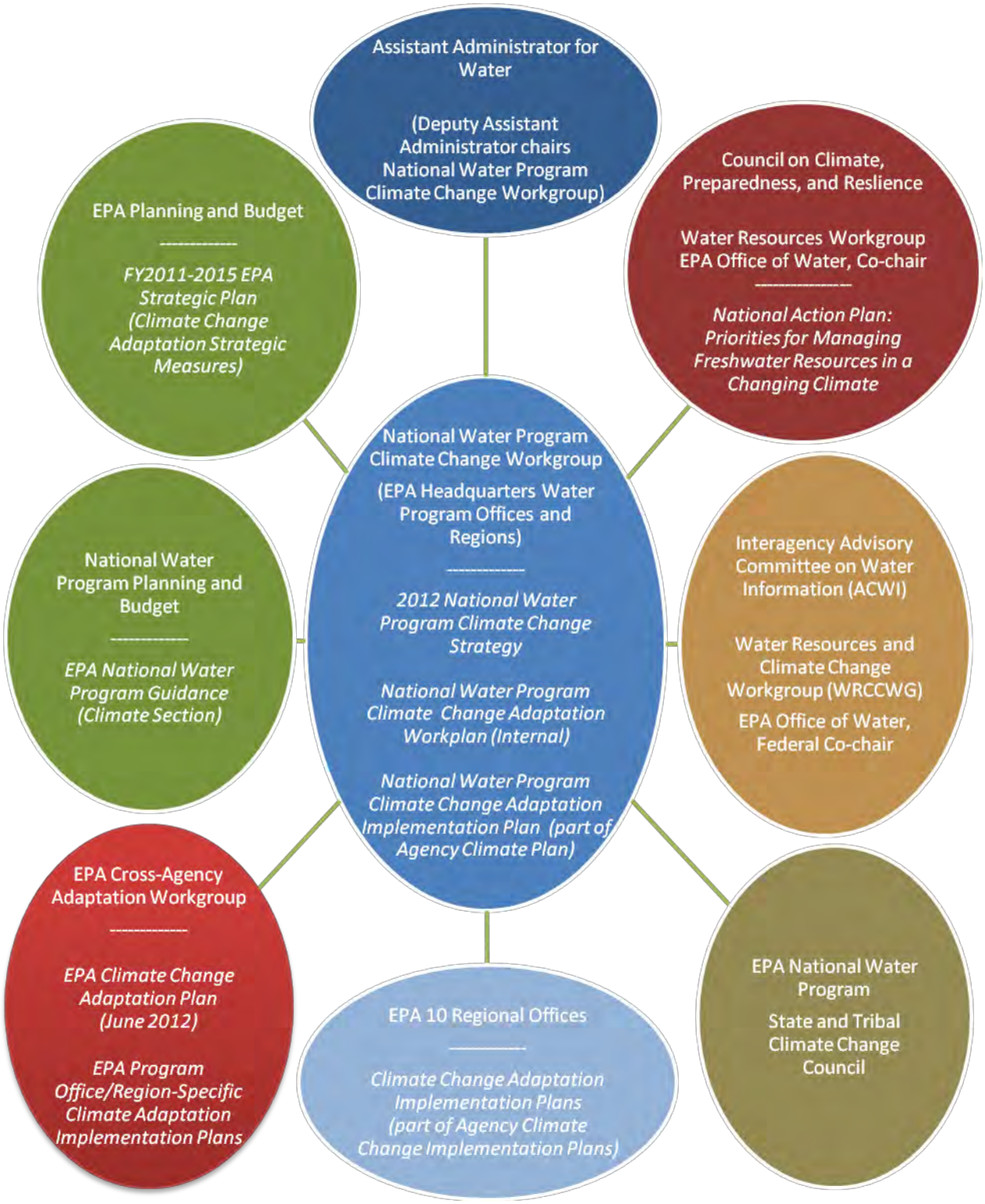
Visions and Goals	*Strategic Actions*	*2012 Baseline Assessment*
Coastal and Ocean Waters (continued)		
Goal 10: Address climate driven environmental changes in coastal areas and ensure that mitigation and adaptation are conducted in an environmentally responsible manner.	SA26: Support coastal wastewater, stormwater, and drinking water infrastructure owners and operators in reducing climate risks and encourage adaptation in coastal areas.	Phase: Assessment Score: 2
	SA27: Support climate readiness of coastal communities, including hazard mitigation, pre-disaster planning, preparedness, and recovery efforts.	
	SA28: Support preparation and response planning for diverse impacts to coastal aquatic environments.	
Goal 11: Ocean environments are protected by EPA programs that incorporate shifting environmental conditions, and other emerging threats.	SA29: Consider climate change impacts on marine water quality in National Water Program ocean management authorities, policies, and programs.	Phase: Assessment Score: 2
	SA30: Use available authorities and work with the regional ocean organizations and other federal and state agencies through regional ocean groups and other networks so that offshore renewable energy production does not adversely affect the marine environment.	
	SA31: Support the evaluation of sub-seabed sequestration of carbon dioxide (CO_2) and any proposals for ocean fertilization.	
	SA32: Participate in interagency development and implementation of federal strategies through the National Ocean Council and the National Ocean Council Strategic Action Plans.	

Visions and Goals	*Strategic Actions*	*2012 Baseline Assessment*
<u>Water Quality</u>: Our Nation's surface water, drinking water, and ground water quality are protected, and the risks of climate change to human health and the environment are diminished, through a variety of adaptation and mitigation strategies.		
Goal 12: Protect waters of the United States and promote management of sustainable surface water resources.	SA33: Encourage States and communities to incorporate climate change considerations into their water quality planning.	Phase: Assessment Score: 2
	SA34: Encourage green infrastructure and low-impact development to protect water quality and make watersheds more resilient.	
	SA35: Promote consideration of climate change impacts by National Pollutant Discharge Elimination System (NPDES) permitting authorities.	
	SA36: Encourage water quality authorities to consider climate change impacts when developing wasteload and load allocations in Total Maximum Daily Loads (TMDLs) where appropriate.	
	SA37: Identify and protect designated uses that are at risk from climate change impacts.	
	SA38: Clarify how to re-evaluate aquatic life water quality criteria on more regular intervals; and develop information to assist States and Tribes who are developing criteria that incorporate climate change considerations for hydrologic condition.	
Goal 13: As the Nation makes decisions to reduce its greenhouse gas emissions and develop alternative sources of energy and fuel, the National Water Program will work to protect water resources from unintended adverse consequences.	SA39: Continue to provide perspective on the water resource implications of new energy technologies.	Phase: Initiation Score: 1
	SA40: Provide assistance to states and permittees to assure that geologic sequestration of carbon dioxide is responsibly managed.	
	SA41: Continue to work with States to help them identify polluted waters, including those affected by biofuels production, and help them develop and implement Total Maximum Daily Loads (TMDLs) for those waters.	
	SA42: Provide informational materials for stakeholders to encourage the consideration of alternative sources of energy and fuels that are water efficient and maintain water quality.	
	SA43: As climate change affects the operation or placement of reservoirs, EPA will work with other Federal agencies and EPA programs to understand the combined effects of climate change and hydropower on flows, water temperature, and water quality.	

Visions and Goals	*Strategic Actions*	*2012 Baseline Assessment*
<u>Water Quality (continued)</u>		
Goal 14: Collaborate to make hydrological and climate data and projections available.	SA44: Monitor climate change impacts to surface waters and ground water.	Phase: Response Development Score: 3
	SA45: Collaborate with other Federal agencies to develop new methods for use of updated precipitation, storm frequency, and observational streamflow data, as well as methods for evaluating projected changes in low flow conditions.	
	SA46: Enhance flow estimation using National Hydrography Dataset Plus (NHDPlus).	
<u>Working With Tribes:</u> Tribes are able to preserve, adapt, and maintain the viability of their culture, traditions, natural resources, and economies in the face of a changing climate.		
Goal 15: Incorporate climate change considerations in the implementation of core programs, and collaborate with other EPA offices and Federal agencies to work with Tribes on climate change issues on a multi-media basis.	SA47: Through formal consultation and other mechanisms, incorporate climate change as a key consideration in the revised National Water Program Tribal Strategy and subsequent implementation of the Clean Water Act, Safe Drinking Water Act, and other core programs.	Phase: Assessment Score: 2
	SA48: Incorporate adaptation into tribal funding mechanisms, and collaborate with other EPA and Federal funding programs to support sustainability and adaptation in tribal communities.	
Goal 16: Tribes have access to information on climate change for decision making.	SA49: Collaborate to explore and develop climate change science, information, and tools for Tribes, and incorporate local knowledge.	Phase: Assessment Score: 2
	SA50: Collaborate to develop communication materials relevant for tribal uses and tribal audiences.	

Visions and Goals	*Strategic Actions*	*2012 Baseline Assessment*
Cross-Cutting Program Support		
Goal 17: Communication, Collaboration, and Training	SA51: Continue building the communication, collaboration, and training mechanisms needed to effectively increase adaptive capacity at the federal, tribal, state, and local levels.	Phase: Response Development Score: 3
Goal 18: Tracking Progress And Measuring Outcomes	SA52: Adopt a phased approach to track programmatic progress towards Strategic Actions; achieve commitments reflected in the Agency *Strategic Plan*; work with the National Water Program Climate Change Workgroup to develop outcome measures.	Phase: Response Development Score: 3
Goal 19: Climate Change and Water Research Needs	SA53: Work with the EPA Office of Research and Development, other water science agencies, and the water research community to further define needs and develop research opportunities to deliver the information needed to support implementation of this *2012 Strategy*, including providing the decision support tools needed by water resource managers.	Phase: Assessment Score: 2
		Total Score: **42 of a possible 133**

APPENDIX 2:
National Water Program Climate Change Organizational Framework



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Appendix 4: Table Illustrating Climate Change Impacts on Clean Water and Drinking Water Program Components

Clean Water/ Drinking Water Program Component	Climate Change Impacts					
	Increased Water Pollution	More Extreme Weather Events	Changes in Water Availability	Sea Level Rise	Coastal Area Impacts	Water Impacts of Energy Production
Drinking Water Standards	■					
Drinking Water Planning	■	■	■	■		■
Underground Injection Control Permits			■	■		■
Source Water Protection	■	■	■			■
Drinking Water SRF (State Revolving Funds)	■		■	■		
Surface Water Standards	■		■			■
Clean Water Planning	■		■	■		■
Discharge Permits	■	■	■			■
Nonpoint Pollution Control	■	■	■			■
Clean Water SRF (State Revolving Funds)	■	■	■	■		■
Technology Based Standards						■
Water Monitoring		■			■	
Storm Water Permits		■	■			
Coastal Zone	■	■		■	■	
Ocean Protection	■	■		■	■	■
Emergency Planning	■	■		■		
Water Restoration/ Total Maximum Daily Loads (TMDLs)	■	■	■		■	■
Wetlands Permits	■	■		■	■	
National Estuaries Program		■		■	■	
Combined Sewer Overflow Plans		■	■			

Prepared by:
Office of Water
U.S. Environmental Protection Agency
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EPA NEW ENGLAND
REGIONAL
CLIMATE ADAPTATION PLAN

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JUNE 10, 2014

Disclaimer

To the extent this document mentions or discusses statutory or regulatory authority, it does so for informational purposes only. This document does not substitute for those statutes or regulations, and readers should consult the statutes or regulations to learn what they require. Neither this document, nor any part of it, is itself a rule or a regulation. Thus, it cannot change or impose legally binding requirements on EPA, States, the public, or the regulated community. Further, any expressed intention, suggestion or recommendation does not impose any legally binding requirements on EPA, States, tribes, the public, or the regulated community. Agency decision makers remain free to exercise their discretion in choosing to implement the actions described in this Plan. Such implementation is contingent upon availability of resources and is subject to change.

Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Bob Perciasepe
Deputy Administrator

September 2013

Map of New England

This map was created by the US EPA GIS Center
on 3/4/2013. Map Tracker ID: 9042

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List of Acronyms

ANR	Vermont Agency of Natural Resources
AST	Above Ground Storage Tanks
BAT	Best Available Control Technology Economically Achievable.
BCT	Best Conventional Pollutant Control Technology
BIP	Balanced indigenous populations
BMP	Best Management Practices
BPT	Best Practicable Control Technology Currently Available
CAA	Clean Air Act
CCMP	Comprehensive Conservation and Management Plans (in the National Estuary Program)
CFR	Code of Federal Regulations
CT	Connecticut
CWA	Clean Water Act
DEP	Department of Environmental Protection
DOT	Department of Transportation
EGU	Electric Generating Units
EPA	Environmental Protection Agency
F	Temperature in Fahrenheit degrees
FEMA	Federal Emergency Management Agency
FIFRA	Fungicide and Rodenticide Act
FRP	Facility Response Plans
GCCN	EPA Region I's Global Climate Change Network
GIS	Geographic Information System (a mapping tool)
HUD	Housing and Urban Development
IPCC	International Panel on Climate Change
LiDAR	Light Detection and Radar (a tool to determine topography using light beams shot from an airplane)
NAAQS	National Ambient Air Quality Standards
NARS	National Aquatic Resource Surveys
NECIA	Northeast Climate Impacts Assessment
NH	New Hampshire
NY	New York
NEON	National Ecological Observatory Network www.neoninc.org/about/overview
NEP	National Estuary Program
NEWMOA	Northeast Waste Management Officials Association
NOAA	National Oceanographic and Atmospheric Administration
NOx	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
MA	Massachusetts
ME	Maine
OA	Ocean Acidification
OPA	Oil Pollution Act
PCBs	Polychlorinated biphenyl
pH	pH scale measures how acidic or basic a substance is. It ranges from 0 to 14. A pH of 7 is neutral. A pH less than 7 is acidic, and a pH greater than 7 is basic.
$PM_{2.5}$	Particles less than 2.5 micrometers in diameter
PPA	Performance Partnership Agreement

PPG	Performance Partnership Grants
RCRA	Resource Conservation and Recovery Act
RI	Rhode Island
SDWA	Safe Drinking Water Act
SO_2	Sulfur dioxide
SPCC	Spill Prevention and Control Countermeasures
SUPERFUND	Superfund is the federal government's program to clean up the nation's uncontrolled hazardous waste sites
TITAN	Threshold Indicator Taxa Analysis
TMDL	Total Maximum Daily Load
TSCA	Toxic Substance Control Act
UNH EPSCoR	University of New Hampshire Experiment Program to Stimulate Competitive Research (EPSCoR) www.epscor.unh.edu/whats-epscor
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USG	Unhealthy for Sensitive Groups
USGS	United States Geological Service
USGCRP	United States Global Climate Research Program is a Federal program that coordinates and integrates global change research across 13 government agencies to ensure that it most effectively and efficiently serves the Nation and the world. USGCRP was mandated by Congress in 1990. http://www.globalchange.gov/home
UST	Underground Storage Tanks
VOC	Volatile Organic Compounds
VT	Vermont
WARNs	Water and Wastewater Agency Response Networks

I. Regional Climate Change Adaptation (RCAP) Executive Summary

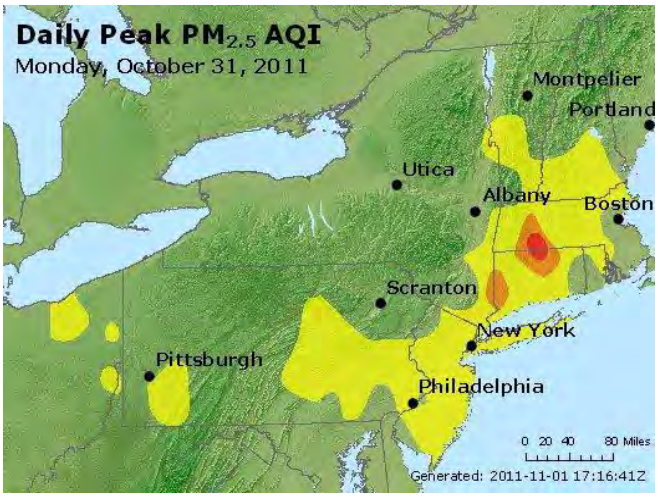
Climate change and its associated impacts to air, water and waste systems are challenging EPA's mission of protecting the environment and public health. One impact, increasing extreme precipitation[1], has already taken a large toll on New England's environment. In August 2011, tropical storm Irene dumped three to five inches of rain throughout Vermont over two days, with many areas receiving more than seven inches. 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.[2]

Figure 1: Route 107 Stockbridge, VT, August 29, 2011[3]

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. As shown in Figure 2, increased usage of local generators and wood stoves in response to the loss of power led to unhealthy ambient air conditions particularly for sensitive groups.[4]

For over 40 years, EPA New England has been protecting the region's environment and public health through the implementation of air, water and waste programs. EPA New England has been working on climate mitigation, greenhouse gas reduction strategies since 2000 and has had a multi-media Global Climate Change Network that has educated EPA staff and worked on climate mitigation and adaptation since 2009.

Figure 2: Daily Peak $PM_{2.5}$ Air Quality Index[5]



In 2009, President Obama established an Interagency Climate Change Task Force. He called on that task force to develop recommendations for adapting to climate change with the goal of promoting a healthy and prosperous nation resilient to climate change. The Task Force's 2010 report recommended that every Federal Agency develop a Climate Change Adaptation Plan. EPA's national Climate Adaptation Plan was developed and released for public comment on February 8, 2013. In 2011, EPA's Administrator Lisa Jackson asked that all EPA regional and program offices develop climate adaptation plans to detail how we will carry out the work in the agency-wide plan, taking into account the impacts on EPA's regional mission and operations. In September 2012, EPA New England convened 30 employees knowledgeable in their media programs and asked them to assess the risks and impacts of climate change that are and will be pertinent to the region's mission and

responsibilities, and to develop a plan of action to address these risks and impacts within the region.

This draft regional climate adaptation plan outlines existing conditions in New England and how we will incorporate the challenges of climate change into our programs and operations. Based on global, regional and state specific scientific research and modeling projections, EPA New England staff determined the vulnerabilities for our programs and facilities and identified priority actions for both the chronic and episodic impacts of climate change.

The major chronic impacts reviewed include:

- Heat – Since 1970 the average annual temperature rose 2°F and the average winter temperature 4°F.[6]
- Extreme Precipitation – Over the past 50 plus years the Northeast has seen a 71% increase in the amount of precipitation falling in very heavy events (defined as the heaviest 1% of all daily events).[7]
- Sea Level Rise - Global sea levels are projected to rise 12 to 48 inches by 2100, depending in large part on the extent to which the Greenland and West Antarctic Ice Sheets experience significant melting.[8]

The episodic impacts include:

- Flooding - In August 2011, tropical storm Irene hit New England. In Vermont alone, recovering from the widespread damage and destruction is expected to cost between $700 million and $1 billion dollars.[9]
- Ocean Storm Surge – In October 2012, Super Storm Sandy caused a storm surge of 9.2 ft. in NY City[10] . The coastal areas of CT and RI were also significantly affected. According to The Boston Harbor Association report, if the storm had hit Boston 5.5 hours earlier on the high tide it would have caused a 5 foot storm surge that would have flooded 6.6% of Boston.[11]

For this plan, regional programs were reviewed and the vulnerabilities of these programs to one or more of the above impacts were determined. For example, an increase in heat could increase the number of unhealthy ozone days.[12] Priority actions to address the vulnerabilities were then drafted. Over 100 actions were identified. Each priority action was evaluated based on its ability to reduce risk, whether the action would protect a critical asset, whether it would be easy to implement (i.e., whether it would be "low-hanging fruit"), whether it would leverage other larger efforts, EPA's unique role and capacity, the time frame to accomplish and the funding needed.

The final section of the plan lays out how these actions will be incorporated into the region's existing programs and how we will measure our progress. For instance, the Agency works with the states and tribes on an annual basis to determine activities that EPA will fund. We will work with the states and tribes to incorporate climate adaptation into those activities. Additionally, the Region has a Global Climate Change Network (GCCN) made up of staff and managers from every office in the Region and each year the GCCN develops a strategy for activities it expects to accomplish for both climate change mitigation and adaptation. The priority actions identified in this plan will be incorporated into the GCCN strategy on an annual basis.

In order to gather stakeholder input, we have held ten webinars with the air, water and waste interstate organizations whose members come from the six New England states air, water and waste environmental agencies, New England nongovernmental organizations, the New England Environmental Business

Council, tribal leaders, tribal environmental managers and tribal historic preservation officers. All of their input has been incorporated into this plan.

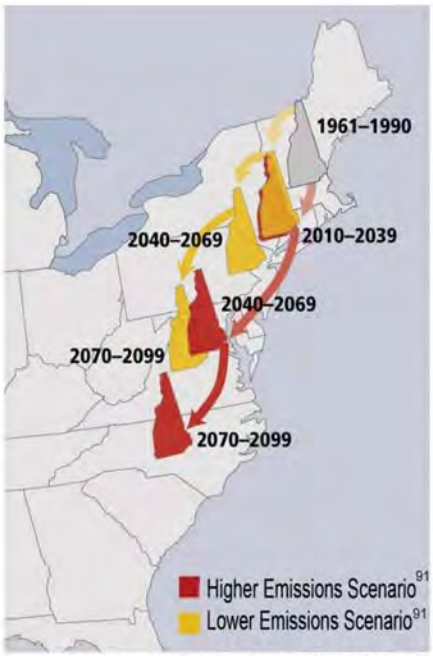
EPA New England will continue to evaluate the science and impacts of climate change and will update the vulnerabilities and priority actions for our programs in order to reduce risk to New England's health and environment.

II. Existing and Forecasted Conditions

Forecasted Climate Change Impacts in New England of Concern for EPA's Regional Mission and Operation

New England is well known for its varying seasons, rocky coastline, extensive beaches, and mix of both urban and rural settings. Over the last several decades, New England has experienced noticeable changes in its climate. New England is and will be uniquely impacted by climate change due to its population distribution, geography, seasons and weather patterns. Below is a summary of existing conditions and forecasts for New England climate change impacts. As indicated by the references, a key source of existing and forecasted information is taken from the 2009 publication by the United State Global Climate Research Program (USGCRP), *Global Climate Change Impacts in the United States*[13] as well as from the 2014 publication *Northeast Chapter of Climate Change Impacts in the United States: The Third National Climate Assessment*[14].
. Where appropriate, we have also included information used by New England States when considering climate change impacts within their respective states.

Figure 3: Projected New Hampshire Summers[21]



Hayhoe *et al.*[359]; Fig. from Frumhoff *et al.*[234]

Population Distribution in New England

New England has a population of over 14 million, with a large portion of the population located along a coast that spans approximately 6,100 miles. From 1960 to 2008, Maine and New Hampshire had the highest increase in the share of population in coastline counties.[15] From 2010 to 2030, New England's population is projected to increase by eight percent.[16]

Figure taken from *Global Climate Change Impacts in the United States*.[19]

Demographics

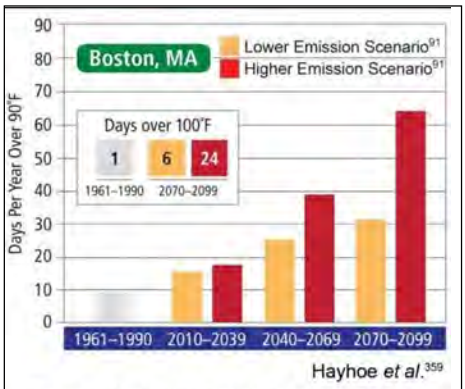
According to the Census, the population in the nation is aging and New England has a larger proportion of the elderly and baby boomers (14.4%) than the rest of the nation (13%).[17] Four of New England's six states are more densely populated than the nation's average.[18] Rhode Island and Massachusetts are the second and third most densely populated states with 91% of its population in urban areas; and Connecticut is fourth with as much as 88% of its population in urban areas.[19]

Increases in Air Temperature

Since 1970, the average annual temperature in the Northeast has risen by 2°F and the average winter temperature has increased by 4°F.[20] This trend is projected to continue. As shown in Figure 3, by 2100 New Hampshire's summers could be as warm as North Carolina's summers are today.[21]

As shown in Figure 4, over the same period, Boston is projected to experience an increase in the number of days reaching 100°F - from an average of one day per year between 1961 and 1990 to as many as 24 days per year by 2100.[22] Under a higher emissions scenario identified by the Intergovernmental Panel on Climate Change (IPCC), Hartford, CT could see as many as 30 days per year with temperatures reaching 100°F.[23] These rising temperatures have potential impacts on public health, ranging from heat-related stress to infectious diseases. This is further explained in *Public Health Impacts* below.

Figure 4: Extreme Heat in Boston[22]



The graph shows model projections of the number of summer days with temperatures over 90°F in Boston, Massachusetts, under lower and higher (referred to as "even higher" on page 23) emissions scenarios.91 The inset shows projected days over 100°F.[359]

Figure taken from *Global Climate Change Impacts in the United States*.[20]

General warming is expected, in New England. However, the Houlton Band of Maliseets, a federally-recognized tribe on the Meduxnekeag River in Maine, cite a reference that suggests that a narrow strip along the eastern Maine coast may not experience a general warming trend. The reference states that in the past "twice daily tidal mixing of the Gulf of Maine brought deep, cold water to the surface, and southwesterly current along the coast brought cool temperatures, often accompanied by fog." The reference states that this effect may continue into the future for this small geographic area.[24] This supposition was not included in the recently published *Northeast Chapter of Climate Change Impacts in the United States: The Third National Climate Assessment*.[25]

Seasonal Shift

Increased air temperatures have already resulted in shifts in the seasonal patterns in New England and that trend is projected to continue. When there is an extended warm period in either late winter or early spring, premature leaf-out or bloom can occur. If this is followed by a frost event, damage to plants can occur. This occurred in 2007 and in 2012 in the northeast, when apple and other fruit crops were hard hit.[26]

In the winter, more precipitation is falling as rain rather than snow, and as a result, there is a reduced snowpack.[27] A 2011 Vermont Agency of Natural Resources group of publications noted that the timing and form of precipitation affects the quantities of water stored in surface waters and aquifers, potentially affecting the availability of water for human use.[28] The publications also state that in the spring, the ice on lakes and rivers melts earlier, resulting in earlier peak river flows. The publications forecast that, combined with reduced snowpack, earlier snow melt is anticipated to lead to an increase in frequency of summer droughts.[29] In addition, both the Commonwealth of Massachusetts and Vermont note that the duration, timing, and frequency of seasonal precipitation and flooding are changing, resulting in impacts on the hydrologic cycle and aquatic habitats and the organisms that depend on them, including migratory fish and aquatic insects.[30, 31] In Vermont, they are concerned that summer low flows from increased drought frequency may also reduce aquatic habitats and make them more isolated, and that lower flows may lead to higher water temperatures, reducing the amounts of dissolved oxygen. Lastly, Vermont

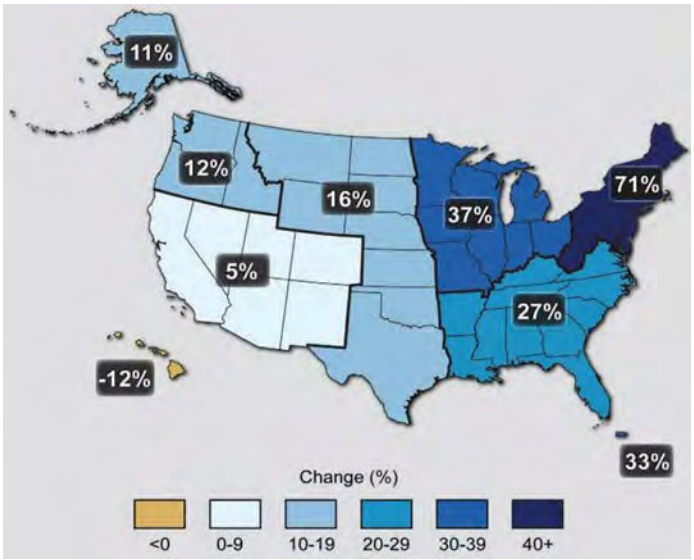
notes that all of these changes have the potential to shift prevalent fish species and reduce cold-water fish populations, potentially allowing new species to gain competitive advantages.[32]

In a Climate Change Adaptation White Paper Series, Vermont stated that a changing climate may cause species to shift their distribution on the landscape to follow the presence of preferred or essential habitats.[33] In this paper, Vermont identified the invasion of Asian long-horned beetle as well as woolly adelgid while Maine has seen Asian shore crab and Eurasian water milfoil.[34] Wooly adelgid is an insect that is native to Japan that threatens Eastern Hemlock trees.[35]

Changes in Precipitation Patterns

Warmer temperatures increase the rate of evaporation of water into the atmosphere, in effect increasing the atmosphere's capacity to "hold" water.[36] Increased evaporation may dry out some areas and increase precipitation in other areas. In fact, drought and increasing heavy precipitation are not mutually exclusive and may even happen in the same locations. While winter precipitation is projected to increase along with temperature, little change is projected for summer rainfall.[37] Combined with greater evaporation from higher temperatures and earlier winter and spring snowmelt, the summer and fall drought risk for the Northeast is projected to increase.[38] At the same time, in the Northeast, heavy precipitation events have increased more dramatically over the past 60 years than in the rest of the country. As shown in Figure 5, in the northeast, the amount of precipitation falling in very heavy precipitation events from 1958 to 2011 has increased by 71%.[39] This increasing trend is projected to continue into the future. The Commonwealth of Massachusetts projects that rainfall during the wettest five days of each year will increase 10% by mid-century and by 20% by 2100.[40]

Figure 5: Percentage Change in Very Heavy Precipitation[39]



The map shows percent increase in the amount of precipitation falling in *very heavy* events (defined as the heaviest 1% of all daily events) from 1958 to 2011 for each region.[37]

Figure taken from Climate Change Impacts in the United States: The Third National Climate Assessment.[37]

Sea Level Rise

Since 1900, sea level in the Northeast has risen by approximately 12 inches.[41] Global sea levels are projected to rise 12 to 48 inches by 2100, depending in large part on the extent to which the Greenland and West Antarctic Ice Sheets experience significant melting.[42] Sea level rise along most of the coastal Northeast is expected to exceed the global average rise due to local land subsidence, with the possibility of even greater regional sea level rise if the Gulf Stream weakens as some models suggest.[43] Two New England States -- New Hampshire and Massachusetts -- cite a 2008 study by Pfeffer, J. T. et al[44] that includes the contribution to sea level rise from the melting of the Greenland and West Antarctic ice sheets that suggests that sea levels could rise as much as 79 inches by 2100.[45] The City of Boston projects that the Boston's sea level rise will range from 24 to 72 inches by the end of the century, depending on how quickly the ice in Greenland and Antarctica melt.[46]

In June of 2012, a USGS study stated that between 1950-1979 and 1980-2009, sea levels between Cape Hatteras and Boston rose approximately three to four times faster than the global average.[47] Taking subsidence at a rate of six inches per century into account, the state of Rhode Island Coastal Resources Management Council has begun to plan for a 36 to 60 inch sea level rise by 2100 and they have codified their projection in state regulations.[48] Other states, such as Massachusetts, also cite subsidence as a potential factor influencing the magnitude of local sea level rise.[49]

Increased Flooding and Storm Surges

In the past 50 years, there has been an increase in flooding in New England, both in coastal and inland areas threatening manmade and natural infrastructure. New England's industrial development in the 19th century was along its rivers where the water could be used as a source of energy. Many of these facilities still exist today and are vulnerable to river flooding. Between 1955 and 1999, floods accounted for $16.97 million in damage annually in Vermont alone.[50] In 2011, tropical storm Irene dumped three to five inches of rain throughout the state over two days, with many areas receiving more than seven inches.[51] The extensive flooding caused millions of dollars of damage to Vermont's infrastructure including damage to 500 miles of road and 200 bridges. The cost of rebuilding this infrastructure is estimated to be up to 250 million.[52] Wells and public water systems were submerged and contaminated with chemicals and pathogens, thereby affecting safe drinking water supplies.[53] A state-wide drinking water advisory was issued to warn citizens of the possibility of harmful chemicals or bacteria in their flooded wells. Approximately 30 public water systems issued "boil water" notices, affecting approximately 16,590 people. Seventeen municipal wastewater treatment facilities also reported compromised operations[54]and private water supply wells were also affected. The Vermont Department of Health distributed over 3,000 free bacterial sample kits for homeowners to test their wells. Of the test kits returned to the Department for testing, 37% were positive for total coliform (of the 37, 8% were positive for E.coli). Lastly, hazardous waste spills increased by a factor of fourteen during the first week after tropical storm Irene.[55] Projecting forward, Vermont anticipates the increasing probability of high-flow events could be as high as 80%.[56]

Coastal flooding is also an issue for New England. It is expected that the combination of a projected increase in heavy precipitation and sea level rise will lead to more frequent, damaging floods in the Northeast.[57] Less winter precipitation falling as snow and more as rain will also increase the number and impact of flooding events as the frozen ground is unable to absorb the winter rain. Sea level rise, storm surges, hurricanes, erosion, and the destruction of important coastal ecosystems will likely contribute to an increase in coastal flooding events, including the frequency of current "100-year flood" levels (severe flood levels with a one-in-100 likelihood of occurring in any given year). Figure 6 shows the current Federal Emergency Management Agency 100-year flood zone (hatched darker blue) as well as the extent of the projected 100-year flood zone in 2100 (lighter blue) for the waterfront/Government Center area of Boston under a "higher-greenhouse gas emissions scenario" used by the Northeast Climate Impacts Assessment (NECIA) in a report titled *Climate Change in the U.S. Northeast*.[58] What is now considered a once in a 100-year coastal flood in Boston is expected to occur, on average, as frequently as every two to three years by mid-century and once every other year by late-century – under either emissions scenario identified by NECIA. Cumulative damage to buildings and building contents, as well as the associated emergency costs, could potentially be as high as $94 billion between 2000 and 2100 in Boston, depending on the sea level rise scenario and which adaptive actions are taken.[59]

Figure 6: Projected 100-Year Flood Zone in Boston[58]

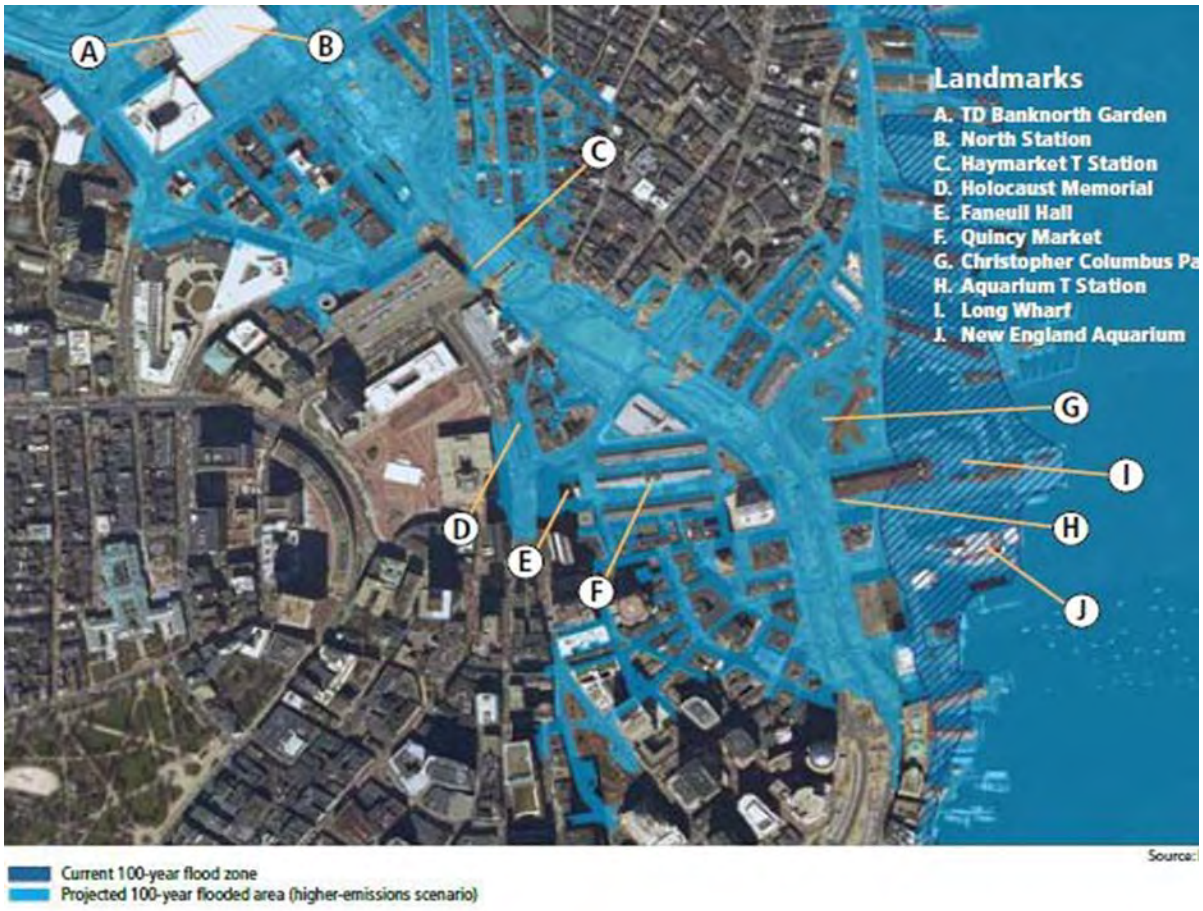


Figure taken from Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions.[59]

Increase in Fresh and Ocean Water Temperature and Acidification

In addition to changes in the level of the sea, the physical and chemical properties of the ocean are changing. As the air temperature warms, it warms the ocean. Globally, sea surface temperatures have been higher during the past three decades than at any other time since reliable observations began in 1880.[60] Warmer fresh and salt waters hold less dissolved oxygen making "hypoxia"[2] more likely, fostering harmful algal blooms, and changing the toxicity of some pollutants.[61]

The pH level of seawater has decreased significantly since 1750, and is projected to drop much more dramatically by the end of the century if carbon dioxide (CO_2) concentrations continue to increase as the oceans absorb this CO_2.[62] According to the 2011 Massachusetts' Climate Change Adaptation Report, pH levels are projected to decrease by 0.1- 0.3 by 2100, making the ocean more acidic.[63] As EPA stated in the draft *National Water Program 2012 Strategy: Response to Climate Change*,[64] scientific research over the last 10 years indicates serious implications of ocean acidification for ocean and coastal marine ecosystems. In its 2010 report, *Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean*, the National Research Council[65] concludes that ocean chemistry is changing at an unprecedented rate due to human-made CO_2 emissions. The report also states that "while the ultimate

[2] Hypoxia occurs when dissolved oxygen declines to the point where aquatic species can no longer survive

consequences are still unknown, there is a risk of ecosystem changes that threaten coral reefs, fisheries, protected species, and other natural resources of value to society." Of particular concern in New England is the threat that acidification has for shellfish populations, especially soft shelled clams, and research on this issue is underway in Maine and elsewhere.

Public Health Impacts

Extreme heat events can and have impacted human health. A three-day heat wave (temperatures reaching triple digits on two days) in Chicago in 1995 led to nearly 700 heat-related deaths.[66] The possibility of similar heat waves are increasingly likely in New England as projections for the number of days per year over 100°F grow (see Figure 4). In September 2010, Maine experienced a heat wave in which many schools closed due to excessive heat and the fact that schools do not have air conditioning. During this heat wave, the National Weather Service issued an advisory warning that "the high heat and humidity combined with the long duration of the current heat wave would make conditions uncomfortable and potentially dangerous especially in hot buildings without air conditioning or proper ventilation."[67] Since the hottest days in the Northeast are often associated with high concentrations of ground-level ozone and other pollutants, the combination of heat stress and poor air quality can pose a health risk to vulnerable groups: young children, the elderly, and those with pre-existing health conditions including asthma.[68]

The combination of warmer temperatures and extreme weather events encourages the spread of infectious diseases in new areas and affects many aspects of human health.[69] Changes in vector-borne diseases are already being seen in the Northeast with Spotted Fever Rickettsiosis, a tick borne infection, reported in 4 of the 6 states. Babesiosis, or animal malaria also carried by ticks may threaten the blood supply. This newly reportable disease has been growing in the northeast and is now reported in every New England state.[70] Suitable habitat for the Asian Tiger Mosquito, which can transmit West Nile and other vector-borne diseases, is expected to increase in the Northeast from the current 5% to 16% in the next two decades and from 43% to 49% by the end of the century, exposing more than 30 million people to the threat of dense infestations by this species.[71]

Over the last 10 summers from 2004 through 2013, New England has averaged 30 days per year with unhealthy air for the current ozone standard of 75 parts per billion. In New England, high ozone levels usually occur between 1:00 and 7:00 pm on hot days from May through September.[72] Hot days are particularly conducive to ground-level ozone formation, and air conditioning loads on such days are often a major contributor to electricity demand spikes. At the same time, some EGUs called "peaking units" only operate during periods of peak demand when the electric grid requires maximum generating capacity, and could be high-emitting sources of nitrogen oxide (NOx) emissions, which are a key contributor to ground-level ozone formation. Peaking units might lack NOx controls because they have low emissions on a seasonal basis, even if hourly NOx emissions are high during periods when they are in use.[73] Thus, it is expected that with an increase in the number of days with high temperatures, New England will see increases in ozone on those days.

Built Environment-Housing and Indoor Air

In the United States, citizens spend over 90% of their time inside with an estimated 70% of that time spent in their homes. The US Census's American Housing Survey in 2009 reported that nearly 6 million housing units have moderate to severe physical infrastructure problems.[74] The National Center for Healthy Homes citing this Census study states that the most common problems in American housing are water leaks from the outside (11%) and inside (8%), roofing problems (6%) and damaged walls (5%). According to the Census's American Community Survey Summary from 2007-2011, only 14% of the

homes in the nation were built before 1939. In New England 28% of the homes were built before 1939.[75] These older homes were built prior to many of the new construction codes and may be more susceptible to structural problems. In addition, the northeast has a higher percentage of multi-family structures; 63% of family homes in the northeast are single family homes, as opposed to 83% in the United States as a whole.[76] New England housing units also rely more on the use of fuel oil or kerosene. In New Hampshire, Vermont and Maine over 50% rely on these fuels for heating vs. only 7% in the entire nation.[77] These fuels are delivered by fuel trucks and those deliveries could be disrupted by severe weather events. All of these factors combined indicate that New Englanders are potentially exposed to more indoor pollutants than those in other parts of the US.

Adaptation Planning Underway in New England

Because of the susceptibility of New England to climate change impacts, New England federal, regional, state agencies, and non-government organizations have already begun addressing this issue. New England states in particular have been out in front of the nation in planning for both climate mitigation and adaptation. Table 1 summarizes the adaptation efforts of the New England states, and the adaptation activities are expanded upon below:

- In 2005, the Governor's Steering Committee on Climate Change for Connecticut produced a Climate Change Action Plan focusing on greenhouse gas emissions. In 2010, the Adaptation Subcommittee of the Governor's Steering Committee produced a report "The Impacts of Climate Change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health," detailing the potential impacts of climate change. In 2011, this subcommittee produced a draft report addressing adaptation strategies in light of identified impacts, "Connecticut Climate Change Preparedness Plan." This report was finalized in July 2013. In January, 2014, the Institute for Community Resiliency and Climate Adaptation was created in Connecticut. The Institute is a collaboration between the University of Connecticut, the state Department of Energy and Environmental Protection, and the National Oceanic and Atmospheric Administration.

- In Maine, Governor LePage recently created a workgroup entitled "Environment and Energy Resources Work Group" which consists of state agencies focused on transportation, energy, fisheries and wildlife, forestry, agriculture and marine resources. The cross-agency effort is aimed at discussing mechanisms for cross agency partnerships, information sharing, efficiencies and streamlining. These efforts will provide specific and identifiable tools to assist decision-makers in preparing for climate change[78].

- In 2008, Massachusetts' Global Warming Solutions Act led to the establishment of a Climate Change Adaptation Advisory Committee that produced a report on adaptation strategies in light of predicted climate changes for the state. The report, published in 2012, provided conclusions and recommendations by the committee regarding anticipated climate change and future adaptation strategies. In addition, the report provides sector-specific impacts and adaptation strategies.

- In December 2007, Governor Lynch of New Hampshire established a Climate Change Policy Task Force, charging the group with the development of a Climate Action Plan for New Hampshire. The report was published in March 2009. The final report focused on greenhouse gas emissions reductions to address climate change but also identified anticipated future impacts of climate change on various sectors: agriculture, forestry and waste, electric generation, transportation and land use.

- In 2010, Rhode Island's Climate Change Commission was established through the state's Climate Risk Reduction Act. In November 2012, a progress report was produced; summarizing key climate risks and vulnerabilities to those risks, identifies existing climate change adaptation initiatives, and highlights the areas that have yet to be addressed. In addition, in Section 145 "Climate Change and Sea Level Rise" of Rhode Island's Coastal Resources Management Program, Rhode Island has codified in regulation that future policies, plans, and regulations proactively plan for and adapt to climate change and sea level rise.[79] In addition, the University of Rhode Island and other collaborators recently launched a website designed to inform the public about climate change and to help prepare for the changes.[80]

- From 2010 to 2012, Vermont's Agency of Natural Resources (Vermont ANR) developed a series of sector-based white papers as part of an initial education effort. Sectors included: agriculture, water resources, recreation, forestry, public health, public safety, fish and wildlife, and transportation. Vermont ANR expects to have a vulnerability assessment and adaptation strategy for Vermont lakes, rivers, forests, and wetlands, including those natural communities and the organisms that inhabit them in 2013.

Table 1: Summary of State Adaptation Planning Efforts

State	*Summary of Adaptation Effort*
Connecticut	Final Adaptation Plan Complete *(Climate Change Preparedness Plan, 2011:* http://www.ct.gov/deep/lib/deep/climatechange/connecticut_climate_preparedness_plan_2011.pdf. *The Impacts of Climate Change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health, 2010:* http://www.ct.gov/deep/lib/deep/climatechange/impactsofclimatechange.pdf.
Maine	Summary of climate change adaptation work is available at http://www.maine.gov/dep/sustainability.
Massachusetts	Initial Adaptation Plan Complete *(Climate Change Adaptation Report, 2011: http://www.mass.gov/eea/air-water-climate-change/climate-change*
New Hampshire	Initial Adaptation Planning Process Underway *(Climate Action Plan, 2009: http://des.nh.gov/organization/divisions/air/tsb/tps/climate/action_plan/documents/nhcap_final.pdf)*
Rhode Island	Initial Adaptation Planning Process Complete *(Adapting to Climate Change in the Ocean State, 2012: http://www.rilin.state.ri.us/Reports/Climate%20Change%20Commission%20Prog%20Report%20Final%2011%2015%2012%20final%202.pdf)*
Vermont	Initial Adaptation Planning Process Underway *(Vermont Climate Change White Papers, 2010-2012: http://www.anr.state.vt.us/anr/climatechange/Adaptation.html)*

In addition to state activity related to adaptation, there are adaptation planning activities occurring at the municipal level as well. For example, Boston, MA; Cambridge, MA; Portland, ME; Scarborough-Old Orchard Beach, ME; and several communities in New Hampshire and the Metropolitan Area Planning Council, a regional planning agency that serves over one hundred cities and town in Metropolitan Boston, are all engaged in adaptation planning.[81] In 2011, EPA New England, in coordination with the Institute for Sustainable Communities, launched the New England Municipal Sustainability Network (NEMSN), which fosters peer to peer communication between municipal sustainability practitioners across the region on key priorities including climate change adaptation. In December of 2011 the NEMSN sponsored climate adaptation training for themselves. At the federal level, in 2010, the New England Federal Partners Climate Workgroup was formed and it includes 17 federal agencies and their staff including National Oceanographic and Atmospheric Administration (NOAA), EPA, Federal Emergency Management Agency (FEMA), United States Geological Service (USGS), United States Army Corps of Engineers (USACE) and Department of Interior (DOI) who are working and coordinating on climate change adaptation and mitigation activities.

III. Vulnerability Assessment

This section contains a preliminary assessment of the vulnerabilities of key EPA New England programs to the impacts of climate change. It builds on the work presented in Part 2 of EPA's agency-wide Plan,[82] and is structured by the goals in EPA's FY 2011-2015 Strategic Plan.[83] These vulnerabilities were identified by the EPA New England Adaptation Planning Workgroup. Note that EPA New England has not conducted a quantitative vulnerability assessment, but has qualitatively evaluated the nature and magnitude of risks associated with climate change impacts. This assessment is based on best professional judgment within EPA at this time and may change in the future as our understanding of climate science evolves.

GOAL 1: Taking Action on Climate Change and Improving Air Quality

A. Overview of Potential Climate Change Impacts

Communities within New England face public health and environmental challenges from ambient and indoor air pollution. Climate change will increase these challenges. EPA New England partners with federal, state, tribal and local agencies to protect public health and the environment by directly implementing programs that address air quality (indoor and outdoor), toxic pollutants, climate change, energy efficiency, pollution prevention, industrial and mobile source pollution, radon, acid rain, stratospheric ozone depletion, and radiation protection. Several program areas are vulnerable to future climate conditions that may be characterized by elevated baseline temperatures, increased frequency and duration of heat waves, more extreme swings in weather conditions (drought and precipitation events), and more severe hurricanes and coastal storms. These future conditions will present challenges to EPA to achieve its core mission.

B. Program-Specific Vulnerabilities

Ozone (O_3) and Nitrogen Oxides (NOx)

New England has made progress in attaining the National Ambient Air Quality Standards (NAAQS) for the current ozone standard of 75 parts per billion, but problem areas remain in southern New England. [84, 85]Although there are continuing NOx and volatile organic compound (VOC) emission reductions from ongoing control strategies for on-road and non-road mobile sources and fossil-fueled fired power plants, future climate conditions may make it more difficult to attain the NAAQS for ozone.

Impacts on O_3 and NOx programs:

- Volatile organic compound emissions from biogenic sources such as trees should increase due to increased temperatures.[86]
- NOx emissions from fossil-fuel burning power plants, operating during peak electricity demand periods, may increase with increased temperatures.[87]
- The rate of ozone production in the atmosphere should increase with increased temperatures.[88]
- Additional O_3 production and inter-regional transport due to prolonged heat waves, stagnation and increases in upwind emissions. [89]
- The length of the ozone monitoring season may be extended into early spring and late fall.[90]

Particulate Matter (PM)

Similarly, New England has made progress in attaining and maintaining the NAAQS for $PM_{2.5}$.

Impacts on PM program:

- There is the potential to see increases in certain air pollutants from power plants (e.g., sulfur dioxide [SO_2], particulate matter less than 2.5 micrometers in diameter [$PM_{2.5}$], etc.) during peak electricity demand due to increased regional temperatures. These increases may contribute to local air quality problems. [91]
- As seen during prolonged power outages from the October 2011 snow storm, $PM_{2.5}$ violations from local increases in $PM_{2.5}$ due to the use of backup electricity (e.g., generators) and heat (e.g., wood stoves, fireplaces) sources because of increased extreme weather events and resulting power outages.
- $PM_{2.5}$ violations from local increases in $PM_{2.5}$ may occur due to the uncontrolled burning of storm debris after intense weather events.

Indoor Air

Impacts on indoor air program:

- Extreme weather conditions associated with climate change may lead to breakdowns in building envelopes, causing the flooding of indoor spaces. Dampness and water intrusion create conditions favorable to fungi and bacteria (including mold). This can also cause building materials to decay or corrode, which can lead to off-gassing of chemicals.[92]

Mercury

Impacts on mercury program:

- Mercury in soils and vegetation, such as boreal peat, may be emitted with increased wildfires adding to the global atmospheric reservoir. [93]Mercury deposition in New England waters and subsequent mercury contamination of fish and wildlife may continue and possibly increase with the increase in extreme precipitation events. [94, 95]
- Precipitation events will incorporate a fraction of this global pool in rain and snow, thus contributing to mercury pollution in the region. Therefore, local and regional efforts to achieve water quality loading thresholds (Total Maximum Daily Loads, TMDLs) may be more difficult to achieve.

C. Enforcement and Compliance

Region 1 conducts both Clean Air Act (CAA) enforcement and compliance assistance to the regulated community on meeting EPA air quality regulations. Increasing resource demands as a result of climate change impacts could put additional strain on the use of declining resources for these Enforcement/Compliance activities.

Impacts on enforcement and compliance programs:

- Increased power plant peaking demand could increase the likelihood of emergency generators being used to meet the peak demand due to increased temperatures and higher mean summer temperatures.
- There may be an increased burden on compliance and enforcement staff to respond to an increased number of industry inquiries for regulatory interpretations and CAA applicability determinations to ensure consistent application of regulatory requirements across the country.
- Major storm or heat events could result in an increased number of requests for temporary waivers from regulatory requirements, including requirements for gasoline and diesel fuels.

GOAL 2: Protecting America's Waters

Cross-Program Water Management

While considerable progress has been made since the enactment of the Clean Water Act and the Safe Drinking Water Act, America's waters continue to be threatened by pollutants including excess nutrient loadings, stormwater runoff, invasive species and drinking-water contaminants. EPA works with states and tribes to develop nutrient limits and to restore and protect the quality of the nation's streams, rivers, lakes, bays, oceans and aquifers. EPA also uses its authority to address urban rivers; to ensure safe drinking water; and to reduce pollution from nonpoint and industrial dischargers. [96]

At EPA New England, protection of regional waters occurs through eleven programs:

1. Water Quality Standards;
2. Monitoring,

3. Assessing and Reporting;
4. Total Maximum Daily Loads (TMDLs);
5. National Pollutant Discharge Elimination System (NPDES);
6. Nonpoint Source Management;
7. Wetlands;
8. Dredging/Ocean Dumping;
9. National Estuary Program;
10. Drinking Water, Wastewater, and Stormwater Infrastructure; and
11. Drinking Water Quality.

A. Overview of Potential Climate Change Impacts

In March 2012, EPA published the draft *2012 National Water Program Climate Change Strategy*[97] which describes the following impacts to water resources.

- **Increases in water pollution due to warmer air and water temperatures and changes in precipitation patterns,** causing an increase in the number of waters categorized as "impaired," with associated impacts on human health and aquatic ecosystems.
- **Impacts on water infrastructure and aquatic systems due to more extreme weather events,** including heavier precipitation and tropical and inland storms.
- **Changes to the availability of drinking water supplies** due to increased frequency, severity and duration of drought, changing patterns of precipitation and snowmelt, increased evaporation, and aquifer saltwater intrusion, affecting public water supply, agriculture, industry, and energy production uses.
- **Waterbody boundary movement and displacement** as rising sea levels alter ocean and estuarine shorelines and as changes in water flow, precipitation, and evaporation affect the size of wetlands and lakes.
- **Changing aquatic biology** due to warmer water and changing flows, resulting in deterioration of aquatic ecosystem health in some areas.
- **Collective impacts on coastal areas** resulting from a combination of sea level rise, increased damage from floods and storms, coastal erosion, salt water intrusion to drinking water supplies, and increasing temperature and acidification of the oceans.
- **Indirect impacts** due to unintended consequences of human response to climate change, such as those resulting from carbon sequestration and other greenhouse gas reduction strategies.

In New England, EPA has identified additional impacts that include:

- Flooding from increasingly frequent and intense rain events as well as intense tropical storms will tax aging infrastructure, including combined sewer systems, wastewater and drinking water facilities and adversely impact water quality.
- Dense coastal development and shoreline armoring with sea walls and other hardening structures will prevent wetland migration and lead to loss of wetlands as the sea level rises.
- Increases in the extent of storm surge and coastal flooding will cause erosion and property damage to the densely populated coasts.
- Sea level rise may increase saltwater intrusion to coastal freshwater aquifers, resulting in water resources that are unusable without desalination. Increased evaporation or reduced recharge into coastal aquifers exacerbates saltwater intrusion.

- Sea level rise will lead to direct and indirect losses for the region's energy infrastructure (e.g., power plants and located along the coast, marine facilities that receive oil and gas deliveries), including equipment damage from flooding or erosion. Damaged energy facilities also may be a source of pollution.
- Aquatic ecosystem species composition and distribution will change due to sea level rise, increased water temperatures, salinity distribution and ocean circulation, changes in precipitation and fresh water runoff, and acidification. This will also result in potential for new or increased prevalence of invasive species.

B. Program-Specific Vulnerabilities

Water Quality Standards

Water Quality Standards are the foundation of the Clean Water Act – they designate the goals and uses for water bodies, setting criteria to protect those uses, and establishing provisions to protect water bodies from pollutants. States, territories, and authorized tribes establish water quality standards, and EPA reviews and approves those standards.

Impacts on Water Quality Standards Program:

- Salinity changes may create a need to reclassify some water bodies from fresh to salt water.
- Recreation and shell fishing season onset and duration may change.
- Some water quality standards may become unattainable due to changing conditions (e.g., warmer water, drier conditions, less snowpack).
- The relative contribution of snowmelt vs. groundwater flow to stream flow could change, affecting stream temperature regimes and biological conditions.
- Some designated uses and their associated criteria may need to be removed or changed based on monitored changes (e.g., intermittent streams may be dry for longer periods of time in summer and no longer support certain aquatic life forms).
- Some standards (i.e., pollutant-specific goals) may need to change to reflect more sensitive environmental conditions.

Monitoring, Assessing, and Reporting

Our nation's waters are monitored by state, federal, and local agencies, universities, dischargers, and volunteers. Water quality data are used to characterize waters, identify trends over time, identify emerging problems, determine whether pollution control programs are working, help to direct pollution control efforts to where they are most needed, and respond to emergencies such as floods and spills.

Impacts on Monitoring Program:

- Current location of monitors may no longer be appropriate in order to effectively monitor and assess changes and to provide access to the monitors (e.g. sea level rise, precipitation, temperatures, stratification).
- Current detection protocols, criteria, monitoring and analysis may not be sufficient to detect ocean acidification and/or salinity.
- Current timing of monitoring may not be sufficient in order to pick up seasonal shifts and the full range of climate vulnerability, especially for recreational and aquatic life uses.
- The current number of monitors used may not be sufficient to assess an increased number of 303(d) impairment listings due to the increased stresses.
- Stream ecosystems will be affected directly, indirectly, and through interactions with other stressors. Biological responses to these changes include altered community composition,

interactions, and functions. Effects will vary regionally and present biomonitoring challenges for water-quality agencies that assess the status and health of ecosystems.
- With more rapidly changing conditions, more monitoring may be required to adequately assess the condition of waterbodies.

Total Maximum Daily Loads

Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop a Total Maximum Daily Load, or TMDL. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.

Impacts on TMDL Program:

Over the past decade, EPA Region 1's cross-program effort to address stormwater-related water quality impairments has provided valuable experience in how to develop and implement TMDLs that address multiple environmental stressors resulting from various flow regimes. For example, impervious surfaces in urban environments deliver a mix of pollutants and increased flow to rivers and streams resulting in soil erosion, stream bank scouring, deposition of sediment and nutrients increases in receiving waters. The increasing amount of impervious surfaces in urban areas causes less precipitation to infiltrate into the ground, which may cause streams to experience much lower base flows during dry conditions, along with low dissolved oxygen, increased eutrophication, and higher stream temperatures. Flashy streamflow conditions (i.e., rapid increases in streamflow and velocity in response to rainfall, followed by rapid recovery to pre-storm conditions) related to excessive stormwater runoff and corresponding droughts are anticipated to become even more frequent and/or intense in response to further climate change.

Stormwater TMDLs now being implemented effectively on a sub-watershed basis involve the use of surrogates for the mix of pollutants in stormwater (i.e., impervious cover, or flow). Innovative and flexible approaches to TMDL development like this show promise for addressing the complex challenges of climate change. For instance, under the surrogate approach, TMDL end-points are tied to aquatic life use protections in State water quality standards, which provide environmental protection based on whatever the current conditions happen to be (rather than future projections based on past conditions). The technical basis for aquatic life use-based TMDLs is derived from significant investments over the past 35 years developing state ambient biological monitoring programs in our Region. Bioassessments (using ambient assemblages of macroinvertebrates, fish, or algae that integrate the effects of multiple stressors over time), in concert with physical and chemical monitoring data, now support the water quality assessment of aquatic life use attainment for these surrogate TMDLs, and provide clear environmental indicators of stream health under whatever the existing conditions are.

Summary of anticipated water quality programmatic climate change vulnerabilities includes:

- Challenges in quantitatively demonstrating how implementation of current stormwater BMPs (occurring primarily through permitting programs), and NPS BMPs, will address future changes in climate;
- TMDLs may need to be revised in the future as monitoring shows that TMDL target attainment isn't leading to designated uses being met;
- Increased need for efforts to support local and state partners in additional local land use planning, stormwater and wastewater TMDL implementation actions needed to achieve the TMDL endpoints (water quality standards);

- Increased need for resources at federal, state, and local levels to address these challenges.

National Pollutant Discharge Elimination System

Water pollution degrades surface waters making them unsafe for existing uses, including drinking water, fishing, swimming, and other water recreation. As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. NPDES permits have a five year permitting cycle.

Impacts on the NPDES program:

- Increased need to respond to requests for assistance from municipalities regarding stormwater management implementation and financing methods.
- Current thermal discharge limits may not sufficiently account for increasing temperatures of the influent and receiving waters.
- The assemblage of aquatic organisms residing or transiting a particular receiving water may change due to water temperature increases.
- Entrainment of different fish species and greater numbers of organisms could occur at power plant and industrial water intakes due to changes in local communities of organisms as a result of habitat changes from increased water temperatures and increased cooling water demand.
- Increased extreme precipitation and stormwater runoff will cause an increase in erosion and sedimentation in receiving waters.
- Reduced flows in streams, especially during summer months, will likely not dilute wastewater treatment plant and other facility effluents as they do now.
- Water quality standards and BAT/BPT/BCT (Best Available Control Technology Economically Achievable / Best Practicable Control Technology Currently Available / Best Conventional Pollutant Control Technology) technology-based limitations may not account for site-specific effects of:
    - changing ambient loading of metals and chemicals from acid deposition, leaching of contaminated groundwater into discharge infrastructure or movement of pollutants resulting from flooding, extreme precipitation and atmospheric exchange,
    - increasing difficulty of meeting permit requirements due to growing frequency of extreme precipitation events, storm surge and sea level rise,
    - changes in discharge toxicity of specific pollutants (such as ammonia), cumulative effects of pollutants and persistence of certain pollutants due to changing ambient surface water and air temperatures.
- A facility's climate change mitigation or adaptation measures may not conform to BAT/BPT/BCT technology-based limitations.
- More compliance issues in impaired watersheds for NPDES and SDW programs.

Nonpoint Source Management

Nonpoint source pollution comes from many diffuse sources and is caused by rainfall and snowmelt runoff that picks up natural and human made pollutants and deposits them in lakes, rivers, wetlands, coastal waters and ground water. State nonpoint source programs, developed under the Clean Water Act (CWA) Section 319 Program, are working to meet this challenge.

Impacts on the Nonpoint Source Management Program:

- Accounting for greater quantities of runoff and pollutant effluents, with more variability, from both urban and suburban stormwater and agricultural sources.

- Increasing heavy precipitation days and more concentration of runoff in intense storms is likely to be more damaging to aquatic habitats, and carry more erosion-related pollutants into water bodies.
- Extended drought conditions that may cause inadequate stream flows and further stress aquatic systems, including the vegetation that is used in riparian areas and in management practices to filter, treat, and infiltrate effluent flows (e.g. best management practice [BMP] utility may need to be reevaluated under future conditions).
- More restoration and protection challenges for watershed protection and NPS programs.

Wetlands

Section 404 of the Clean Water Act requires EPA to concur with permits issued by the U.S. Army Corps of Engineers to allow dredging or filling of wetlands. Wetlands function to protect ecosystems, streams and other aquatic resources. Wetlands provide four crucial functions for helping to make the Nation more resilient in response to climate change:

- Coastal protection in the face of sea level rise and increased hurricane intensity, including the ability to reduce wave energy;
- Protecting Water Supplies in the face of increased drought conditions by providing groundwater recharge and maintaining minimum stream flows;
- Flood mitigation in the face of increased precipitation and storm frequency in the northeastern United States. The capacity of wetlands and headwater streams to reduce flood peaks, detain stormwater, and filter pollutants is critical to the protection of life, property, and water quality;
- Wetlands can serve to sequester carbon.

Impacts on wetlands program (coastal and inland wetlands):

- Wetland migration due to sea level rise that inundate or submerge the wetlands.
- Variability in salinity levels, caused by drought, sea level rise, and increased precipitation and changes in the plant and animal species that inhabit the wetlands as well as potential impacts on endangered species and/or critical habitats.
- Increased sedimentation and nutrient loading, with increased precipitation potentially changing wetland characteristics and structures.
- Drying out of seasonal wetlands with increased drought, which may also potentially change wetland characteristics.
- Changes in soil dynamics may also affect wetland characteristics, such as hydrology, size, and sediment types.
- Physical damage or elimination of wetlands and dune structures that protect them due to hurricanes and other seasonal changes.
- Changes in temperature and rainfall patterns can affect the nature and distribution of inland wetlands. Decreased precipitation and increased temperatures (greater evaporation and less frequent flooding), can result in loss of vernal pools and shallow emergent wetland. These changes can affect the plant and animal species that inhabit the wetlands and may cause potential impacts on endangered species and/or critical habitats. Sea level rise may submerge/inundate wetlands, potentially changing wetland characteristics (e.g. designation from fresh to saltwater wetland).
- Sea level rise and increased storm activity will increase erosion of salt marshes. For coastal marshes, if sea levels rise at a rate that exceeds the accumulation of substrate (marsh sediments) the coastal wetlands will break down due to inundation, erosion and intrusion by salt water.

Ocean Dumping and Dredging

The Ocean Dumping and Dredged Materials Management programs established by Congress in 1972, prohibits ocean dumping of materials that would unreasonably degrade or endanger human health or the marine environment.

Impacts on the Ocean Dumping and Dredging program:

- Increase need and frequency for dredging due to increased precipitation intensity, and severe storms that may cause erosion and sedimentation of streams, rivers, and harbors.
- Earlier sedimentation due to shorter winters and earlier snowmelts.
- Shifting sediments and forming of shoals in harbors that impede safe navigation and may require emergency dredging.
- Need for dredged materials to protect shorelines, beaches, dunes and marshes from sea level rise.

National Estuary Program

The National Estuary Program (NEP) was established in 1987 to restore and protect the physical, chemical, and biological integrity of "estuaries of national significance" by focusing our Clean Water Act authorities in these highly productive ecosystems. There are 28 NEPs across the country, six of which are entirely or partially within EPA New England. The NEPs promote technical transfer of information, expertise, and best management practices to accelerate and embellish implementation of "core" Clean Water Act programs. Lessons learned by the NEPs are shared across the network of 28 programs nationally, as well as with other coastal watersheds facing similar water pollution and water quality impairments. This approach has proven to be a success over the past 25 years and the NEP is seen as a model for other comprehensive watershed and community-based programs.

Impacts on the NEP Program:

- Biological communities are vulnerable to sea level rise, warming ocean temperatures, acidification, and increased sedimentation and erosion caused by extreme precipitation events as well as other impacts described in other water programs above.

Drinking Water, Wastewater, and Stormwater Infrastructure

The Clean Water Act and the Safe Drinking Water Act are the two primary federal laws that protect water quality and specifically drinking water quality. Both laws include provisions that authorize EPA to award annual grants to states to help capitalize their State Revolving Fund (SRF) programs, which support construction and maintenance of wastewater, stormwater, and drinking water treatment and conveyance infrastructure. The following are some of the most significant threats to water infrastructure posed by climate change.

Impacts on Drinking Water, Wastewater and Stormwater Infrastructure Programs:

- Damage to infrastructure due to increases in flooding from extreme precipitation, storm surges, loss of wetlands, and sea level rise.
- Source water intake changes may be needed due to droughts and summertime extreme heat.
- Coastal infrastructure may be impacted by sea level rise.
- Pathogen growth may be fostered due to warmer waters and may test the reliability of drinking water disinfection.
- Additional pollutant loadings of nutrients, pesticides, and other chemicals may challenge drinking water treatment.
- Fresh water supplies for all uses, particularly drinking water, may be at risk in coastal areas with sea level rise.

- Coastal aquifers may experience salt water intrusion where withdrawals are outstripping recharge and increased pressure head from higher sea levels may worsen this problem.
- Community drinking water intakes may end up in brackish waters as the salt front migrates up coastal rivers and streams.
- There may be an impairment of ability to treat wastewater or provide drinking water in the aftermath of extreme weather events due to compromised energy infrastructure.
- Decentralized septic systems may be vulnerable to damage from sea level rise, storm surge, and flooding.

Drinking Water Quality

The Safe Drinking Water Act (SDWA) is the main federal law that ensures the quality of Americans' drinking water. EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards.

Impacts on Drinking Water Quality Program:

- Changes in aquifer recharge due to earlier ice breakup causing earlier peak river flows may require changes in source and demand management.
- Increased runoff and turbidity due to more precipitation falling as rain than as snow.
- Source and demand management changes due to short-term droughts lasting 1-3 months and more frequent days of extreme heat.
- Threats to source water quality due to flooding, storm surges, coastal flooding, loss of wetlands, and sea level rise.
- Diminished reliability of future water supply may require water supply management and water demand management practice changes.
- Changes in the salt front of estuaries and tidal rivers due to sea level rise and fresh water flow changes may result in increased pressure to manage freshwater reservoirs to increase flows and attempt to maintain salinity regimes, in order to protect estuarine productivity and drinking water supplies. Water quality standards in watersheds experiencing reservoir depletion may need to reflect these conditions.
- Biological expectations may need to be adjusted due to saltwater intrusion.
- May become harder to meet drinking water standards due to higher flows with associated erosion and sedimentation and lower flows and increased pollutant contamination and reduced dissolved oxygen.
- Increased contaminants in public drinking water sources and supplies due to runoff from increased rain events.

C. Enforcement and Compliance

- Extreme weather events can do significant and potentially long-term damage to drinking water facilities and sewage treatment plants, resulting in contaminated drinking water and the discharge of untreated sewage in violation of applicable requirements. Such damage will increase the burden on Enforcement/Compliance programs to respond to these violations and water quality impairments resulting from such damage.

- It may be physically more difficult to conduct compliance evaluations and inspections in the field due to harsher weather conditions and extreme weather events. The weather conditions could have an adverse effect both on the physical well-being of inspectors, as well as on equipment used

to monitor and test compliance. Weather conditions and the aftermath of extreme weather events may affect our ability to actually collect samples and determine compliance.

- Impacts on Enforcement/Compliance resources for enforcement of wetlands regulations could be particularly impacted by the response to storm surges in vulnerable areas (see wetlands section, above).

GOAL 3: Cleaning up Communities and Advancing Sustainable Development

Contaminated site cleanup and waste/petroleum management occur under a variety of EPA programs, most commonly Superfund (i.e., remedial, time-critical and non-time critical removals, and emergency response), Resource Conservation and Recovery Act (RCRA), Toxic Substance Control Act (TSCA) (e.g., polychlorinated biphenyls – PCBs), Clean Air Act (CAA) (e.g., asbestos), and the Oil Pollution Act (OPA). A high percentage of cleanups, including most Brownfields sites, are regulated through State programs.

A. Overview of Potential Climate Change Impacts

The potential climate change impacts described below broadly apply to each of the cleanup and management programs; however, the implications of these climate change impacts may differ by program.

For New England, the impacts that could most likely pose risks to contaminated sites (including controlled, uncontrolled, and undiscovered contamination), waste management facilities, and petroleum storage facilities are sea level rise, extreme storm events (precipitation and wind), temperature extremes, and decreasing precipitation days and increasing drought intensity. Ocean acidification and increased water temperatures may also pose additional risks to coastal petroleum storage facilities and affect the natural bio-degradation of oils released to the environment. Potential environmental conditions arising from these impacts and specific examples illustrating how they could influence contaminated sites are described below. The likelihood and severity of climate change impacts can also be expected to vary considerably from site to site depending on the location, cleanup technologies/approaches used, and many other factors.

Sea Level Rise: Sea level rise will affect coastal areas in every New England state except for Vermont. The impact on contaminated sites, waste management facilities, and petroleum storage facilities may be partially mitigated because sea level rise is expected to occur gradually over the course of decades. This may allow additional time to appropriately plan for and respond to these changing conditions (e.g., construction of berms, removal of wastes, and completion of shorter-term treatment activities).

As a result of sea level rise, contaminated sites, waste management facilities, and petroleum storage facilities located in vulnerable areas could be subject to inundation and salt water intrusion. Inundation may lead to the release and dispersal of contaminants, physical damage to remediation-related structures, degradation of coastal aquifers (thereby impacting cleanup performance goals), and other adverse impacts. Saltwater intrusion may also impair habitat restoration efforts; cause corrosion of underground

tanks, piping, and other equipment; and may lead to changes in soil/water chemical and biological properties, altering the toxicity, transport, and natural degradation of contaminants.

Extreme Storm Events: Existing climate studies suggest that New England has been experiencing more intense storm events. Unlike sea level rise, which predominantly affects coastal areas, extreme storm events can impact a much wider range of contaminated sites. These impacts could include:

- Flooding of surface water bodies and surrounding land areas due to heavy precipitation events (i.e., regional drainage).
- Flooding of coastal areas and rivers from storm surge due to higher intensity hurricanes.
- Increased local surface runoff.
- Increased infiltration of storm water into soils and elevation of water tables.
- Increased wind damage and dispersion of contaminants.

Because much of the historical development of industry and commerce in New England occurred along rivers, canals, coasts, and other water bodies, these areas often have a higher density of contaminated sites, waste management facilities, and petroleum storage facilities. This increases the number of these sites and facilities potentially vulnerable to flooding. Potential consequences of this flooding include the spread of contaminants through erosion, dissolving of contaminants, physical entrainment and deposition of soils or sediments, and flotation and rupture of tanks or drums. Flooding and high winds may also result in the delay or impairment of remedial operations, and damage to remediation and waste/petroleum management structures, contaminated buildings, utilities and other related infrastructure. In addition, the increased amounts of infiltration and runoff, and higher water table levels, could impact the performance of remediation systems and require management of greater volumes of clean and contaminated ground- and surface-water. In this way, increased precipitation events and hurricanes may potentially impact sites even if they are remote from coastal areas and rivers.

In addition, prior to the enactment of environmental laws, industrial wastes were routinely discharged to rivers/streams, industrial canals, ponds and other water bodies. As a result, many contaminants may exist within the layers of sediment that accumulated over the years. Increased water flows due to extreme storm events could potentially re-suspend these sediments, or damage sediment caps, which are engineered covers intended to prevent contaminated sediments from migrating. Furthermore, river and canal flooding could also potentially cause the breaching or failure of dams — such as old mill dams which are numerous in New England — resulting in the spread of contaminated sediment previously contained by the dams. Such events could also cause flooding impacts to sites or chemical facilities downstream.

Temperature Change: The direct consequence of elevated temperatures on contaminated site cleanups is expected to be relatively limited. However, elevated temperatures could lead to increased pressurization of storage containers, volatilization of hazardous materials, and other factors which may affect design and operation of remediation systems and emergency response actions. Worker health and safety concerns during site operations may also be impacted by higher temperatures (e.g., handling of pressurized drums, heat stress to responders).

Decreasing Precipitation Days/Increasing Drought Intensity: Decreasing precipitation compounded by higher ambient temperatures may increase drought conditions that could adversely impact the function of remediation systems (e.g., vegetative layers on landfills, phytoremediation). Droughts also may increase the potential for wildfires that could further damage remediation systems, and cause contaminant releases from facilities used to manage hazardous materials and wastes, and from buildings containing asbestos and other hazardous construction materials.

Ocean Acidification: The acidification of sea water may adversely impact the corrosion and degradation of pipelines and construction materials (e.g. concrete pads/berms) used to convey, store, or contain petroleum products at coastal facilities.

Increased Water Temperatures: Increased water temperatures may lead to a change in native or endemic organisms available for biotic degradation of petroleum released to the environment.

B. Program-Specific Vulnerabilities

Longer-term Cleanups (e.g., Superfund Remedial, Superfund Removal, RCRA Corrective Action, TSCA)

Longer-term response cleanups such as those occurring under the Superfund remedial and removal programs and the RCRA corrective action program are intended to significantly reduce the dangers associated with the threats of and actual releases of hazardous substances, pollutants and contaminants that pose an unacceptable risk to human health and the environment. Many of these cleanups are also viewed as "permanent" solutions, and thus must be "protective" of human health and the environment.

Impacts on Longer-term Cleanups:
Cleanups where waste is left in place (e.g., landfills, cap-in-place remedies) or involve treatment that occurs over a long period of time (e.g., ground water pump & treat systems) could be especially vulnerable to changes in climate. For remedies that are typically of much shorter duration (e.g., soil vapor extraction, enhanced thermal treatment), the impacts of climate change are more predictable and easier to factor into the selection and design of a particular remedy. Some specific programmatic vulnerabilities are:

- Climate change introduces uncertainties into the underlying assumptions that could affect the selection and design of future remedies (e.g., precipitation records and floodplain maps used for remedy selection and design may not account for future climate change impacts) potentially leading to:
  - more extensive and costly remedies, such as excavation and removal of wastes, for sites that are potentially vulnerable to sea level rise and flooding
  - designs that are based on conservative engineering assumptions to reflect uncertainty over future environmental conditions (e.g., planning for increased surface water runoff or infiltration from extreme storm events)
- There could be physical damage to structures and other components of the site remedy due to extreme flooding, hurricanes, winter rain/ice storms, and increased drought conditions.
- In some cases, cleanups that were once believed to be protective may no longer meet that standard as changes in climate occur. This could result in extensive and potentially costly redesign, and potentially create an extra demand on EPA and State legal and technical resources.
- Sites that were previously not considered or were excluded from cleanup programs may now require reconsideration under site assessment programs (e.g., changes in the direction and extent of contaminated ground water; collapse of abandoned, structurally unstable buildings containing asbestos, lead paint, and other hazardous construction materials).
- The validity of past and ongoing modeling/monitoring could be affected by changing environmental conditions (e.g., changing groundwater flow, groundwater and surface water salinity and other chemical properties).
- Assumptions made for the use and value of natural resources may be affected by changes to those natural resources (e.g., degradation of an aquifer due to salt water intrusion).

- Time-critical removal actions, which often bridge the gap between emergency response actions and longer-term remedial actions, may involve unique challenges resulting from climate change impacts, such as:
    - The preliminary assessment/site investigation (PA/SI) phase of time-critical removal actions does not currently include potential climate change impacts, and the associated risk may not be factored into cleanup prioritization.
    - The remedy selection process that provides the foundation for more permanent remedies may not adequately consider climate impacts.
    - Time-critical removals often involve labor intensive operations, leading to additional vulnerabilities from acute impacts of climate change (e.g. flooding and ground water level, temporary or long-term power outages, extreme heat). These impacts may lead to increased costs, decreased productivity, and increased migration of contaminants.
    - The available capacities for off-site disposal, waste transport, construction equipment, and laboratory services may be overwhelmed by extreme storm events that may generate large volumes of hazardous materials and debris (including household hazardous waste). The intermixing of hazardous materials and debris complicates the separation, collection, and transport of these materials and also increases disposal costs. Temporary, on-site staging of hazardous materials and debris may also be adversely affected by flooding and other conditions that limit usable land space.
    - Extreme storm events may create chaotic conditions that increase health and safety risks to personnel during time-critical removal and emergency response actions (e.g., unstable buildings/structures; release and intermingling of hazardous materials; physical hazards; contamination by biological wastes from the flooding of waste water treatment facilities, sewers).
    - Flooding may lead to increased need for dewatering, water treatment and other remediation processes that can add greatly to the cost of cleaning up the site.

Emergency Response Program

EPA coordinates and implements a wide range of activities to ensure that adequate and timely response measures are taken in communities affected by hazardous substances and oil releases where state and local first responder capabilities have been exceeded or where additional support is needed. EPA's emergency response program responds to chemical, oil, biological and radiological releases and large-scale national emergencies, including homeland security incidents.

Impacts on Emergency Response Program:

- Releases of hazardous materials or chemicals through high winds, flooding, and storm surge and a need for increased frequency and intensity of emergency response for both hazardous materials and oil. Current response resources, including laboratory services, may not be adequate for responses to extreme events. Specific impacts include:
    - The industrial mill infrastructure along New England Rivers poses a unique threat to the region. Many of these structures contain hazardous chemicals, oil, and contaminated soil directly adjacent to streams and rivers that may release with extreme storms and flooding events. Old, structurally unstable mill buildings containing containerized hazardous substances or hazardous material as part of the structure (e.g., asbestos, lead paint, PCBs) may collapse due to storm forces and cause releases that could warrant response actions. Potential for failure of aging mill dams will increase as frequency and intensity of storms stress the structures, leading to potential impact to chemical and oil facilities downstream.

- Increased number of brown/black outs could adversely impact the operation of chemical facility processes and equipment, leading to potential releases of hazardous materials (e.g., runaway reactions).
- Coastal hazardous material and oil facilities may be impacted by extreme storm events (e.g., storm surge). The United States Coast Guard (USCG) has jurisdiction over hazardous material and oil spills along the coast, but the U. S. EPA has interagency agreements in place to support the USCG during responses.
- Collection of household hazardous waste (HHW) and biological waste collection or mitigation may be included in EPA's mission during extreme weather events. In preparation for more frequent events, additional planning may be necessary to plan for response to these wastes

- Pest type and range may change with climate changes and there may be an increase or change in type of pesticides stored and transported across the region resulting in potential increase in releases.[98]
- Additional planning for emergency response may be needed:
  - The impacts of increased blackouts/brownouts, severe storm damage, and other adverse conditions may need to be incorporated into current national and area contingency plans.
  - Facility Response Plans (FRP) and Spill Prevention and Control Countermeasures (SPCC) plans may not adequately consider climate change impacts.
  - Current regional debris management plans rely on historical climate assumptions and do not address the increasing uncertainty in climatic extreme events.
  - Additional planning may be needed as Stafford Act declarations (federal emergency declarations) may be more frequent with a changing climate.
  - Current energy infrastructure (oil, natural gas, nuclear) in New England may not include climate change assumptions for emergency planning.

RCRA Hazardous Waste Management Facilities

The Resource Conservation and Recovery Act (RCRA) regulates, among other things, the treatment, storage, and disposal of hazardous wastes. Owners/operators of these treatment, storage, and disposal (TSD) facilities must generally obtain a permit for those activities. Facilities that generate hazardous waste and store it for 90 days or less are also regulated under RCRA. In New England, the individual states are authorized to implement this program in lieu of EPA.

In order to operate as a TSD facility, the owner/operator must comply with numerous technical requirements which ensure that covered activities can be conducted in a manner that is protective of human health and the environment. These requirements apply to on-going hazardous waste management units (e.g., drum and tank storage, surface impoundments, waste piles), as well as to the closure (i.e., cleaning and decommissioning) of those units that are no longer in use. TSD facilities must also conduct cleanup of past and present releases of hazardous constituents.

Impacts on RCRA Hazardous Waste Management Facilities:

The same climate change impacts that could affect contaminated site cleanups may also affect the management and operation of hazardous waste facilities. Some examples are:

- Tanks containing hazardous waste could be damaged by high winds or flying debris during hurricanes.
- Integrity of drums and drum storage areas could be compromised by flooding, allowing drums to be floated out of containment barriers, or cause intermingling of incompatible wastes, etc.
- The potential for failure of process equipment (e.g., pressure relief valves, emergency vent fans and pumps) could increase with increases in winter rain and ice storms.

- Over-pressurization of tanks containing volatile wastes and the emergency venting of these wastes could occur with extreme ambient temperatures.
- Buildings or other structures used for indoor storage of waste piles could be damaged or flooded in a hurricane causing the release of this material.
- Emergency evacuation routes for facility personnel and the surrounding community, as well as facility access by fire and other emergency response vehicles, could be flooded or otherwise restricted due to an extreme storm event.

While the New England states are authorized to implement the RCRA hazardous waste management program, EPA retains oversight authority to ensure compliance with the statute and regulations and there may be a need for increased coordination to respond to climate change impacts.

Some specific programmatic vulnerabilities for EPA in its oversight role are:

- Uncertainties in the underlying assumptions that could affect the design, operation and management of hazardous waste facilities, including contingency planning (e.g., RCRA TSD facilities must meet specific requirements if waste management units are located within a 100-year floodplain).
- Financial assurance estimates for closure/post-closure may not reflect changing climate change impacts on those activities.

Oil Program and Underground Storage Tanks

The Oil Pollution Act (OPA) was signed into law in August 1990. The OPA improved the nation's ability to prevent and respond to oil spills by establishing provisions that expand the federal government's ability, and provide the money and resources necessary, to respond to oil spills. To reduce the likelihood of a spill, regulations issued under CWA Section 311(j) (published in the Code of Federal Regulations, 40 CFR Part 112) require facilities that store oil in specified threshold amounts to prepare spill prevention, control, and countermeasure (SPCC) plans and to adopt certain measures to keep releases from reaching navigable waters. Certain types of facilities that pose a greater risk of release must also develop plans to respond promptly to clean up any spills that do occur[99]. It is estimated that there are between 1,000 and 12,000 SPCC facilities per state and 200 FRP facilities in New England.

EPA created the Office of Underground Storage Tanks to carry out a Congressional mandate to develop and implement a regulatory program under RCRA for underground storage tank (UST) systems. EPA works with its state, territorial, and tribal partners to prevent and clean up releases from UST systems. The greatest potential threat from a leaking UST is contamination of groundwater, the source of drinking water for nearly half of all Americans. EPA, states, and tribes work together to protect the environment and human health from potential UST releases.[100]

Impacts on the Oil and Underground Storage Tank Programs:

- Secondary containment and flooding of coastal facilities may be compromised by sea level rise.
- Increase in precipitation and floods may have many impacts, as follows:
    - Decrease the effectiveness of secondary containment.
    - Increase flow and pressure to underground infrastructure/structures i.e. pipelines, wastewater treatment facilities, power plants, and paper mills. Increased flow and pressure to containment systems may result in back feed and flow of product resulting in increased discharges of oil.
    - Decrease tank headspace thereby displacing buffer space available to prevent overflow/ overfill, potentially leading to increased oil spills.
    - Increase weathering of underground and aboveground storage tanks (ASTs and USTs).

    - Increase flow and changes of navigable water depth, thereby increasing difficulty in preparing and implementing planning distance, booming strategies, and cleanup strategies.
- Failure of infrastructure (e.g. pipelines, and secondary containment) and damage or displacement of tanks due to increased intensity of hurricanes and resulting winds and storm surges. Damage to storage tanks would increase the likelihood of spills to navigable waters, coastlines and oceans.
- Increased degradation and weathering of pipelines and infrastructure due to ocean acidification could result in oil spills.
- Higher ambient temperatures that decrease the viscosity of heavy oil and the lowering of water tables due to drought conditions may potentially increase the mobilization of oil spills.
- Change in native or endemic organism availability for biotic degradation of oil due to increase in water temperatures.

C. Enforcement and Compliance

- There may be an increased demand for compliance monitoring support during emergency/disaster situations (e.g., hurricanes, tornadoes, floods, drought, wildfires), and it may be difficult to deploy compliance experts in a timely manner to the areas where assistance is needed. Infrastructure failures may also result in regulatory violations which could require a state or federal enforcement response.

GOAL 4: Ensuring the Safety of Chemicals and Preventing Pollution

A. Pesticides

EPA receives its authority to regulate pesticide products under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) registers or licenses pesticide products for sale, distribution, and use in the United States. As part of pesticide product registration EPA approves, or more properly "accepts" pesticide label language. In addition, states, usually through a program housed in the State Department of Agriculture, registers pesticide products available for use in individual states. Anyone planning to import pesticides into the U.S. must notify EPA.

EPA's Pesticides program covers:

- Providing oversight to state and tribal pesticide programs responsible for certifying and training pesticide applicators and enforcing pesticide use.
- Implementing the federal certification plan for Pesticide Applicators using Restricted Use Pesticides in Indian Country.
- Evaluating Potential New Pesticides and Uses.
- Providing for Special Local Needs and Emergency Situations.
- Reviewing Safety of Older Pesticides.
- Registering and inspecting Pesticide Producing Establishments.
- Enforcing Pesticide Requirements.
- Risk assessment.
- Pesticide Field Programs.

Impacts on Pesticides Program:

- New pest problems will occur in New England, many of which will be from exotic invasive species.
- Potential changes in program focus to include more emphasis on structural and public health pests due to weather related impacts on housing and vector pest habitats (i.e., more standing water)
- Changes in pests and pest pressures due to increases in temperatures and variations in rainfall patterns.
- Increase in fungal and microbial organisms in agricultural and non-agricultural settings due to extreme rainfall.
- Changes in chemical and non-chemical agricultural practices due to extreme storms and farmers' inability to work in their fields (e.g. increases in the likelihood of run-off and off-target movement of chemical products; limits on the potential use of certain non-chemical methods such as cultivation because it may not be possible to bring heavy farm equipment onto wet fields and saturated soils).
- Increased use of aerial applications resulting in increased risk of pesticide drift due to extreme storm events.
- Increase in dry condition pests due to drought (e.g. mites that feed on a variety of field, vegetable and fruit crops).

Changes in pesticide choices and quantities may require changes to the pesticide applicator certification and training programs. Changes in chemical selection could result in new and increased chemical exposures, especially for indoor applications. Types of new pest problems could include:

- Indoor and outdoor molds and microorganisms which are controlled by disinfectant pesticide products;
- Public health pests such as mosquitoes and ticks;
- Forest pests,
- Aquatic pests including weeds; and
- Various agricultural pests including weeds, insects and plant diseases.

B. Enforcement, Compliance and Pollution Prevention

Enforcement

As with other regulatory programs, climate impacts noted above could cause an increased strain on Enforcement/Compliance resources because of an increased need to respond to changes in pesticide choices and application methods.

Pollution Prevention

The long term response to climate change may create demands on EPA and state pollution prevention programs due to the need to provide additional assistance to the regulated community. As an example, there may be increased demand for assistance regarding mitigation methods for reducing GHG emissions. Green Chemistry resources will be in greater demand as businesses and the public seek more sustainable substitutes for materials used for manufacturing and other industrial and commercial activities.

Facilities and Operations

Climate change poses a range of risks to EPA New England's facilities and operations. The following sections detail the general risks and then delve into the risks specific to each facility. Note that each

facility does not operate in isolation; the climate impacts experienced by each facility will be greatly influenced by the larger systems (utilities, transportation, communities) of which it is a part.

A. Overview of Potential Climate Change Impacts[101]

From the facilities and operations perspective, the vulnerabilities associated with climate change encompass issues of energy security, water quality and supply, severe weather and flooding damage, personnel safety, physical security, and communications interruptions. Facilities and operations support the broader agency mission of protecting air, water, and human health through the provision of functional, appropriate, and safe working spaces for personnel. Beyond the infrastructure and utilities that serve EPA rented or owned facilities and the operations that support the function of those facilities, broader impacts of climate change on transportation and communication systems are also vulnerabilities that can hamper EPA New England's efforts to meet agency goals. While telework policies are in place to address these vulnerabilities, the magnitude of these impacts may extend to those alternate work locations, causing significant disruption to employee work and ultimately hampering fulfillment of the EPA New England mission.

However, while operations may be vulnerable in the areas described above, EPA New England has developed a Continuity of Operations Plan (COOP) to maintain emergency functions should any particular facility or location be compromised. This plan provides guidance for continued uninterrupted operations and the performance of essential functions during emergency situations. The COOP includes provisions for physical relocation from current facilities and resource planning for up to 30 days.

B. Facility-Specific Vulnerabilities

The Boston McCormack office building located in Boston, MA is approximately 0.5 miles from the Boston waterfront and sits at an elevation of approximately 12.3 feet (2.76 meters) above mean sea level.[102] The building is a massive granite structure, serviced by underground utilities for water, natural gas and steam heating. All building mechanical systems are on the 17th floor roof. Most notable about this facility is its position as a part of a larger urban community. While impacts can be explored with the view that the building sits in isolation from the rest of the city, more likely, the experience of impacts will be moderated and influenced by its proximity to other buildings and infrastructure of significance.

The impacts and risks associated with higher water levels from sea level rise, storm surge or flooding include: building damage, inaccessibility of the building to employees, and damage to the larger utility systems that support the operation of the McCormack building. In addition, mobile equipment (e.g. vehicles, emergency response resources, etc.) stored in the building's basement may be vulnerable to flooding. However, the structural soundness of the building will limit the impacts of extreme weather on the building itself, and the location of mechanical systems on the 17th floor will limit the damage to critical building equipment. In addition, the McCormack building is equipped with a natural gas fueled backup generator.

The Boston office utilizes a parking garage for Government Owned Vehicles. The vehicles are on the ninth floor of the parking structure and are not susceptible to flooding concerns because of the high elevation. However, access to this facility may be hampered by local flooding, affecting the usability of those vehicles.

The Chelmsford Lab is built high on a hill approximately 40 miles from Boston Harbor, at an elevation of 156.2 feet (47.61 meters) above mean sea level[103] obviating any risks of sea level rise or direct flooding. However, surrounding roads may be flooded during extreme storms.

The power grid near the Chelmsford Lab is particularly susceptible to several hour power interruptions due to rain and wind. Due to the existing weaknesses of the power grid, the Lab is equipped to manage short interruptions. At this facility, oil fueled backup generators have been sufficient for up to 44 hours of backup power and can be extended by additional fuel deliveries.

EPA's Emergency Response Warehouse is located approximately 30 miles from Boston Harbor at the intersection of Routes 128 and I-93 in an industrial park. At an elevation of 73.3 feet (22.36 meters) above mean sea level,[104] the likelihood of sea level rise impacts is very low. Impacts to the larger transportation systems may affect accessibility, but similar to the McCormack building, those impacts are a part of the larger context and beyond EPA's control and jurisdiction. The susceptibility of this facility and its access roads to flooding due to nearby rivers and water bodies is currently unknown. Impacts to this warehouse may affect the access to and availability of emergency response resources that are stored at this location.

Tribal and Vulnerable Populations

The impacts of climate change may disproportionately impact tribal communities and vulnerable populations, including children.

Tribal Communities

EPA values its unique government-to-government relationship with Indian 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* and the *2011 Policy on Consultation and Coordination with Indian Tribes*. These policies recognize and support the sovereign decision-making authority of tribal governments.

Supporting the development of adaptive capacity among tribes is a priority for the EPA. 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 to develop adaptation strategies that promote sustainability and reduce the impact of climate change on Indian tribes.

EPA engaged tribes through a formal consultation process in the development of the Agency's *Climate Change Adaptation Plan*. Tribes identified some of the most pressing issues as erosion, temperature change, drought and various changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. At the same time, tribes challenged EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative burdens are reduced.

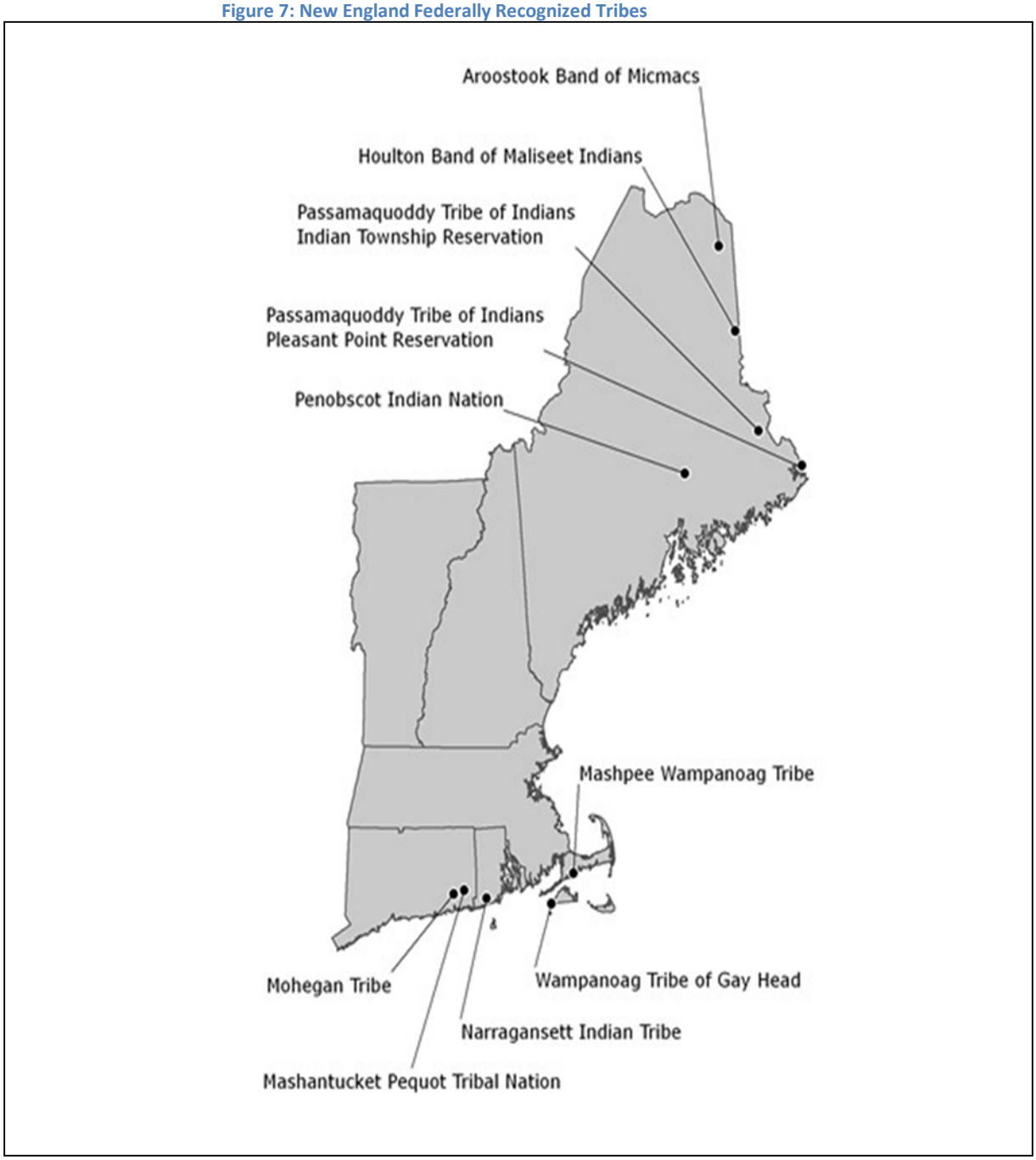
This Implementation Plan identifies specific steps that will be taken to partner with tribal governments on an ongoing basis to increase their adaptive capacity and address their adaptation-related priorities. These collaborative efforts will benefit from the expertise provide by our tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in assessing the

current and future impacts of climate change and has been used by tribes for millennia as a valuable tool to adapt to changing surroundings. Consistent with the principles in the 1984 Indian Policy, TEK is viewed as a complementary resource that can inform planning and decision-making.

Networks and partnerships already in place will be used to assist tribes with climate change issues, including the National Tribal Operations Committee, Regional Tribal Operations Committees, the EPA-Tribal Science Council, the Institute for Tribal Environmental Professionals and the Indian General Assistance Program (IGAP). Additionally, efforts will be made to coordinate with other Regional and Program Offices in EPA, since climate change has many impacts that transcend media and regional boundaries. Transparency and information sharing will be a focus, in order to leverage activities already taking place within EPA Offices and tribal governments.

There are 10 federally recognized tribes (see Figure 7 [105]) in New England and climate change may have the potential to disproportionately impact tribal communities compared to non-tribal communities.

Figure 7: New England Federally Recognized Tribes



Environmental Justice

The impacts of climate change raise environmental justice issues. Environmental justice focuses on the health of and environmental conditions affecting minority, low-income, and indigenous populations. EPA places emphasis on these populations because they have historically been exposed to a combination of physical, chemical, biological, social, and cultural factors that have imposed greater environmental burdens on them than those imposed on the general population. Climate change is likely to exacerbate existing and introduce new environmental burdens and associated health impacts in communities dealing with environmental justice challenges across the nation.[106]

Children

The impacts of climate change can have unique effects on the health of children. Children are different from adults in how they interact with their environment and how their health may be affected.

Below is a list of potential impacts on tribal populations, environmental justice communities, and children, broadly organized by EPA programs.

A. Air

Impacts on tribal programs (raised by tribal leaders and tribal environmental departments at various meetings with the Agency):

- Potentially higher health risk of methyl mercury contamination due to higher fish and shellfish consumption by tribal members compared to the average consumer.[107]
- Potentially higher risk of exposure to increase in mercury and cadmium as well as other pollutants as it concentrates in moose liver, turtle, and fiddlehead ferns consumed by the Maine tribal populations. [108, 109]
- Potentially higher mercury exposure from tribal members' reliance on wood stoves for home heating, and increased air transport and deposition of mercury or other contaminants that bioaccumulate on wood bark. [110]
- Higher incidence of asthma as indoor air exposure to mold and second-hand smoke exposure increases with more time spent indoors due to more extreme weather events.
- Impacts to sustenance practices due to warmer ambient temperatures and extended warmer seasons as predator tick populations impact moose and deer hunting[111], invasive plant species impact agronomic practices such as fiddlehead harvesting and blueberry farming, and invasive insects such as the emerald ash borer impact native practices involving black ash species (e.g. basket-making for harvesting).[112]
- Moose populations may decline due to warmer mean temperatures in winter.[113]
- Forestry operations and changes of species from hardwoods such as oak and maple to more spruce and fir populations with temperature increase.

Impacts on vulnerable populations:

- Combination of heat stress and high concentrations of tropospheric ozone could pose a health risk to young children, the elderly, and those with pre-existing health conditions, including asthma.[114]Increase in health risks from worsening indoor environmental conditions due to increases in mold and other indoor air pollutants as a result of increased flooding or leaks from storm events.[115]
- Increase risk to low-income households from extreme heat events due to lack of air conditioning or failure to use air-conditioning to cut down on associated energy costs.[116]

Impacts on children:

- Increased frequencies of elevated levels of ozone may lead to a number of adverse health effects in children, such as shortness of breath, chest pain when inhaling deeply, wheezing and coughing, temporary decreases in lung function, and lower respiratory tract infections.[117, 118]
- Increased levels of particle pollution during extreme weather events could cause increased exposure to children. Childhood exposure to particulate matter has been associated with respiratory symptoms, decreased lung function, development of chronic bronchitis, and worsening

of asthma. Children's exposure to particle pollution can result in increased hospital admissions, emergency room visits, absences from school and restricted activity days.
- If radon is present in schools, higher incidence of exposure to radon with more time spent indoors due to more extreme weather events.

B. Water

Impacts on tribal programs:

- Coastal infrastructure may be impacted by sea level rise including the Passamaquoddy Pleasant Point wastewater treatment facility that is located near sea level with an ocean outfall discharge.
- Ocean acidification may have a particularly acute impact on the coastal tribal members, including Passamaquoddy, Mashpee Wampanoag and the Wampanoag Tribe of Gay Head (Aquinnah) who depend on shellfish harvesting for sustenance practices, employment and economic development.
- Lobster shell wasting disease that may be linked to climate change has also been raised as a concern.[119]
- Damage to wildlife and fish habitat, potentially altering spawning habitat by increasing siltation due to sea level rise.
- Cold water fish species such as trout and salmon may be more susceptible to poisons, parasites and disease, and stunted fish growth, as well as increased juvenile mortality resulting from lower oxygen levels due to warmer waters.
- Fishery habitat including nesting sites and increased fish mortality due to flooding of tribal rivers as a result of increased snowfall and rapid snowmelt. Tribal communities depend on sustenance fishing.

Impacts on vulnerable populations:

- Increase in severity and frequency of extreme storms can result in catastrophic effects for coastal environmental justice communities with limited resources to prepare and respond to natural disasters.
- Increase risk of exposure to hazardous substances as flooding from more intense and frequent storms and sea-level rise may lead to contaminant releases from Corrective Action sites, Superfund sites, Brownfield sites and landfills which often are located in close proximity to environmental justice communities.
- Impacts to water infrastructure may put vulnerable and economically deprived communities at risk, both for access to clean and safe water as well as for their ability to respond to emergencies during extreme events.

Impacts on children:

- Extreme weather also can result in the breakdown of sanitation and sewer systems, increasing the likelihood of water-borne illness. Children are especially susceptible to such illness due to their developing immune systems.
- School drinking water supplies may be compromised. New England schools are responsible for providing safe drinking water to their students, staff and visitors. Many school systems do not have access to a nearby public water supplier and provide drinking water by operating their own onsite well water system.
- Increases in the extent of storm surge and coastal flooding will cause erosion and property damage to schools along the densely populated coasts.

C. Waste and Pesticides

No tribal impacts were identified that would be different from the impacts of the surrounding community for these programs.

Impacts on vulnerable populations:

- Potential changes in pesticide exposures may exacerbate existing burdens placed on children, agricultural workers and other groups who may be disproportionally affected.

Impacts on Children:

- Schools may experience a higher incidence of exposure to chemicals and pesticides increases with more time spent indoors due to more extreme weather events.

Cross-Cutting Vulnerabilities

A. Energy

Managing electricity and natural gas facilities to meet environmental goals and reliability standards will be challenged by long term temperature increases and increased extreme weather events.

Temperature increases will increase energy demand, particularly on peak summer days. As demand increases, additions and adjustments to the electric generating system need to be made. Many of the typical responses to these increases may increase air pollution emissions.

Additionally, since thermal power plants operate at lower capacities in the summer versus the winter, the higher ambient temperatures get, the less efficient the power plants are over a greater portion of the year, resulting in the consumption of more fuel, thus more emissions, to produce an equivalent amount of usable energy. In addition, higher cooling water temperatures during summer months also mean that the power plant will operate at less than its peak capacity. As a result, as long-term temperatures increase, the overall efficiency of most power plants will decrease, resulting in higher emissions per megawatt-hour produced over a larger portion of the year. This situation will not be unique to New England, and New England will also be adversely impacted by additional pollution moving into the region as a result of similar situations in upwind states and control areas.

The increased frequency of extreme weather events will impact the integrity of the energy system and can lead to the disruption of electrical service. During the cold weather season, residents without power are forced to utilize alternative methods of heating such as wood stoves or fireplaces. The resulting increase in wood burning can contribute to elevated ambient fine particle ($PM_{2.5}$) pollution concentrations. This phenomenon was observed in the several days of "unhealthy for sensitive groups" (USG) $PM_{2.5}$ concentration measured in the Springfield, MA area following the October 29, 2011 snowstorm.[120] Power losses usually result in the increased usage of local generators which produce much more pollution per unit of usable energy than a typical power plant. In addition, since both drinking and waste water require substantial amounts of energy, long term disruptions in energy infrastructure can result in negative public health outcomes related to an inability to provide clean water or treat wastewater. Restoration of such capabilities within acceptable environmental parameters should be a priority for emergency response restoration efforts as well.

Sea level rise will also lead to direct and indirect losses for the region's energy infrastructure (e.g., power plants located along the coast, marine facilities that receive oil and gas deliveries), including equipment damage from flooding or erosion.

Air Issues/Impacts:

- Increased atmospheric concentrations of criteria pollutants due to increased electric demand resulting from heat waves and generally higher temperatures. New England will be impacted from inter-regional transport of pollutants caused by similar situations in upwind states.[121]
- Increased levels of criteria pollutants may result from decreased capacities of electric generating units to operate due increased temperatures of cooling water. Long term temperature increases may require a proportionally higher number of electric generating units (EGUs) to provide equivalent amounts of power.

Water Issues/Impacts

- Decreased power output from power plants resulting from increases in the waterbody temperatures that supply cooling water to the plant.
- The Region may be requested to allow enforcement forbearance to allow the discharge of heated water into water bodies that exceed the temperature limits in violation of the power plant's NPDES permit, in order to permit electrical generation.
- Impairment or inability to treat wastewater or provide drinking water in the aftermath of extreme weather events.

B. Communications

Effective communication to stakeholders is critical to meeting EPA's mission. The following are impacts on communications at EPA New England.

- As communities are impacted by severe storms, impaired waters, contaminated flood waters, and other impacts of climate change, current communication mechanisms regarding the environment and public health during these periods may not be sufficient to ensure that communities receive the appropriate guidance on how to react to these events and protect public health.
- Current mechanisms of communications with states, cities and towns, and guidance regarding how to best handle climate change impacts and vulnerabilities may not be sufficient.
- Current mechanisms regarding how EPA communicates information may not be sufficiently easy to access and understandable to the audience in need, both during emergency events and when conducting communication on climate change impacts.

IV. Priority Actions

The EPA New England climate change programmatic vulnerability assessment points to the specific program and operations that may be impacted by the projected climate changes. Based on these vulnerabilities, EPA New England identified priority actions it could take to ensure that we can continue to accomplish our mission and operate at our multiple locations. These priorities represent EPA New England's commitment to address the known programmatic vulnerabilities, and to continue to identify other vulnerabilities that may occur over time due to climate change.

The workgroup developed a set of criteria to take into consideration when evaluating the priority actions. The following qualitative criteria were considered. .

- Timeframe when risk would occur?
- Magnitude of impact of risk on environment or health?
- Magnitude of impact on EPA program?
- Does the action reduce the risk?
- Does the action protect a critical resource/investment?
- Does the action address "low-hanging fruit" that would be easy to accomplish?
- Would the action leverage a larger effort outside of EPA?
- Does EPA have a unique role or capacity to address this issue?
- What is the timeframe of the problem that this action would be addressing?
  Could the action be accomplished within current budgets or would additional funds be necessary?
  Taking these criteria into account, priority actions were determined for each strategic goal. The following section summarizes the priority actions for each goal.

GOAL 1

Ozone and NOx

1. Work with other EPA Regions and HQ air program managers to develop a strategy, in context to other programmatic priorities, on how to incorporate climate adaptation into air quality programs (e.g., SIPs, permits).
2. Develop new VOC and NOx control strategies with the States to offset the effects from higher peak (and prolonged) temperatures as necessary.

PM

3. Devote more Regional staff time to providing the public with "Burn Wise" information, and work with the states and tribes to inform the public about unhealthy air quality.
4. Work with the States to analyze further control strategies for wood combustion to avoid $PM_{2.5}$ violations.

Indoor Air

5. Prepare information and recommendations regarding mold and other indoor air quality issues for distribution to the public due to increase in extreme events and flooding, and residents spending more time indoors.
6. Enhance messaging on the dangers from backup electricity sources (e.g. generators) and heat sources (e.g., wood stoves, fireplaces) that might be used more frequently due to power outages.
7. Devote more Regional staff time as needed to answer indoor air calls from the public.

Enforcement

8. Enhance Regional compliance assistance efforts to insure emergency generators are properly used, and are in compliance with applicable state and federal requirements.
9. Enhance Regional compliance monitoring efforts to insure that air pollution sources are properly controlled and in compliance with applicable state and federal requirements.

Tribal Programs

10. Work with New England tribes to monitor and assess local mercury deposition trends and advise them on potential additional health precautions to take, if and when trends indicate increases in atmospheric deposition and corresponding increasing mercury levels in fish and turtle.

GOAL 2

Water Quality Standards

1. As circumstances arise, revise water quality criteria to reflect climate change impacts.
2. As conditions change, modify water body classifications (salt v. fresh water) or Integrated Report designations (e.g., causes of impairment) to reflect climate change impacts.

Monitoring, Assessment, and Listing

3. Increase monitoring to adequately assess the effects of rapidly changing conditions.
4. Continue to support EPA's National Aquatic Resource Surveys (NARS), which provide ongoing assessment of the ecological condition of statistically representative samples of wadeable streams, large rivers, wetlands and coastal resources.
5. Implement collaborative year-round monitoring of high-quality (reference) wadeable streams, with other water resources to follow as feasible, for temperature, flow, physical habitat, biological resources, and other water quality parameters such as nutrients, as proposed in the state, tribal and federal Northeast (New England and NY) stream climate change monitoring network.
6. Work with HQs to develop and implement a national monitoring program for ocean acidification (OA), which is caused by the dissolution and reaction of carbon dioxide (CO2) into ocean water.
7. Modify freshwater, estuarine, and marine sampling protocols and locations based on effects of climate change, including sea level rise, considering the need for a long term monitoring record.

Total Maximum Daily Load (TMDL)

Over the past decade, EPA Region 1's cross-program effort to address stormwater-related water quality impairments has provided valuable experience in how to develop and implement TMDLs that address multiple environmental stressors resulting from various flow regimes. For example, impervious surfaces in urban environments deliver a mix of pollutants and increased flow to rivers and streams resulting in soil erosion, stream bank scouring, deposition of sediment and nutrients increases in receiving waters. The increasing amount of impervious surfaces in urban areas causes less precipitation to infiltrate into the ground, which may cause streams to experience much lower base flows during dry conditions, along with low dissolved oxygen, increased eutrophication, and higher stream temperatures. Flashy streamflow conditions (i.e., rapid increases in streamflow and velocity in response to rainfall, followed by rapid recovery to pre-storm conditions) related to excessive stormwater runoff and corresponding droughts are anticipated to become even more frequent and/or intense in response to further climate change.

Stormwater TMDLs now being implemented effectively on a sub-watershed basis involve the use of surrogates for the mix of pollutants in stormwater (i.e., impervious cover, or flow). Innovative and flexible approaches to TMDL development like this show promise for addressing the complex challenges of climate change. For instance, under the surrogate approach, TMDL end-points are tied to aquatic life use protections in State water quality standards, which provide environmental protection based on whatever the current conditions happen to be (rather than future projections based on past conditions). The technical basis for aquatic life use-based TMDLs is derived from significant investments over the past 35 years developing state ambient biological monitoring programs in our Region. Bioassessments (using ambient assemblages of macroinvertebrates, fish, or algae that integrate the effects of multiple stressors over time), in concert with physical and chemical monitoring data, now support the water quality assessment of aquatic life use attainment for these surrogate TMDLs, and provide clear environmental indicators of stream health under whatever the existing conditions are.

8. Promote use of hydrological information to the extent available and adequate that takes climate change effects into consideration during development of TMDLs, their implementation plans, NPS plans, and NPDES permits.
9. Support increased monitoring to assess the effectiveness of attained TMDL targets in the face of changing conditions.
10. Promote close collaboration among TMDL, NPDES, and NPS program staff during stormwater TMDL development and public outreach, in order to help MS4s and other stakeholders understand the need for more detailed local watershed planning for stream restoration actions and the use of structural and non-structural BMPs as part of post-TMDL implementation.
    To address new information and evolving circumstances, focus climate change adaptation on the selection and design of more effective TMDL implementation. For example:
    - Promote selection of BMP types that perform well under varying climate conditions, such as certain low impact development practices.
    - Promote consideration of projected precipitation changes during the design of stormwater BMPs and other practices built to accommodate or treat specific storm sizes or runoff volumes, especially when these investments are anticipated to have life expectancies of 30 years of more.
    - Support BMP studies to evaluate how resilient BMPs are to climate change, and whether additional capacity is warranted to address future concerns, such as flooding or groundwater recharge.

Cross-Program Water Management

In line with EPA's agency-wide climate change priorities and strategic measures, Region 1 priority actions will continue to focus on cross-program stormwater management, and will continue interagency collaboration and development of decision-making tools capable of promoting environmentally sound and cost-effective management actions. For example:

11. 2010 RARE-funded project, *Assessing Effectiveness of Green Infrastructure Stormwater BMPs at the Small Watershed Scale* (WQ Branch & ORD/Narragansett).
12. 2011 ORD Green Infrastructure-funded project, *Development of an Integrated Watershed Management Optimization Decision Support Tool*, which accounts for water supply, wastewater, stormwater, in-stream conditions, groundwater, and land use to achieve optimal actions to achieve water quantity-related management goals at least cost (collaboration among WQ and SDW programs).
13. Major regional meetings in 2012 and 2013 were co-sponsored with USFWS and USGS on temperature data and monitoring which has prompted NE CSC research projects on climate

change impact on headwater systems (areas of aquatic refugia), and development of a multi-agency regional stream temperature framework and database for New England (ME, NH, CT, RI, and MA) and the Great Lakes States (MN, WI, IL, MI, IN, OH, PA, NY).

14. , Develop *Optimizing Stormwater/Nutrient Management – Region 1 Opti-Tool*, a user-friendly (spreadsheet) tool allowing optimization of structural and non-structural BMPs, and account for BMP pollutant removal, stormwater flow control performance, and estimated cost (collaboration among TMDL and NPDES programs).
15. Estimate how stormwater controls would work cumulatively to address future changes to precipitation patterns in order to determine whether or not modification of the levels of control is warranted.

National Pollutant Discharge Elimination System (NPDES) Permits

16. Review water treatment requirements as reduced water flows in streams, especially during summer months, will not dilute treatment plant effluents as they do now, so more treatment may be needed to maintain current water quality standards.
17. Stormwater permits will need to account for increased extreme precipitation and erosion and sedimentation.
18. Promote the "Soak up the Rain" program.
19. Permits with temperature limits (e.g., electric generating units) will need to account for increased water temperatures in receiving waters and potential changes to local assemblages of aquatic organisms.

Non-Point Source (NPS)

20. Promote appropriately sized best management practices (BMPs).
21. Promote demand management ways to preserve base stream flow levels.
22. Find additional sources of funding for NPS abatement.
23. Promote appropriately sized transportation infrastructure.
24. Identify and use drought resistant species to aid in infiltration in BMPs.

Wetlands (coastal and inland)

25. Increase use of invasive species control plans and their implementation in coastal wetlands.
26. Increase protection for vernal pools.
27. Promote beneficial uses of dredged material such as for beach nourishment, and marsh restoration as well as the potential use of thin layer dredged material disposal in eroding coastal wetlands.
28. Review and comment on Corps permit applications for coastal engineering structures to evaluate potential adverse impact on coastal wetlands, considering sea level rise and marsh migration potential.
29. Recommend consideration of "living shorelines" where appropriate to restore eroding wetlands and protect shorelines as an alternative to hard engineering structures.
30. Prioritize restoration work for tidal wetlands that have room to migrate.
31. Work with HQs and other regions to determine how to take into account seasonal variabilities in precipitation for "Waters of US" determinations.

Dredging/Ocean Dumping

32. Promote beneficial uses of dredged material such as for beach nourishment, and marsh restoration as well as the potential use of thin layer dredged material disposal in eroding coastal wetlands.
33. Establish emergency dredging protocols to prepare for increased erosion and sedimentation associated with more extreme precipitation.

34. Promote Regional Sediment Management approaches to better understand sediment dynamics and potentially reduce the need for, or frequency of, dredging.
35. Modify dredging windows to better align with changes in seasonality (earlier fish migration and spawning).

National Estuary Program (NEP)

36. Through the Climate Ready Estuaries program, assist state and local partners conduct vulnerability assessments, prepare adaptation plans, and develop tools to facilitate these activities, like the Connecticut Adaptation Resources Toolkit.
37. Promote the New England Environmental Finance Center's use of the Coastal Adaptation to Sea Level Rise Tool (COAST) to raise awareness among coastal cities and towns about the economic impact of sea level rise and storm surge on coastal property and infrastructure.
38. Develop guidance for different coastal habitat types (dunes, dams, etc.) restoration activities to account for sea level rise.
39. Revise and update Comprehensive Conservation and Management Plans (CCMPs) to address vulnerabilities to climate change and include adaptation measures.
40. Prioritize wetlands that have room to migrate for restoration.
41. Promote implementation of more effective erosion and sediment controls to adapt to increasing heavy precipitation events and storm intensity.
42. Support efforts to better characterize impacts of ocean and coastal acidification in cooperation with the Northeast Coastal Acidification Network (NECAN).

Drinking Water, Wastewater, Stormwater Infrastructure

43. Educate and encourage use of Water and Wastewater Agency Response Networks (WARNs) to promote specialized water sector mutual aid and recovery in events of infrastructure damage or other emergencies.
44. Through the Climate Ready Water Utilities program, educate facility operators on using localized climate projections to help identify specific vulnerabilities, including Geographic Information Systems (GIS) and Light Detection and Ranging (LiDAR) mapping of flood zones. Facilities should then update and train staff on revised Emergency Response Plans as needed.
45. Promote the WaterSense program to help utilities implement water efficiency/conservation measures to reduce or delay the need for system expansion and reduce energy use.
46. Encourage utilities to compile an inventory of utility assets to help determine the location, importance and condition of each asset, which will lead to an improved response in emergency situations. Provide assistance to municipalities and others on use of asset management methods.
47. Promote green infrastructure projects, such as low impact development (LID), to help manage wet weather and improve water quality, reduce hydraulic loads on combined sewers, and reduce the risk of flooding. Increase public understanding of the need to implement and finance stormwater management systems.
48. Develop outreach and tools for flood proofing infrastructure.
49. Promote opportunities such as periodic larger-scale system evaluations, planned upgrades, or new construction to incorporate climate-change considerations into facility design. Educate utilities on tools to seek federal funding (FedFUNDS tool) and other opportunities to address needed improvements.
50. To help ensure that climate change impacts on septic systems are addressed in a proactive manner, assess which areas in New England may be vulnerable to damage to decentralized septic systems due to sea level rise, storm surge, and flooding, starting with Cape Cod. Based on the results of the mapping assessment, determine appropriate actions, including promoting improved

decentralized sewage system management in accordance with EPA's Voluntary Guidelines.

Quality and Availability of Safe Drinking Water

51. Promote source water protection and watershed management activities to protect water supplies from increased threats to water quality and to increase recharge to aquifers. Use natural flood control vegetation for protection.
52. Encourage source redundancy and flexibility for seasonal adjustments to meet demand, water quantity and availability.
53. Provide new information, as available, on specific threats to water quality and sources, such as: cyanobacteria, drinking water bacterial requirements and water sector general vulnerabilities.
54. Promote erosion and sediment controls.
55. Promote monitoring of weather conditions and trends, use modeling and mapping to better prepare and adapt for expected changes, including in emergency response plans.

GOAL 3

Longer-term Cleanups (e.g., Superfund Remedial, Superfund Time-Critical Removal, RCRA Corrective Action, TSCA) and RCRA Hazardous Waste Management Facilities

1. Include consideration of potential climate change impacts in EPA New England management reviews of Superfund National Priority List (NPL) sites.
2. In conjunction with the New England Waste Management Officials' Association (NEWMOA) and member state agencies, initiate an interagency dialog to plan and coordinate efforts to consider climate change impacts at contaminated site cleanups and RCRA hazardous waste management facilities.
3. Identify and assess the potential vulnerability of NPL sites within delineated GIS-mapped zones (i.e., sea level rise, flooding due to storm surge, and flooding due to higher precipitation events) based on a consideration of site-specific factors (e.g., local topography, proximity to rivers/canals, design and duration of cleanup remedies, potential risk to the cleanup).
4. Based on the findings from the evaluation of potentially vulnerable NPL sites, develop an action plan to evaluate the vulnerability of other contaminated sites (e.g., Brownfields, Superfund Time-Critical Removal, RCRA corrective action) and RCRA Hazardous Waste Management Facilities.
5. Develop and conduct training on considering climate change impacts in site cleanups for EPA and state project managers.
6. Work with HQs to revise technical guidance (e.g., relating to 5-year reviews, management reviews, remedial investigation/feasibility studies, remedial design, sediment management) to address consideration of climate change impacts.
7. Coordinate with HQs and FEMA and other federal agencies to update, as necessary, reference maps and data (e.g., 100- year flood plain, precipitation from 100-year storm events) to aid in the evaluation, design and implementation of cleanup response actions.

Emergency Response

8. Continue coordination among program offices to plan for potential coordination during emergency response actions**.**
9. Utilize the GIS-based EPA FlexViewer platform to prepare for and respond to climate change impacts in New England.
10. Provide training to responders in preparation and response of climate change impacts with option for state agencies to participate in the training (e.g. potential for increased pesticide responses, extreme storm events, Stafford Act declarations, incident command structure, etc.).

11. Conduct an assessment of current regional resources and response framework to determine if resource levels and existing plans would be sufficient to adequately respond to an extreme event, such as a hurricane or large storm.
12. Incorporate climate change impact planning into regional contingency plans (e.g. debris management plans, area contingency plans, etc.).
13. Assess interagency agreements with the Coast Guard to determine how coastal impacts from climate change will be addressed.
14. Coordinate with OEME to assess whether current regional laboratory capabilities will be sufficient during responses to extreme events and whether the infrastructure can sustain potentially increasing demands over time.

Oil Program (e.g., Spill Prevention, Control, and Countermeasure (SPCC)/ Facility Response Plans (FRP) Facilities)

15. Develop, conduct, and/or maintain training on climate change impacts for EPA, USCG and state counterparts.
16. Enhance GIS-based mapping tools to incorporate climate change impacts and identify vulnerable zones to aid in planning.
17. Conduct management reviews of SPCC/FRP New England Facilities within potential impact zones to aid in setting inspection targets.
18. Develop technical guidance to aid in climate change impact planning.
19. Continue monitoring efforts to determine if SPCC and FRP regulated facilities are impacted by climate change.
20. Coordinate with OEME to identify specific research needs.

GOAL 4

Ensuring Safety of Chemicals:

1. Increase EPA support for pesticide enforcement and applicator education – direct and through states and tribes.
2. Strengthen and develop new relationships with federal (or other) agencies for new pesticide related problems (e.g., USDA, CDC, HUD, DOD, etc.).
3. Change regional oversight to meet new priority areas. Provide pollution prevention assistance to states, businesses, and others that promote sustainable practices. Implement regional Green Chemistry strategy to promote development of more sustainable manufacturing methods and materials.

FACILITIES AND OPERATIONS

1. Develop/codify storm event pre-deployment strategies for government owned vehicles (currently informally included in the COOP). Develop/codify storm event pre-deployment strategies for vehicles and equipment stored in the garage and ground floor of the McCormack building.
2. Develop extended contingency/telework plans for employees (management/human resources).
3. Ensure Continuity of Operations Plan can also address situations that extend beyond 30 days.
4. Conduct further research to assess the risks of flooding associated with nearby water bodies, rivers, lakes and ocean.
5. Work toward developing a deeper understanding of how flooding occurs through storm surge in urban areas, given that the impacts of sea level rise and storm surge are not well understood, particularly for the McCormack building.

TRIBAL AND VULNERABLE POPULATIONS

1. Work with EPA programs to target climate adaptation efforts in the most vulnerable communities, including tribes.
2. Educate vulnerable populations about climate adaptation. Provide assistance to tribes (if requested) in developing their individual tribal adaptation plans or a comprehensive regional tribal adaptation plan if pursued by the tribes.
3. Expand use of existing communication tools and develop a comprehensive contact list of organizations representing vulnerable populations as a resource for preparedness and response to extreme events.
4. Utilize GIS-based mapping tools to identify coastal vulnerable populations that could be potentially subject to an increased sea level rise, flooding due to storm surge, and flooding due to higher precipitation events.

CROSS CUTTING ACTIONS

1. Utilize GIS-based mapping tools to delineate New England zones that could be potentially subject to an increased sea level rise, flooding due to storm surge, and flooding due to higher precipitation events.
2. Leverage21st century 'big data' science initiatives relevant to New England climate change such as NEON, UNH EPSCoR and other novel environmental monitoring technologies.
3. Incorporate climate change adaptation into performance partnership agreements (PPA)/performance partnership grants (PPG) state program requirements.
4. Develop and implement adaptation plans with state and local partners to address risks to habitats, infrastructure, and human populations; estuarine and coastal area plans will be initiated first.
5. Deliver technical assistance programs to communities on smart growth topics such as how to achieve compact, walkable, transit-oriented development.
6. Work with the Partnership for Sustainable Communities (HUD, DOT, EPA, FEMA, and USDA Rural Development) to help communities become more disaster resilient, and ensure that our programs don't support non-resilient development in vulnerable locations. Beginning in June 2014, disseminate final report from post-Irene Smart Growth Implementation Assistance project, which includes a checklist for communities interested in improving their flood resilience.
7. Develop and implement adaptation training for all staff.

COMMUNICATIONS

1. EPA R1 Drinking Water program will work with states and tribes to improve effectiveness when providing requested assistance to states and tribes in emergency events by doing training to our Regional Water Team volunteers on doing phone call damage assessments on an event-specific basis.
2. EPA R1 Drinking Water program will work with State programs to improve data collection and sharing by revising our damage assessment forms as needed per each State's preference.
3. Increase education to states, tribes, cities, and municipalities on common climate change impacts and guidance for the impacted.
4. Evaluate how EPA can ensure that we are easily accessible and responsive to tribes and states during and after large storms or other emergency events.
5. Streamline how EPA communicates information so that it is easy to access and understandable to the audience in need. These efforts should be coordinated with federal, tribal, and state partners.

V. Measurement and Evaluation

This section describes how EPA New England will incorporate priority actions into its programs and how these actions will be measured.

A. Measure: Integrate climate adaptation priority actions into the GCCN strategy annually and into other planning documents as needed.

Evaluation: Include consideration of climate impacts into at least 3 processes (e.g., permitting, grant solicitation, enforcement integrated strategies, Invasive Species Control Plans) in the GCCN FY 14 plan. Annually thereafter, review the vulnerabilities and priority actions to update according to the current science and actions taken by others to determine what to address in the annual GCCN Strategy.

B. Measure: Work with states and tribes to integrate climate adaptation into State-EPA and Tribal-EPA planning mechanisms (e.g. PPA/PPGs, begin preliminary discussion in FY 14). Work with grantees and local communities to integrate climate adaptation into planning mechanisms.

Evaluation: All NE states and at least some of the tribes will incorporate adaptation into at least one program action and planning mechanism. Grantees and local communities incorporate adaptation into their planning.

C. Measure: EPA New England will work with EPA national Program offices on national program climate adaptation guidance (e.g., oil program, streamlining of FIFRA registration process, dredging)

Evaluation: Participation in workgroups as invited.

D. Measure: Improve preparedness for extreme events, including incorporating climate change impacts (e.g., flooding, storm surge) into planning documents (e.g. Emergency Planning documents) and outreach (e.g., guidance use of back-up power and alternative heating sources).

Evaluation: EPA will develop response protocols and tools for public outreach; Dialogue with Region 2 to learn from Super Storm Sandy experience.

E. Measure: Collaborate with other federal agencies, academics and NGOs in New England regarding climate change impacts (e.g. coordinating with NEFP, NROC, etc.)

Evaluation: Identify and act on collaboration opportunities to increase scientific understanding and to increase resiliency.

F. Measure: Train EPA employees and states and tribes where appropriate on how to consider impacts of climate change in their EPA duties and obligations.

Evaluation: 90% participation in climate adaptation training.

G. Measure: Conduct outreach on climate change impacts to affected stakeholders (E.g., Soak Up The Rain, outreach to vulnerable population, Burn Wise)

Evaluation: Development of outreach tools and outreach campaigns or events.

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EPA Region 2

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Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Bob Perciasepe

Deputy Administrator

September 2013

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INTRODUCTION

The first section of the Regional Implementation Plan provides an initial assessment of the implications of climate change for EPA Region 2's programs and objectives. This regional vulnerability assessment builds on the preliminary agency-wide vulnerability assessment contained in EPA's Climate Change Adaptation Plan (draft released Feb 2013[1]) and was developed in concert with vulnerability assessments developed by EPA's national program offices.

This Assessment is divided into three main sections: Background on projected climate change effects; EPA Region 2's Vulnerability Assessment based on programmatic expertise; and an attached Summary Table analyzing the range of vulnerabilities. The information on climate change impacts in the Background section comes from peer-reviewed scientific literature, including the major climate assessments produced by the U.S. Global Change Research Program. The Vulnerability Assessment section sets forth the Region's preliminary judgment regarding the risks that those climate change impacts pose to the programs that Region 2 implements and to our facilities, assets and day-to-day operations. Finally, the Summary Table follows a common format put forth for all the Regions and Program Offices, and presents a broad picture of how climate change impacts may affect programs in Region 2.

This assessment of our programmatic risks and vulnerabilities should be viewed as a living document that will be updated as needed and when possible, to account for new knowledge, data and scientific evidence. As in the agency-wide Climate Change Adaptation Plan, our assessment of regional programmatic vulnerabilities is organized around EPA's strategic goals.

BACKGROUND: REGION 2'S KNOWN VULNERABILITIES TO CLIMATE CHANGE IMPACTS

In order to determine our region-specific vulnerabilities, EPA Region 2 began with a research effort to understand the current science and modeling on climate change effects. This section summarizes the state of the science for known or expected vulnerabilities for the region.

OUR STATES & TERRITORIES & INDIAN NATIONS: NEW YORK, NEW JERSEY, PUERTO RICO & THE U.S. VIRGIN ISLANDS

Climate change, interacting with changes in land use and demographics, will affect important human facets in the United States, especially those related to human health, communities, and welfare. The challenges presented by population growth, an aging population, migration patterns, and urban and coastal development will be affected by changes in temperature, precipitation, and extreme climate-related events. According to the International Panel on Climate Change (IPCC), global average temperature over the 21st century is expected to increase by between 3.5 and 7°F. The large range is due to uncertainties both in future GHG concentrations and the sensitivity of the climate system to GHG emissions. The greatest warming is expected over land and in the

[1] http://epa.gov/climatechange/impacts-adaptation/fed-programs.html

high altitudes of the northern hemisphere where local warming may exceed 15° F. In these regions, winter warming is expected to be greatest (NPCC 2010). Hurricane wind speeds, rainfall intensity, and storm surge levels are likely to increase. Other changes include measurable sea level rise and increases in the occurrence of coastal and riverine flooding (NYSERDA 2011). Given the diverse geography covered by Region 2 and the varied environmental programs that EPA implements in this region, climate change presents a broad array of risks to the achievement of our mission. The risks vary somewhat between the continental states (NY/NJ) and the tropical region where Puerto Rico and the Virgin Islands are located, but the theme of coastal concerns is common for the Region as a whole.

PRECIPITATION AND INLAND EFFECTS

Nearly all climate models are predicting changes in precipitation patterns. In New York and New Jersey, precipitation will fall in heavier events with hotter and drier periods in between. Similarly, the Caribbean may see less frequent but heavier storm events, with more severe drought periods. Severe storms are also predicted to increase, with 100-year storms likely to occur every 80 years by the end of the century (USGCRP 2009, NYSERDA 2011). In the New York area, average precipitation is projected to increase up to 5% by 2020, up to 10% by 2050, and as much as 15% by 2080. Much of this increase is projected to fall in the winter months (NYSERDA 2011), and more likely to fall as rain instead of snow. In upstate New York, the changing balance between rain and snow has already reduced snowpack and, in addition, many areas have already seen flooding from extreme rainfall events like Hurricane Irene. Warming temperatures have led to decreases in ice cover on lakes and rivers. By the end of this century, the length of the winter snow season in northern New York is predicted to be reduced by half (USGCRP 2009).

In the Great Lakes region, which includes portions of upstate NY, reduction in ice cover will lead to cold air moving over open water that would have otherwise been frozen. This will increase evaporation, leading to heavier and more frequent lake effect snow. Rising atmospheric temperatures will cause annual spring runoff due to snowmelt to occur up to two weeks earlier in the year. This change will decrease water from runoff later in the year, stressing ecosystems that depend on the availability of water in the summer (USGCRP 2009). Studies also predict a decrease in the Great Lakes water levels due to increased evaporation and decreased runoff from snowmelt. This has implications for energy generation and downstream ecosystems (NYSERDA 2011). Rising air temperatures also increase water temperatures. In lakes and reservoirs, warmer surface waters reduce the frequency of turnover with

cooler bottom waters, resulting in increased periods of stratification (USGCRP 2009). Increased stratification isolates layers of warm water, which is less capable of holding dissolved oxygen (DO), which is critical to supporting aquatic ecosystems (NYSERDA 2011).

SEA LEVEL AND OCEANS

Climate change also has impacts on marine resources and coastal regions. Currently, sea levels are rising an average of 0.86 to 1.5 inches per decade, as measured by tide gauges, with an average of 1.2 inches per decade since 1900. Before the Industrial Revolution, the rate of increase had been approximately 0.34 to 0.43 inches per decade, mostly as a result of land subsidence (NPCC 2010). For the Long Island and New York City shorelines, models predict a rise of 7-12 inches by 2050 and 19-29 inches by 2080. Under a rapid ice melt scenario in the arctic, sea levels could rise by as much as 55 inches by 2080 (NYSERDA 2011). Freshwaters and marine waters alike are expected to see increases in temperature with higher air temperatures. Models predict an ocean temperature increase of 1.8 – 2.5^{o}F for near-shore waters by 2050, depending on the model used (NYSERDA 2011).

When atmospheric CO_2 increases, more CO_2 is dissolved in the ocean, decreasing the pH of the water and creating an acidic environment that dissolves the hard shells of corals, shellfish and smaller organisms. This process, called ocean acidification, also decreases the availability of calcium carbonate ($CaCO_3$), a building block for the shells and exoskeletons of many marine organisms. Although dissolution of CO_2 in oceans is a natural process, the current rate of ocean CO_2 dissolution is unprecedented, with serious implications for the marine food chain and ocean ecosystems.

Puerto Rico (PR) and the United States Virgin Islands (USVI) are especially vulnerable to the impacts of climate change due to their smaller land size (and therefore diminished resources, population mobility, infrastructure and resilience), limited water resources, vulnerable ecosystems, susceptibility to natural hazards and the location of large urban centers near the coastline (e.g. San Juan, Charlotte-Amalie). Threats of climate change to this portion of the Caribbean include the potential increase in sea level of at least 15.7 inches based on a linear trend of observed sea level rise (PRCCC 2012), increase in average annual temperature between 3.5 - 5 °F, (USGCRP 2009) and decrease in precipitation between 5 to 20% by the end of the century (USGCRP 2009). Other impacts include the formation of more intense hurricanes and increase in ocean temperature and acidity (USGCRP 2008). These threats will cause myriad adverse effects to PR and the USVI including: increases in coastal inundation, storm surge, erosion and increased water pollution as a result of coastal flooding, threatening vital infrastructure, settlements and facilities that support the livelihood of near shore and low lying communities; compromised water resources in PR and USVI islands; heavy impacts on coral reefs in PR and the USVI; and changes in fisheries and other marine-based resources.

HUMAN HEALTH

Climate change is very likely to accentuate the disparities already evident in the American health care system. Many of the expected health effects are likely to fall disproportionately on the poor, the elderly, the disabled, and the uninsured. The most important adaptation to ameliorate health effects from climate change is to support and maintain the United States' public health infrastructure (USGCRP

2008). Urban areas are especially prone to increased morbidity and mortality due to heat waves and poor air quality that results from higher temperatures and dry conditions. In addition to air pollution and heat-related impacts on health, extreme weather events due to climate change will likely increase risk for injuries such as those from debris during storm events where high winds and fast moving flood waters are involved. In Region 2, recent severe storm events have also caused unexpectedly high incidences of drowning. Moreover, flood waters can expose people to harmful environmental contaminants, especially if the flooding affects people who live nearby industrial sites or facilities that store or contain hazardous materials. For coastal and waterfront communities, heavy storms can cause storm surges that overwhelm or damage wastewater and drinking water treatment systems with high water volumes or salt water. The result is that communities are inundated with sewage- and industrial waste-contaminated waters, the health impacts of which could be severe gastrointestinal and respiratory illnesses. In PR and the USVI, potential adverse human health impacts are expected due to these previously discussed concerns, as well as increased incidence of vector-borne diseases and more frequent dust storms.

The National Research Council 2011 report, *Climate Change, the Indoor Environment, and Health* addresses the impacts that climate change may have on the indoor environment and the resulting health effects. The report points to extensive research on how climate change affects the outdoor environment, how the outdoor environment affects indoor environments under different climate conditions, and how indoor environments affect occupant health, among other related topics. The impacts on the indoor environment include poor indoor air quality, for example, due to changing indoor concentrations of pollutants from increased outdoor concentrations of those pollutants caused by alterations in atmospheric chemistry or atmospheric circulation. Other indoor impacts include: moisture and mold, flooding, infectious agents and pests, and thermal stress (NRC 2011).

VULNERABLE COMMUNITIES

OVERBURDENED COMMUNITIES

Certain parts of the population, such as children, the elderly, minority persons, persons of low income, persons with underlying medical conditions and disabilities, persons with limited access to information (such as those with low English proficiency), and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society.

This Implementation 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 Plan is conducted, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive

capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events (e.g., Superstorm Sandy) and the subsequent recovery efforts.

As noted in the agency-wide Climate Adaptation Plan, the populations most vulnerable to climate change often include children, elderly, poor, persons with underlying medical conditions and disabilities, and tribal and indigenous populations, and this applies in Region 2. The primary concerns are extreme storm events, sea level rise, and extreme high temperatures. Without strong adaptation measures, climate related health impacts may become more prevalent as the frequency and severity of extreme climate events such as heat waves, flooding, and severe storms increase .

According to the U.S. Census, the U.S. population is aging; the percent of the population over age 65 is projected to be 13 percent by 2010 and 20 percent by 2030, at which time NY and NJ alone will be home to over 7.8 million seniors over age 65. Older adults, very young children, persons with underlying medical conditions such as some disabilities or compromised immune functions are vulnerable to temperature extremes. Heat-related mortality affects low-income and minority populations disproportionately, because they are generally concentrated in highly developed urban environments that suffer from heat island effects (USGCRP 2008). For the past decade, Region 2 communities from the Caribbean to the northeast have faced summers with increasing numbers of days over 90° F. For example, between 2010 and 2011, San Juan, Puerto Rico experienced 100 days of temperatures over 90 degrees; the same number of days with such extreme temperatures was experienced between 1900 to 1949 – a span of nearly 50 years (PRCCC 2012). Low-income seniors are at highest risk for heat-related health impacts. According to estimates from the New York City Department of Aging, 55% of people hospitalized for heat-related illness were over 65 years of age; most of these were

CASE STUDY: SUPERSTORM SANDY

Superstorm Sandy, which struck the east coast in late October 2012, starkly illustrated the special vulnerability that low-income, elderly and people with serious medical conditions face from extreme storms and flooding. While Sandy was not necessarily a result of, or exacerbated by, climate change, it was an example of the extreme weather events that are expected to become increasingly frequent in the NY/NJ region over time, due to climate change. The extended deprivations wrought by Superstorm Sandy and the associated flooding (e.g. loss of power and heat for days or weeks; difficulty in obtaining food and supplies, medical care, transportation) were felt particularly by vulnerable populations, who in many cases lacked some of the resources or options available to others -- such as the ability to stay with friends or family or at hotels located outside of the affected area.

Of the more than 100 people in NY and NJ who lost their lives due to Superstorm Sandy, the majority were seniors. Many of the buildings that had to be evacuated in New York City as the storm approached (because of their location in low-lying areas) were public housing for low-income residents. It was reported that one week after the storm, 174 of the 402 public housing buildings that were impacted by the storm still lacked heat and hot water; 114 of them lacked power. The lack of heat meant enduring near-freezing temperatures with no heat and no hot water for bathing. Lacking power meant they had no lights or water for ordinary household uses because water needs to be pumped up to their homes. Because of the significant damage incurred by many of these buildings during the storm, many of the residents needed to remain in shelters or temporary housing for an extended period.

low-income seniors. Fortunately, air conditioning is an effective intervention in preserving heat health and reducing risk of heat-related death. However, as the EPA Climate Adaptation Action Plan acknowledges, economic constraints prevent some low-income households from using air conditioning for relief against extreme heat. For example, a family may not have access to an air conditioning unit, or choose not to use one so as to cut down on energy costs. Air conditioning may also not be a good solution in some heavily industrialized urban communities because high usage encourages power producers to run highly polluting "peaker plants" (e.g., older, high-emission power plants that are put into service to meet periods of peak energy demands) or puts the community at risk for power outages, which creates other hardships. Warming temperatures will also likely increase ozone concentrations. Increased ozone concentrations could in turn contribute to increased morbidity and mortality due to cardiovascular and pulmonary illnesses, including exacerbation of asthma and chronic obstructive pulmonary disorder (COPD) if current regulatory standards are not attained. If the projections for increased drought risk and lower precipitation in summer months prove correct, ozone health impacts will become a major issue for the respiratory health of residents in our region.

With sea level rise and the projected increase in the frequency and intensity of storms, low lying communities in our region will also likely see more health issues related to exposure to mold and mildew, which have been known to trigger asthma and allergic reaction as well as more severe respiratory symptoms. In areas where flooding can damage electrical systems necessitating the use of residential generators, we also expect to see more health problems related to carbon monoxide poisoning, especially when residents do not know to ensure proper ventilation when such equipment are in use. Flooding of industrial and environmental infrastructure also presents unique challenges to vulnerable communities. For example, during and after Superstorm Sandy, Indian nation communities like the Shinnecock people who live in the lowlands along the coast of Long Island Sound were faced with potential loss of drinking water because floodwaters infiltrated the private wells on which they rely for drinking water. Similarly, the low-income community of the Ironbound section in Newark, New Jersey, was inundated with flood waters that carried raw sewage and treatment chemicals from the nearby sewage treatment plant and industrial operations.

INDIAN NATIONS

EPA values its unique government-to-government relationship with Indian nations 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 and the 2011 Policy on Consultation and Coordination with Indian nations. These policies recognize and support the sovereign decision-making authority of tribal governments.

Supporting the development of adaptive capacity among nations is a priority for the EPA. Nations 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 to develop adaptation strategies that promote sustainability and reduce the impact of climate change on Indian nations.

EPA engaged nations through a formal consultation process in the development of the Agency's Climate Change Adaptation Plan. Nations identified some of the most pressing issues as erosion, temperature change, drought and various changes in access to and quality of water. Nations recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. At the same time, nations challenged EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative burdens are reduced.

This Implementation Plan identifies specific steps that will be taken to partner with tribal governments on an ongoing basis to increase their adaptive capacity and address their adaptation-related priorities. These collaborative efforts will benefit from the expertise provide by our tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change and has been used by nations for millennia as a valuable tool to adapt to changing surroundings. Consistent with the principles in the 1984 Indian Policy, TEK is viewed as a complementary resource that can inform planning and decision-making.

Networks and partnerships already in place will be used to assist nations with climate change issues, including Regional Tribal Operations Committees, the Institute for Tribal Environmental Professionals and the Indian General Assistance Program (IGAP). Additionally, efforts will be made to coordinate with other Regional and Program Offices in EPA, since climate change has many impacts that transcend media and regional boundaries. Transparency and information sharing will be a focus, in order to leverage activities already taking place within EPA Offices and tribal governments.

Region 2 is also home to eight Federally-recognized Indian nation communities, all located in NY State. The nations in Region 2 are likely to be impacted by similar vulnerabilities discussed in other portions of this vulnerability assessment. In addition to those vulnerabilities mentioned throughout, nations in Region 2 have indicated that there are ecological as well as cultural activities that are vulnerable to the effects of climate change, directly affecting many of the cycles of the natural world.

The nations have noted a change in the composition of tree species in forests due to climate change. The change in forest tree species may not be moving at a rate as fast as that of climate change and therefore could lead to diminishing forest size. This

has resulted in an increased reliance on the planting by Indian nation communities of tree species that are more typically found in southern climates like the Carolina region of the U.S. Moreover, there is a growing concern that climate conditions are affecting many species of culturally significant trees such as the maple tree, causing an infestation of pests, insects, and fungi attacks.

The harvesting of culturally important crops such as maple syrup and wild strawberries as well as the undertaking of ceremonies to celebrate their harvest and medicinal purposes have also been affected by the changing climate. The traditional timing for harvesting crops depends largely upon the weather. If there is a cold winter with a lot of snow, the nations will have a good harvest of maple syrup in the spring. If there is a mild winter with limited precipitation, the maple syrup is not as plentiful and even in some cases, not available. In addition, the wild strawberry plant has unique nutritional and medicinal qualities that contribute to blood purifying and blood building. The berries, leaves and roots of the wild strawberry plant also contribute to a variety of women's health concerns and pregnancies. During the mid to late spring is traditionally the time that the wild strawberries come into being. But with changing climate, they now grow in the summer months, or are not as bountiful as previous years.

The undertaking of cultural activities such as ceremonies held in nations' longhouses have significantly been impacted with the unpredictable climate. For example, the Thunder Dance (or "Welcoming of our Grandfathers") is typically held two times per year with the first being held during the spring when one to three thunderstorms are heard and the second ceremony held during a dry period when rain is needed for crops. The nations thank the Thunderers or Grandfathers in the ceremony for returning again that year and for continuing to perform their responsibility of providing rain and fresh water, renewing the lakes, rivers, streams and wells. With the changing climate however, thunder is now common during rain and snow storms in the winter months (December thru February). Likewise, the ceremonies for the Strawberry, String Bean, and Green Corn are determined based upon the time for harvest, which more often depends upon the unpredictable climate conditions. Other cultural and economic activities such as fishing and hunting of wild game have also been impacted by changes in streams, other fishing waters, and natural habitats.

Climate change impacts for indigenous cultures are not expected to be clearly all positive or all negative. For example, increased air temperatures have the potential to lengthen the growing seasons of medicinal plants, higher CO_2 concentrations in the air can enhance plant growth, and in some areas, the availability of water resources may increase as rainfall patterns shift as a result of climate change. However, increased air temperatures may impair growth of certain species of traditional plants and cause them to migrate to zones outside Indian nation communities in our Region while allowing for a rise in invasive plant species, and water resources may be negatively impacted by extreme rainfall events that compromise drinking water supplies. While the extent and nature of climate related impacts are not clear, it is apparent to indigenous cultures that there will be climate related impacts that will impact their cultural heritage.

EPA REGION 2'S PROGRAMMATIC VULNERABILITIES TO CLIMATE CHANGE

This section focuses on those vulnerabilities that we believe, at this time, are most significant to EPA Region 2, and are presented in alignment with EPA's priorities where possible. A summary of program vulnerabilities to climate change is contained in the attached table.

1. TAKING ACTION ON CLIMATE CHANGE AND IMPROVING AIR QUALITY

TROPOSPHERIC OZONE POLLUTION

Various studies project that daily maximum ozone levels could increase between 2 and 5 parts per billion (current 8 hour ozone standard is 75 ppb) across the eastern U.S. between 2020 and 2080 due to climate change if no additional emissions controls for ozone precursors are implemented (Hogrefe 2004). The potential lengthening of the ozone season has also been projected, as reported in the 2007 IPCC Report and ClimAID. Region 2 States are located in the Ozone Transport Region[2], which indicates the sensitivity of the area to tropospheric ozone. The Jamestown, NY, NYC metro area and Philadelphia metro area currently violate the 2008 8-hr ozone National Ambient Air Quality Standard (NAAQS).

The projected ozone impacts of climate change may make it more difficult for New York and New Jersey to maintain compliance with existing ozone standards. Sources in or upwind of the Region may be required to implement additional control measures or emissions controls. EPA's air programs would oversee states' efforts to develop State Implementation Plan (SIP) revisions to address the issue.

PARTICULATE MATTER (PM)

WILDFIRES

Though wildfires are not common in Region 2, they have been known to occur in the Pinelands region of central/southern NJ, NJ Meadowlands and in Staten Island, NY. The risks of wildfire occurrences could be enhanced by climate change-induced effects such as higher temperatures, decreased soil moisture, and longer and more numerous periods of drought (IPCC 2007). All of these factors could increase the number, length, and size of wildfires.

The projected particulate impacts from wildfires could, but are not likely to, hinder areas in Region 2 from meeting or maintaining compliance with the PM NAAQS. Region 2's air program would oversee states' efforts to develop SIP revisions to address the issue if wildfire events lead to issues in complying with the PM NAAQS.

OTHER SOURCES OF PM AIR EMISSIONS

An increase in extreme weather events, which in the case of storms could include strong winds and/or heavy precipitation, increase the risk of disrupting energy delivery to many areas in Region 2. For

[2] See Clean Air Act §184(a) for list of states in the Ozone Transport Region.

example, electrical and natural gas distribution could be disrupted by downed trees and flooding. Extended periods with energy delivery disruption in cold seasons could lead to increased use of alternative heating fuels such as wood or backup generators. Residences which rarely use fireplaces could begin using them in a manner that does not reflect best practices. Using wood for heating that has not been seasoned properly or using fireplaces improperly increases the amount of wood smoke exhausted from wood burning devices, which can have negative impacts on human health and air quality. Occupants of indoor environments where wood is burned could be exposed to wood smoke. A major health threat from smoke comes from fine particles, also known as particle pollution (EPA). Particle pollution has been linked to premature death in people with heart or lung disease, nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, and increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing (EPA). The increased PM could affect also an area's ability to comply with the PM NAAQS, which could have regional health impacts. In addition, weather events with high winds and storm surges such as those many areas in Region 2 have experienced, can generate a tremendous amount of debris from, among other things, destroyed buildings, displaced sand and felled trees. Efforts to remove construction debris (e.g., from buildings) could require months and involve a large number of vehicles which could generate combustion related emissions. Biomass removal could involve incineration which could also operate for months and adversely impact air quality. Region's 2 air program would be required to monitor clean-up efforts to assure compliance with the PM NAAQS.

INDOOR ENVIRONMENTS

INDOOR AIR QUALITY

One of the best sources of information on impacts on the indoor environment is *Climate Change, the Indoor Environment, and Health*. The following subsections provide findings from this report from the National Research Council. Indoor environments can be contaminated by chemical, organic, and particulate pollutants that migrate from outdoors. Indoor migration is likely to be of particular concern on high temperature days in residences without air conditioning. Indoor air can also be contaminated by gas stoves and other indoor emission sources, such as building materials, radon, wood stoves, and environmental tobacco smoke. Climate change can affect these factors in various ways. For example, changes in the outdoor concentrations of a pollutant due to alterations in atmospheric chemistry or atmospheric circulation will affect indoor concentrations. The expected increased use of air conditioning, if accompanied by reduced ventilation, could increase the concentrations of pollutants emitted from indoor sources. Additionally, power outages—caused by heat waves or other extreme weather events—could lead to the use of portable electricity generators that burn fossil fuels and emit poisonous carbon monoxide (NRC 2011).

DAMPNESS, MOISTURE, AND FLOODING

Extreme weather conditions associated with climate change may lead to more frequent breakdowns in building envelopes—the physical barrier between outdoor and indoor spaces—followed by infiltration of water into indoor spaces. Dampness and water intrusion create conditions that encourage the growth of fungi and bacteria and may cause building materials and furnishings to decay or corrode, leading in

turn to chemical emissions. Poorly designed or maintained heating, ventilation, and air conditioning systems may introduce moisture and create condensation on indoor surfaces. Humid conditions can, however, be improved by well-designed and properly operating systems. Mold growth prevention and remediation activities also may introduce fungicides and other agents into the indoor environment (NRC 2011).

PESTS AND INFECTIOUS AGENTS

Weather fluctuations and seasonal to annual climate variability influences the incidence of many infectious diseases which may affect the evolution of existing and emergence of new infectious diseases, for example, by affecting the geographic range of disease vectors. The ecological niches for pests will change in response to climate change, leading to changed patterns or routes of human exposure and potentially, increased use of pesticides in these locations. Climate change may also lead to shifting patterns of indoor exposure to pesticides as occupants and building owners respond to infestations of pests (e.g. termites) whose geographic ranges may have changed. Although decreases in pest populations in some locations may lower the incidence of allergic reactions to particular pests, the overall incidence of allergic disease may not go down, because those individuals with a predisposition to allergies may become sensitized to other regional airborne allergies (NRC, 2011).

THERMAL STRESS

Extreme heat and cold have several well-documented adverse health effects. High relative humidity exacerbates these effects in hot conditions. As increased frequency of extreme weather events may result in power outages, corresponding increased use of portable generators may expose occupants to potentially dangerous conditions indoors. Seniors, persons with medical conditions, persons of low-income, and residents of urban environments are more likely to be exposed to extreme temperature events. These vulnerable populations experience excessive temperatures almost exclusively in indoor environments. Increased temperatures will result in increased use of air conditioning. Air conditioning provides protection from heat but is associated with higher reported prevalence of some ailments, perhaps because of contaminants in HVAC systems (NRC, 2011).

BUILDING VENTILATION AND WEATHERIZATION

Leaky buildings are common and cause energy loss, moisture problems, and migration of contaminants from the outdoors (e.g. pests, chemical, volatile organic compounds, and particulates). Research indicates that poor ventilation is associated with occupant health problems and lower productivity in all populations, and is exacerbated in vulnerable populations such as children, seniors and persons with medical conditions (NRC 2011).

Residents may weatherize buildings to increase comfort and indoor environmental quality in addition to saving energy. Although in general these actions should be encouraged, this may lead to a reduction in ventilation and an increase in indoor environmental pollutants unless measures are taken to preserve or improve indoor air quality. EPA has developed practical guidance for improving or maintaining indoor environmental quality during home energy upgrades or remodeling in single-family homes and schools.

EPA's guidance and protocols may need to be revised to include state and local considerations for projected climatic changes. In addition, these programs may need to increase partnerships with other agencies to address training needs and workforce development for building owners, managers, and others, as well as develop new tracking mechanisms to assess the effectiveness of weatherization and remodeling techniques as they relate to indoor environmental quality.

INCREASED ENERGY DEMAND

Increased temperatures due to climate change could have a potential two-fold effect on energy consumption for heating and cooling. Energy used for heating is likely to decrease while energy used for cooling is likely to increase. Summer peak demand in the New York metro area could increase 7 to 17%. Increases in peak demand without changes to energy infrastructure could lead to increased brownouts (IPCC 2007, NYSERDA 2011) or operation of "peaker" electric generating units in order to meet the increased demand. During high energy demand days, peaker units operate and generally produce more emissions than the typical electric generating unit. Furthermore, increased energy use for cooling would occur in the summer, which would lead to increased emissions during the ozone season (unless there is an increase in the supply of renewable energy to match the increased energy demand). The emissions impacts from increased energy demand could hinder areas in Region 2 from meeting or maintaining compliance with the NAAQS (PM, O_3, NO_x). Sources in or upwind of the Region may be required to implement additional control measures or emissions controls. Region 2's air program would oversee states' efforts to develop SIP revisions to address the issue.

MOBILE SOURCE EMISSIONS

Warming due to climate change could lead to damages to transportation infrastructure. Increased frequency, intensity, and/or duration of heat events could lead to railway deformities, road softening, and traffic-related rutting due to the road softening (IPCC 2007). If damages to transportation infrastructure lead to increased congestion, traffic-related emissions could increase. If the costs of maintaining roads and rail lines in good repair divert limited funds from planned mass transit capital projects this could hinder work performed by the Region 2 states and EPA Region 2 in promoting and supporting mass transit projects to reduce transportation related emissions (NYMTC, FTA). Heavy precipitation events resulting from climate change can threaten travel routes on coastal and low lying roadways, lead to the closure of airports, and damage to shipping channels and ports (IPCC 2007). If these damages and closures lead to traffic congestion in other locations, this could cause increases in mobile source emissions. Extreme events experienced in Region 2, such as hurricanes, that hinder refinery operations or fuel transportation could require EPA to grant fuel waivers to allow more polluting fuels to be used for a short time period. Extended periods of congestion could arise in areas that are flooded, which could lead to increased transportation related emissions (USDOT, USDOE).

2. PROTECTING AMERICA'S WATERS

WATERSHEDS, AQUATIC ECOSYSTEMS AND WETLANDS

SEWERS AND WASTEWATER SYSTEMS

Variability in precipitation patterns and an increase in the intensity and severity of storms will lead to an increase in the number of sewer overflows and wastewater bypasses. Predicted increases in storm events and rainfall intensity, as well as sea level rise and storm surges, will contribute to the frequency and volumes of combined sewer overflow (CSO) discharges in heavily urbanized regions in New York and New Jersey. New York State has 76 CSO permit holders with 966 outfalls, and New Jersey has 25 CSO permit holders with 217 outfalls. These include the Region's largest cities, such as New York City, Albany, Binghamton, Rochester, Syracuse, Buffalo, Jersey City and Newark. Furthermore, increased heavy precipitation events could trigger increased sewer overflows and wastewater bypasses, especially in low-lying communities like those surrounding the Martín Peña Canal in San Juan, PR. These overflows contain not only stormwater but also pollutants such as untreated human and industrial waste, toxic materials, debris, and oil and grease. Consequences include an increased risks of waterborne diseases, greater loads of pollutants entering our waterways, aquatic habitat impairments, loss of recreational access to water bodies due to high bacteria levels, fish kills, fishing and shellfishing restrictions, and increased flows in streams and other conveyance channels that could be eroded. This reduces EPA's ability to ensure human health and safety and our goal to make waterbodies fishable and swimmable. Utilities will be challenged by the need to address uncertainties associated with severe storm events and frequency when they evaluate the costs and benefits of alternative approaches for capital infrastructure planning and outlays. Communities seeking to reduce sewer and wastewater overflows should coordinate with the state agency administering EPA's State Revolving Fund (SRF) for funding consideration. Climate change will lead to a need for greater investment provided by the SRF.

Increased precipitation may also result in additional pollutant loadings of nutrients, pesticides, and other chemicals, further challenging permittees' ability to meet water quality standards and permit requirements. For industrial dischargers and wastewater treatment plants, lower baseflows due to increased evapotranspiration and increased likelihood of drought conditions will make meeting permit requirements more challenging. This will have an impact on our watershed programs as well as our regulatory programs, including the NPDES[3] and TMDL[4] programs.

WATER QUALITY STANDARDS AND PERMITTING

Under section 303(d) of the Clean Water Act, states, territories and authorized tribes are required to develop lists of impaired waters (i.e., "the 303(d) list"). These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes after the implementation of effluent limitations or other pollution control requirements. For future TMDLs, models to evaluate impacts under a range of projected future climatic shifts, using the best information and tools available, will need to be used on a site-specific basis. For the NPDES program, there will be a need to incorporate greater uncertainty into permit calculations to reflect the uncertainty

[3] As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

[4] A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that load among the various sources of that pollutant.

in climate projections related to NPDES permitting (e.g., precipitation projections), revise low-flow stream estimates, and consider warmer surface waters when evaluating applications for variances from thermal effluent limitations.

WETLANDS AND WATER BODY ECOSYSTEMS

As sea level rises, barrier island configurations will change and coastal shorelines will retreat. Wetlands will be inundated and eroded, and low-lying areas will be inundated more frequently – some permanently – by the advancing sea. Freshwater wetlands will be subject to changes in hydrology, precipitation and temperatures impacting the ecological services that they provide. Since coastal areas are already well developed, there would be limited opportunity for wetlands to migrate upland. There will need to be a focus on wetland protection, restoration and capacity for resiliency in all wetland ecosystems. As sea level rises, temperature increases and rainfall patterns change the salinity of estuaries, coastal wetlands, and tidal rivers, which are likely to become more variable, further altering the composition and ecosystem function of existing wetlands. Furthermore, Mid-Atlantic tidal marshes, mangrove forests and other coastal ecosystems in the Caribbean which provide important services for shoreline protection, species habitat, and nutrient cycling in the environment will be vulnerable with sea level rise. Inland wetlands - which provide important services in flood protection, water quality, nutrient cycling and species habitat - will be vulnerable with changes in precipitation and groundwater recharge. EPA Region 2's wetland and mangrove protection and restoration efforts will face challenges due to uncertainty with regards to sea level rise and the wetland's ability to migrate and respond to changes in hydrology and precipitation.

Changing water flow to lakes and streams, increased evaporation, and changed precipitation in some areas will affect the size of wetlands and lakes. For example, water levels in the Great Lakes are expected to fall. Headwater streams will be increasingly dry during summer months as drought conditions occur more often and evapotranspiration increases. This will have an effect on aquatic ecosystems because species that are susceptible to higher temperatures or lower dissolved oxygen levels, such as freshwater trout fisheries in New York and New Jersey, will lose viable habitat.

Increasing sea surface temperatures and ocean acidification have the potential to reduce the stability of corals in Puerto Rico and the Virgin Islands, especially in the presence of stresses from the existing land-based sources of pollution and overuse of the reefs for fishing and recreation. In the Caribbean, already

stressed coral reef ecosystems will be highly compromised by the increasing sea surface temperature which will result in more chronic bleaching events and subsequent vulnerability to diseases associated with bleaching. Ocean acidification will reduce the capacity of reef corals to calcify and protect themselves against more frequent hurricanes (EPA 2012). The collapse of coral reef ecosystems will have a significant impact on greater ocean ecosystems, food supplies and recreation and tourism industries. This will make implementation of local stormwater runoff reduction and improved coral reef management efforts by EPA and its partner agencies much more critical for preserving current coral reef habitat.

DRINKING WATER, WASTEWATER AND STORMWATER INFRASTRUCTURE

WATER INFRASTRUCTURE CAPACITY

An increased number of flood events of greater intensity is impacting water infrastructure. Many water and wastewater treatment systems and pumping stations in New York and New Jersey were damaged due to Hurricane Irene and Superstorm Sandy in 2011 and 2012. For example, many of the wastewater facilities were flooded and/or shut down or lost power during these events, after which they only performed primary treatment for a period until the digester systems stabilized and discharged untreated or partially treated sewage to local waterbodies. Furthermore, providing emergency support to these facilities was complicated by flooding of low-lying access roads, damaged electrical supply systems or shortages of fuel for backup generators, and overstretched personnel. In New Jersey, the Passaic Valley Sewerage Authority facilities alone suffered $300 million dollars of damage due to Superstorm Sandy. This has required major financial resources to pay for the repair or replacement of damaged infrastructure or proactively retrofit existing infrastructure, including treatment plants, pumping stations and conveyance systems.

In June 2013, New York City presented a comprehensive coastal protection plan which articulates a diverse selection of coastal protection measures tailored to the specific geomorphology of and risks facing neighborhoods most in peril[1]; other local governments will likely develop similar plans as well. Dredged material management plans will need to be adjusted because a number of the coastal resiliency projects will use dredged sediments and also due to potentially greater sediment loadings entering our waterways and harbors from more intense storm events. While the Army Corps of Engineers is the primary permitting authority on dredged material management in the coastal zone, EPA and the states have oversight roles of dredged materials management activities and are involved in developing dredged materials management plans. Coastal protection measures may also have an impact on water quality in Region 2 coastal waters and in the New York and New Jersey Harbor and Estuary in particular.

General population growth combined with a loss of snowpack in the Northeast and declining surface and groundwater quality and quantity, particularly in the Caribbean, will increase competition for water among energy, agriculture sectors, public drinking water supply, and maintenance of ecological service.

[1] See "PlaNYC: A Stronger, More Resilient New York" - http://www.nyc.gov/html/sirr/html/report/report.shtml

This will have an impact on water supply and water use, along with the water body's ability to provide ecosystem services. An example is the stress placed on the cold-water trout fishery due to inadequate reservoir releases in the Pequannock River in New Jersey due to drinking water diversions which causes water temperatures to be elevated in the stream during the summer months.

Sea level rise in coastal areas puts fresh water supplies for all uses, particularly drinking water, at increased risk. Salt water intrusion into coastal aquifers is a problem in some areas where withdrawals are outstripping recharge; increased pressure head from a higher sea-level worsens this problem. As sea level rises, community drinking water intakes may end up in brackish waters as the salt front migrates up coastal rivers and streams. For example, sodium concentrations could increase at the drinking water intakes on the Delaware River that serve Camden, NJ, degrading the community's supply of drinking water.[5] The integrity of coastal water infrastructure systems could be put at increased risk because systems designed for current sea levels are likely to have to operate under conditions where the sea level is 2 to 5 feet greater than current levels. Wastewater outfalls will have reduced capacity and will have to be redesigned given increased water heights in receiving waters. Communities may need infrastructure improvements to become more resilient to sea level rise and more frequent storm events.

In Region 2, many low-income and/or minority communities are located within or near floodplains or in areas with older water infrastructure which may not be designed to handle increased water flows. Residents of these areas are vulnerable to flooding impacts from a variety of sources; a major concern in this regard is the incidence of wastewater and stormwater sewer systems back-ups that could cause localized flooding and water inflows into basements in urban areas. These flooding events are likely to increase in frequency and magnitude with more frequent heavy rainfall events under climate change (NYSERDA 2011). Unfortunately, communities most impacted by this flooding risk are also those least able to relocate from flood-prone areas, and therefore are more likely to be impacted by weather events that could disrupt the drinking water and electrical supply as well as damage plumbing and electrical systems at homes and businesses.

GROUNDWATER RECHARGE

Increased temperatures will lead to increased evapotranspiration, thereby reducing the amount of water available to recharge groundwater aquifers. In the Northeast more precipitation is forecast to occur as heavy downpours and in addition, the snowpack is expected to be reduced. Overall, this will result in increased surface runoff and reduced infiltration and groundwater recharge, particularly in upland areas. This will place strains on the use of groundwater for municipal, industrial, and agricultural water supply. For example, the Long Island Aquifer is a source of drinking water for 2.7 million people in New York State, and over 900 million gallons per day (mgd) of water is used (8% of total water use). Aquifers supply drinking water to New Jersey at the rate of 570 mgd (31% of total water use) and Puerto

Rico at the rate of 137 mgd[6]. In order to ensure adequate water supplies, the importance of groundwater protection from contamination will become more crucial in maintaining water supplies for the Region.

SEPTIC SYSTEMS

When there is flooding, or when soils are saturated for extended periods of time, septic systems cannot function properly. Proper septic system performance depends on having aerated conditions in the soil so that bacteria can properly treat wastewater by removing pathogens and other contaminants. Flooding events and rising groundwater tables due to sea level rise and increased precipitation saturate the soils and causes sewage backing up in buildings. Flooding also allows contaminants to enter ground and surface water, reducing water quality and recreational access. In Region 2, the major contaminants that could increase due to climate change are bacterial contamination, greater algal blooms due to increased nutrient loadings, and higher nitrate concentrations in groundwater. Additionally, certain areas such as Suffolk County, NY or some coastal areas of Puerto Rico rely primarily on cesspools and septic systems for sanitation; these areas are particularly threatened by impacts from climate change. EPA works with local officials and partner organizations to support onsite wastewater management and develops voluntary policies and guidance for onsite wastewater management programs.

QUALITY AND AVAILABILITY OF SAFE DRINKING WATER

Protecting public health from contaminants in drinking water will require adapting to the impacts of climate change. Warmer waters foster pathogen growth, which affects the reliability and the cost of drinking water disinfection. Increased precipitation, and in particular, more extreme rainfall events may result in additional pollutant loadings of nutrients, pesticides, and other chemicals, further challenging drinking water treatment. New York City's ability to continue to meet the criteria for the drinking water filtration avoidance, thereby reducing the need for water supply treatment, may be affected due to increased runoff and turbidity. Small water systems, such as non-PRASA (Puerto Rico Aqueduct and Sewer Authority) systems in Puerto Rico, are particularly vulnerable due to reduced water yields and/or poor water quality. Longer periods of drought are expected to occur and may produce an increase in the energy and costs associated with the production of drinking water.

New drinking water sources and/or enhanced treatment will be needed in some localities, including relocating water intakes and building desalinization plants. Rising sea levels cause intrusion of saltwater into the underground freshwater aquifer, contaminating the supply of usable groundwater and reducing the freshwater supply for the Caribbean islands, on Long Island, and in coastal sections of New Jersey. Desalination to treat marine or brackish water is becoming increasingly important in certain locations in the Virgin Islands and circumstances where demand is driven by population growth or drought. Wastewater or stormwater utilities could distribute reclaimed water from a centralized treatment

[6] http://www.ngwa.org, http://pubs.usgs.gov/circ/2004/circ1268/htdocs/table04.html

system for park irrigation or other uses, which may require additional treatment. EPA's drinking water and groundwater protection programs will be involved in permitting and monitoring the systems and providing technical support.

Aquifer Storage & Recovery (ASR) is a process of storing water underground to provide future domestic, industrial and agricultural water supplies. ASR is increasingly used where fresh water demand is beginning to or projected to exceed supply, and ASR is likely to increase in drought prone areas. When applied to stormwater, this practice can also reduce nonpoint source pollution of our lakes, streams and rivers. However, the infiltration or injection of polluted stormwater increases the risk of contamination of fresh water aquifers. In Region 2, the majority of ASR facilities are located in New Jersey. In light of increasing demand, EPA will need to ensure that groundwater quality and supply are maintained given greater use of this resource (EPA 2012).

3. CLEANING UP COMMUNITIES

RISK OF CONTAMINANT RELEASES

The prospect of more intense and more frequent storms and sea-level rise carries with it the risk of contaminant releases from RCRA Corrective Action sites, Superfund sites, Brownfield sites and landfills. As noted in EPA's Climate Change Adaptation Plan, inundation and flooding may lead to transport of contaminants through surface soils, groundwater, surface waters and/or coastal waters. Uncontrolled migration of contaminants may pose an increased risk of adverse health and environmental impacts. An example in Region 2 is American Cyanamid, a Superfund site on the banks of the Raritan River in Bridgewater Township, NJ. The site has two impoundments of harmful chemicals that release contamination during major flood events such as Hurricanes Floyd and Irene (1999 and 2011 respectively). There is currently no remedy selected for the impoundments area of the site, so future flood events will continue to release contamination on the site and into the river until a remedy is selected and implemented.

While this issue is, of course, most relevant to sites that have not yet been remediated, some sites where a containment remedy has been performed may also be vulnerable. For example, saltwater intrusion and increased groundwater salinity in coastal aquifers may increase the permeability of clay liners installed at waste sites, such as landfills, allowing contaminants to spread to nearby properties. Several landfills in Puerto Rico and the USVI are located at or near sea level. Many of these landfills are still operating and/or have been improperly closed. Rising sea level poses a significant risk of erosion to these landfills and the potential migration of contaminants towards nearby communities and ecosystems (i.e. coastal wetlands and coral reefs). Examples of these are the Culebra Island Landfill and the Rincón Municipal Landfill.

Severe storms, storm surge and sea level rise may also cause flooding of coastal or other riparian located facilities in Region 2 where chemicals, oil or other hazardous substances are present. Of notable concern are pesticide and chemical production or storage facilities, which are governed by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Toxics Substances Control Act (TSCA),

respectively. These facilities are also vulnerable to extreme weather events, possibly leading to the dispersal of such materials to nearby properties or surface waters and, in turn, creating risks to public health and the environment. This is an issue about which local Environmental Justice groups have raised concerns to EPA, as a number of such facilities in our Region are located near low-income minority communities. Releases of hazardous substances or other materials from such facilities could potentially lead to cleanup actions by EPA's Superfund program, the oil spill response program, or state or local government response programs to conduct cleanup actions.

ADVERSE EFFECTS ON CLEANUPS AND EMERGENCY RESPONSE

As noted in the Agency-wide Climate Change Adaptation Plan, changes in precipitation patterns and temperature as a result of climate change may adversely affect the performance of some site cleanup remedies and may require some remedies to be changed. In February 2012, EPA's Office of Solid Waste and Emergency Response (OSWER) released a report, *Adaptation of Superfund Remediation to Climate Change*, which identified vulnerabilities to site remedies nationwide. The assessment identified sites with on-site pump and treat or containment remedies within 100- and 500-year floodplains, as well as those within the modeled 5 ft. sea level rise zone. While the report concluded that there are multiple programmatic systems in place to address effects of climate change on Superfund sites, more evaluation is ongoing to look at more specifics regarding vulnerabilities during a site's lifecycle, as well as at sediment and other types of sites. The report also found that climate change effects could be accounted for within the remedy assessment criteria or the Five Year Review process, but site managers may need to be more aware of these opportunities for addressing adaptation issues. Other vulnerabilities include changes in site conditions and contaminant characterization of groundwater plumes as groundwater recharge may be affected by climate change. Flooding and storm surges are also likely to affect ongoing ecological redevelopment of sites, as well as oil tank storage.

4. ASSURING THE SAFETY OF CHEMICALS AND PREVENTING POLLUTION

USE OF TOXIC CHEMICALS

A changing climate will likely result in changes in the kind of agricultural crops planted in New York, New Jersey, and the Caribbean. For example, current cash crops in the Northeast such as apples, maple syrup, and cranberries will likely move further north into Canada while crops now grown in the Southeast will move into the region (USGCRP 2009). This in turn will affect the quantity, type, and timing of agricultural chemical use as well as the appropriate application method. These changes in chemical use and application could impact the appropriate risk management decisions made by EPA Region 2's Pesticides Program in determining what pesticides and geographic areas to focus our efforts to ensure compliance with the Federal Fungicide, Insecticide, and Rodenticide Act (FIFRA), particularly with regard to the protection of migrant farm workers and rural communities. For instance, soil fumigation as a method to apply pesticides is now rarely used in Region 2 but would be expected to become more common as crops move into the area that requires pest techniques that are associated with longer growing seasons and warmer winters (NYSERDA 2011). Soil fumigants are among the most hazardous of all pesticides and rapidly volatilize once in the soil. Once in gaseous form, the fumigant can disperse throughout the soil and contact target pests making them extremely effective. However, because of the

volatility of fumigants, people who live, visit, and/or work near fumigated fields may be exposed to these toxic emissions if the gases travel offsite either via wind aboveground or through wells, sewers, vaults and other underground pathways to the surface. Consequently, EPA Region 2's Pesticides Program would likely need to reevaluate its priorities if spray drift from fumigants becomes more common in Region 2.

Similarly, changes in temperature and precipitation levels are expected to result in increased cases of the West Nile Virus and other diseases carried by mosquitoes, some not usually found this far north. In fact, the migration of *Aedes albopicus* (Asian tiger mosquito) has resulted in increasing populations in more northern regions, especially Region 2 (Shope 1991). These mosquitoes have begun to take over areas previously inhabited by *the Culex species of mosquito* during the winter (i.e., NYC). The movement of this invasive species may increase the northward spread of Dengue. As the incidence and type of diseases carried by mosquitoes increases, EPA Region 2's Pesticides Program will likely need to broaden their knowledge of new types of pesticides and/or application methods to ensure compliance with FIFRA. EPA will also need to engage diverse stakeholders with disparate views on the merits of spraying pesticides. These activities will have resource implications for EPA Region 2 as will most of the programmatic impacts referenced in this Assessment.

EXPOSURE TO TOXIC CHEMICALS FROM INFRASTRUCTURE DAMAGE

The extreme weather events that are likely to occur as a result of climate change (e.g., high winds, heavy precipitation events) may damage community infrastructure (e.g., schools and child care facilities) and residential homes. As a result, there may be an increased risk of exposure to lead, asbestos and PCBs, when these buildings are initially damaged and when they are renovated/demolished as part of the recovery efforts. Children are particularly vulnerable to this risk, particularly those living in disadvantaged communities where buildings tend to be older and poorly maintained. Therefore, to mitigate/prevent such exposure and ensure compliance with the Toxic Substances Control Act (TSCA), EPA Region 2's Toxics Substances program will need to educate the affected communities about safeguarding themselves and provide technical assistance to debris removal companies and the construction/renovation industry. Depending on the extent of the communities impacted and the amount of damage resulting from these extreme weather events, the capacity of EPA Region 2 Toxic Substance program to provide such information/assistance in a timely manner, especially in a face-to-face format, could be sorely tested.

5. EPA REGION 2'S FACILITIES AND OPERATIONS

EPA Region 2's main office is in Lower Manhattan, with other facilities in Edison, NJ, and Guaynabo, PR, as well as small field offices in Hudson Falls and Buffalo, NY, Stamford, CT and in the U.S. Virgin Islands. Our Edison, NJ facility houses, among other things, our regional laboratory and EPA's Emergency Response Team. Overall, Region 2 currently has about 840 employees. The climate change impacts discussed in the above sections present a number of risks to Region 2's staff, facilities, assets, and day-to-day operations, as summarized below.

FACILITY OPERATIONS, SAFETY AND EMERGENCY COMMUNICATIONS

Extreme heat, bad air quality or other weather conditions exacerbated by climate change may increase the health risks of EPA Region 2 employees and contractors engaged in field work -- such as sampling, remediation and inspections -- or force them to delay such work. In addition, increased demands placed on electrical grids during heat waves could jeopardize the grids' integrity or force utility providers to institute rolling brownouts or blackouts. The occurrence of such outages would force EPA to use auxiliary power sources (generators, uninterrupted power supplies). Building lighting, HVAC systems and/or elevator service may have to be reduced or adjusted to compensate for the loss of power. EPA offices in the Caribbean could potentially close for short periods of time due to impacts of hurricane, tropical storms or other weather events and potential impacts on the facilities themselves and the employees' ability to safely travel to and from work. In addition, potential water shortages due to reduced water availability as a result of prolonged drought could disrupt day to day operations. Severe storms (for example, as seen during Superstorm Sandy) could also cripple public transportation systems, highways and roads, and/or result in significant gasoline shortages, thus preventing Region 2 employees from being able to come into work. We have prepared for such scenarios through our telework program, portable computing equipment for employees, and remote networking capabilities, but at a minimum, some impact on productivity can be expected. In addition, many regional staff conducts field-based work, such as site remediation and inspections. Instability of weather patterns (with more heavy snow and ice events in winter months) also impacts the safety of staff traveling to and from remote (and sometimes off-road) locations and increases the chance for automobile accidents with government vehicles.

EPA Operations & Superstorm Sandy

When Superstorm Sandy struck the east coast in October 2012, EPA Region 2's main office – located in lower Manhattan – lost its main power supply for five days and its heat supply longer, which forced the closure of the building for almost two weeks (9 business days). Closing the main office had a major impact on our operations, and due to the extent of impact – power outages, wireless and landline telephone service limitations – employees had limited ability to access their work virtually. The storm also knocked out the normal power supply for our Edison, NJ facility, forcing the facility (and the Region's command center for emergency response) to operate on emergency backup power. For nonessential Edison, NJ staff – including laboratory staff – the Edison facility was closed for five business days, creating a backlog in regular work while additional storm-related needs were developing. Edison's Regional Emergency Operations Center (REOC) ran on generator power from Monday through Saturday. Bottled water and dispensers had to be brought in to supply potable water for staff working at the REOC.

In addition to building operations, road and tunnel closures, hobbled public transportation (NYC subway, PATH, NJ Transit trains and light rail) and gasoline shortages created hardships mobilizing the workforce at both locations, whether bringing employees into the office or more importantly deploying employees to the field to assist other state and federal agencies.

Regardless of whether Superstorm Sandy can be directly attributed to climate change, the storm is illustrative of the sort of extreme weather events that are expected to occur in the Northeast with greater frequency in the future, as a result of climate change.

EPA Region 2 has Continuity of Operations Plans that are formulated to address an "all hazards" approach. Damages to EPA facilities and/or impacts to critical infrastructure due to extreme weather events could force Region 2 to implement those plans, or even Devolution of Operations Plans, in order for EPA to continue to execute Mission Essential Functions. The Region maintains a Continuity of Operations site in Edison, NJ that is capable of providing fully supported workspace for up to 200 emergency support personnel. The site has backup power and was constructed to withstand hurricane force winds and earthquake level forces.

Over time, climate change may result in EPA Region 2 personnel – including those working in our emergency response program or who collect or analyze environmental samples, as well as our contract support staff, public affairs staff, and others -- being increasingly drawn away from their normal day-to-day activities to respond to extreme weather events or emergencies. This, in turn, could lead to a reduced capacity to perform regular duties (e.g., monitoring compliance with and enforcing hazardous waste laws).

IMPACTS ON WATER SUPPLIES USED BY EPA REGION 2

As described previously, water availability, quality, and safety could be compromised by climate-influenced events. At all regional offices and the laboratory, the staff relies upon potable drinking water from municipalities. The availability of safe drinking water (as described in the Superstorm Sandy example) needs to be considered for all offices. Water supply issues could impact the Regional Lab at Edison, NJ and its ability to operate. In Edison, the ORD National Risk Management Research Laboratory conducts research on stormwater management practices and technologies. In-situ research requires copious amounts of water to mimic various storm intensities (and related overflows). Droughts can impact the Laboratory staff's ability to test technologies and conduct research because access to water could be limited through rationing/availability.

EPA developed a Water Conservation Strategy that identifies water conservation projects and approaches that reduce potable water use by 2% annually. This strategy applies to EPA-owned spaces, such as the Edison, NJ facility and laboratory that are owned and operated by the Regional office. Projects to ameliorate local water supply issues include gray water (rain water runoff and water condensation) capture for cooling. Increased drought intensity – and overall changes with the frequency and intensity of storm events – may reduce the availability of gray water over time.

In addition, water shortages could impact office operations of leased space in Puerto Rico, U.S. Virgin Islands, New York and New Jersey. Spaces leased from the U.S. General Services Administration (GSA) may be dependent upon water for consumption, cooling, landscaping, etc. However, GSA (directly or indirectly) is the responsible party for addressing water conservation and stormwater reduction. During extreme drought conditions, employees may be asked to conserve water such as limit watering plants, showering at the facility gym, etc. Long-term droughts and increased scarcity of water may cause local water rates to increase thereby increasing operational costs related to potable water use in office buildings and negotiated during lease renewal.

EPA REGION 2 PRIORITY ACTIONS

Adaptation planning efforts in Region 2 began with a vulnerability assessment of Regional programs to identify how climate impacts may affect our mission, program and operations. Region 2 focused on actions that would address the areas of highest likely risk and subsequently developed a preliminary list of action items to address the impacts identified in the vulnerability assessment. Next the group identified criteria to select the best actions from the preliminary list and developed a draft set of priority actions selected by applying the criteria. See the criteria listed below.

CRITERIA

- Action meets other regional/national objectives [Consider whether action is part of EPA's core or optional programs]
- Action must be implemented in order to enable other actions (sequencing)
- Region 2 is the best fit as implementer or co-implementer
- Action is achievable
- Action fills a gap
- Action reduces risk significantly
- We can measure benefits of the action
- There are resources available to do the action
- Action has short-term and long-term benefits
- Actions that address current impacts are more important than actions that address projected impacts
- The action avoids maladaptation
- Action addresses EJ communities and vulnerable areas/populations
- The law can provide an opportunity for the action; There is legal authority for the action
- The action is scalable and transferable
- Action advances sustainability
- Action has durability/stability/longevity

The following section lists priorities that represent regional actions to reduce the impacts of climate change to EPA Region 2 programs. Region 2 priority actions are categorized to demonstrate the region's short-term priorities, and long term priorities. The short-term priority action designation reflects the regional offices' assessment of appropriate resources and ability to implement the actions in the near-term while long-term priority actions are slated for the future and pending resource allocation. Additionally, the region identifies goals that are best suited for a headquarters or nationally-led initiative, due to factors such as scope, rulemaking authority, and resource requirements. Region 2 is committed to supporting the development of potential legal strategies underlying existing and new priority actions on adaptation and will more broadly consider options to improve the effective use of legal tools in the response and recovery phases following impacts from climate change. Such legal tools are relevant to consideration of a range of issues including but not limited to access issues, waivers, no-action assurances, and efforts to secure staging areas. Region 2 will also seek opportunities and develop options to increase resilience at entities regulated by environmental statutes and regulations by incorporating information and knowledge on vulnerabilities into permits, environmental reviews, injunctive relief portions of enforcement documents, and other EPA decisions and approvals, where appropriate.

Region 2 recognizes the iterative nature of adaptation planning and will use an adaptive management framework, or develop adaptation strategies based on assessments that are monitored, revisited, redesigned and adjusted over time, to implement these priority actions. An adaptive management framework will be particularly helpful given uncertainties about Regional climate change impacts and the effectiveness of our priority actions as well as changing resources and needs. Through an adaptation management framework, Region 2 will be able to more nimbly and effectively reprioritize and revise our actions.

SHORT TERM PRIORITIES

THE SHORT-TERM PRIORITY ACTION DESIGNATION REFLECTS THE REGIONAL OFFICES' ASSESSMENT OF APPROPRIATE RESOURCES AND ABILITY TO IMPLEMENT THE ACTIONS IN THE NEAR-TERM.

AIR

- Focus enforcement resources on emitters of tropospheric ozone precursors, volatile organic compounds (VOCs) and NOx, to reduce the impacts on air quality associated with projected temperature rise due to climate change.
- Increase outreach regarding the effects of emissions from emergency generators and wood smoke. Educate emergency generator purchasers about newer, cleaner, and more efficient generators. Promote best practices for using emergency generators and wood burning to reduce emissions associated with generating electricity and heat during extreme weather events which disrupt energy delivery. Enhance messaging on dangers from increased use of back-up electricity sources (e.g. generators) and heat sources (e.g. woodstoves, fireplaces) during power outages.

WATER

Region 2 contributed to the development and implementation of the National Water Program 2012 Strategy: Response to Climate Change[7] which identifies 19 Goals and 53 Strategic Actions that are being implemented nationally. The priority actions listed here include short-term priorities for which sufficient levels of funding and resources are available for implementation.

- Promote the Climate Ready Water Utilities program and the Climate Resilience Evaluation and Awareness Tool (CREAT) tool to water utilities and municipalities. Support utilities in modifying treatment plants to withstand future storm surges.
- Work with states to establish SRF criteria for building resistance to climate change impacts through infrastructure investment.
- Promote Green Infrastructure practices to state and municipal governments to help them better manage increased precipitation and flooding. Develop and finalize the regional Green Infrastructure Action Plan.

[7] http://water.epa.gov/scitech/climatechange/2012-National-Water-Program-Strategy.cfm

- Identify and assess public water supply systems that are close to streams or rivers that may be subject to climate impacts, including flooding and severe storm events.
- Implement the Coral Reef Protection Plan, which addresses climate impacts to corals such as ocean acidification and coral bleaching, as well as waste discharges, water quality criteria, and areas to be protected through a watershed management approach.
- Continue to support and incorporate climate change considerations into funding and support for coastal habitat restoration and monitoring activities.
- Engage with Regional National Estuary Programs (NEPs) to implement climate change priorities identified in NEP Action Plans and other key documents. Work with regional NEP programs to incorporate climate change considerations into funding and coastal habitat restoration activities, as appropriate.
- Improve coordination of Clean Water Act funding that supports wetland protection and monitoring to incorporate resilience of wetlands to climate change and sea level rise. Funding sources include CWA 104, 106, 319, and 320 grant programs.
- Collaborate with NOAA, US Fish & Wildlife, and FEMA to identify opportunities for coordination of wetland restoration funding. Identify duplicative actions and possibilities for collaboration to ensure more efficient use of federal funds. Streamlining restoration spending may free up funds that can be used for further restoration work, which can protect coastal communities from sea level rise, erosion and storm surge.
- Promote wetland conservation and restoration through Supplemental Environmental Projects (SEPs) in the Caribbean.

WASTE: SUPERFUND & RCRA

- Assess vulnerabilities of existing Superfund/Resource Conservation and Recovery Act (RCRA) sites, including proximity to flood zones, coastal or riverfront sites, etc. (National Priorities List or NPL, non-NPL, RCRA corrective action facilities, Formerly Utilized Site Remedial Action Program or FUSRAP sites) working with state and other federal agencies as appropriate. To be completed internally by site managers with a vulnerability checklist. Additional resources would be needed for a more complex vulnerability assessment, which may be more appropriate as a nationally-led report.
- Include consideration of potential climate change impacts in Five Year Reviews of NPL sites (e.g. flooding impacts to capped sites, changes to aquifers and plume migration, etc.).

EMERGENCY RESPONSE

Since Superstorm Sandy made landfall on the coast of New York and New Jersey the evening of Oct. 29, 2012, EPA Region 2 has been providing ongoing emergency response in our two northeastern states. In addition to emergency response actions provided by our on-scene coordinators, Region 2 staff persons were stationed at the FEMA Joint Field Operations as part of the federal response to Superstorm Sandy in New York and New Jersey to develop Recovery Support Strategies. Region 2 continues to coordinate with other federal agencies on addressing climate risk in the rebuilding process. The region's immediate response work is not fully captured within the scope of this plan. Response work addresses a number of environmental and human health concerns including monitoring water quality, managing household hazardous waste and disaster debris in accordance with the National Response Framework. EPA Region 2 has been implementing recovery actions in accordance with the Superstorm Sandy Supplemental Appropriations bill. The bill provides funds for EPA in the following program areas: the drinking water and waste water State Revolving Loan Funds, Superfund sites, and monitoring environmental conditions.

The Region is working with state and federal partners to build climate resiliency into the recovery activities implemented by many federal and local organizations through the Superstorm Sandy Supplemental Appropriations bill. In the long-term, the Region will take into consideration lessons learned from recent climate events, including Superstorm Sandy response operations work, to address climate change in emergency response preparedness.

COMMUNITIES & VULNERABLE POPULATIONS

- Inspect regulated facilities in flood prone areas that store hazardous waste, chemicals, and oil to promote climate resilient practices. Design materials to distribute containing environmental assistance resources for regulated facilities in flood prone areas and distribute through inspections, meetings, and outreach events and in partnership with other technical assistance providers such as small business assistance programs. Make use of existing mapping applications with new climate data projections to identify regulated facilities in flood prone areas, especially in EJ areas.
- Identify areas of opportunity in hazard mitigation planning to integrate sustainability principles (including land use principles) into community planning documents to reduce further impacts and connect sustainability to long term recovery from extreme weather events. Expand partnership with research institutes, and FEMA to develop tools that planners can access.
- Develop and distribute resource materials for communities to conduct assessments of climate vulnerabilities and devise potential strategies for climate resilience.
- Use the EPA Environmental Justice Screening tool, EJSCREEN, to do an assessment of Superstorm Sandy-impacted communities. Support FEMA and the Federal Disaster Recovery Support Strategy to identify communities with potential areas of EJ concern for purposes of targeting and prioritizing technical support/assistance for local recovery efforts. Develop a plan for incorporating EJ in community development scenario planning protocols that will help communities rebuild sustainably.
- Incorporate climate adaptation concerns for communities and vulnerable populations into regional science priorities which prioritize future science and research funding.
- Use GIS-mapping and existing climate model information to assess vulnerabilities of public infrastructure (electric utilities, wastewater treatment plants, chemical storage facilities, public transport facilities, gasoline and oil storage locations).
- Create a regionally specific website to provide resources and information to stakeholders on preparing for the impacts of climate related events such as heat waves. Highlight priority actions as they are accomplished via press events, social media, and/or press releases.
- Address vulnerabilities regarding the water infrastructure and other industrial facilities with emphasis on low-income communities located near coastal water bodies in the Caribbean (e.g. Martín Peña and G-8 communities).
- Address climate change-related impacts in NEPA reviews, including consideration of options to reduce environmental consequences of climate change-related impacts on proposed federal actions.

INDIAN NATIONS

- Support Region 2 Nations in assessing impacts to tribal lands and cultural activities.
- Support tribal climate change information sharing amongst tribes in Region 2 and beyond. Region 2 will promote increased capacity for Indian nations to create and maintain adaptation plans for their

communities, and promote improved communications between EPA and Indian nation communities, and also tribal organizations, on climate change activities.

FACILITIES

- Update communication methods to staff during incidences of long and short term disruptions to wireless and phone capabilities. Address methods for communicating staff availability to other Regions, HQ, etc. during long and short term office and facility closures.
- Update disaster/emergency planning for operations, including protocols for asset management and tracking as well as the transition from normal operations to emergency status and vice versa.
- At our Guaynabo facility, promote use of WaterSense products.

LONG TERM PRIORITIES

LONG-TERM ACTIONS ARE SLATED FOR THE FUTURE AND PENDING RESOURCE ALLOCATION.

AIR

- Establish post-storm planning with multiple components to address air quality aspects of waste removal, including maximizing potential for re-use or composting of vegetative debris; removal of non-reusable debris *(e.g. asbestos); cleanest transportation options, e.g. marine, rail instead of trucks.
- Work with Headquarters to implement any necessary changes to air quality guidance and procedures to account for a changing climate (e.g., adjustments to waiver and waiver extension request procedures in response to more frequent or severe extreme weather impacts on facilities).
- Bring air pollution consequences of climate change impacts on transportation systems to the attention of state and local partners.

WATER-CARIBBEAN[8]

- Foster renewal of discussions about the implementation of source water protection programs in the Caribbean islands.
- Train Caribbean enforcement officers to increase awareness of the impact of climate change to regulated facilities and their activities. Give out information to public works personnel during Municipal Separate Storm Sewer Systems (MS4) inspections.
- Improve communications with Puerto Rico Department of Natural & Environmental Resources and U.S. Virgin Islands Department of Planning & Natural Resources and other state agencies for collaborations in the respective coastal zone management programs in the Caribbean to work together in addressing coastal vulnerabilities.
- Implement water conservation programs to address anticipated levels of reduced precipitation in the Caribbean. Promote more sustainable small water systems infrastructure, operation and maintenance for the Caribbean islands.

[8] New York and New Jersey long-term priority actions are identified in the "Moving Toward a Climate Resilient Region" Section.

- Outreach and implementation of water reuse/reclamation programs to address future water scarcity for the Caribbean islands.

WASTE: SUPERFUND & RCRA

- In the Caribbean, promote Climate Change Adaptation SEPs, in future enforcement orders, permits to CWA sites as well as RCRA Hazardous Waste sites.
- Promote more P2/Sustainable Practices in the Caribbean to prevent/minimize releases of hazardous material as a result of hurricanes, flooding, etc.

EMERGENCY RESPONSE

- Develop database/ for reuse and recycling of disaster debris. Simultaneously develop in-house expertise for debris management and conduct training for EPA staff through ICS exercises.
- Conduct outreach with states & municipalities to encourage development and implementation of disaster debris management plans.
- Conduct outreach with states and municipalities to improve management of household hazardous waste to prevent releases during extreme weather events. Increase awareness among federal, state and local agencies/first responders about the impacts of climate change in emergency situations in the Caribbean.
- Review CEPD's emergency response plan to ensure that the vulnerabilities of the new San Juan office location are considered.
- Improve communications with DNER/DPNR and other Caribbean state agencies for collaborations in the respective coastal zone management programs to mitigate impacts during emergencies.

COMMUNITIES & VULNERABLE POPULATIONS

- Increase number of communities that receive information about availability of technical assistance, such as Complete Streets, planning for older populations in communities.
- Promote more Pollution Prevention/Sustainable Practices in the Caribbean to prevent/minimize releases of hazardous material as a result of hurricanes, flooding, etc.
- Compile case studies that showcase implementation of climate adaptation and mitigation efforts to describe their effectiveness.
- Coordinate with states and local governments that are piloting and demonstrating use of climate information in research, planning and rebuilding efforts.
- Support economic development strategies for building communities with climate resiliency through job training, education and coordination.
- Develop outreach such as workshops, webinars, etc. on resilient buildings. Feature EPA Indoor airPLUS for building reconstruction and EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades for building upgrades. Prepare information and recommendations regarding mold and indoor air quality issues for distribution to the public. Disseminate factsheets on re-entry to homes, schools, daycare centers, buildings, etc. Address energy efficiency impacts on indoor air quality for homes and schools to avoid maladaptation.

MOVING TOWARD A CLIMATE RESILIENT REGION

Like other regions and program offices in EPA, Region 2 faces significant constraints on funding and employee resources. Region 2's decision to segregate our priority actions into short-term and long-term actions in the preceding sections of this document recognizes those constraints. There are additional actions that EPA has not included in either the short-term or long-term actions, above, because the timing of those additional actions might not be clear or because this document is not seen as the vehicle to drive those actions. In addition to funding and employee resource constraints, these additional actions may require difficult policy or legal decisions before we can implement them. They might also require action by another party. For example, many of these actions must be addressed in partnership with states, territories, tribes and municipalities, all of which face serious budget restrictions and difficult policy choices of their own. In some cases, EPA is already implementing portions of additional actions through work driven by factors external to this Adaptation Plan. Below are some of the actions that fit into this additional category. EPA Region 2 will consider the appropriate timing of these additional actions in the context of the adaptive management framework.

Region 2 sees future opportunity to work with state regulators during the planning and permitting process, for the air and oil sector and sewage treatment plants, in accounting for climate change related issues. This could require considering the elevation of a facility, location of facility intakes, and location of emissions control equipment to account for project climate change impacts. In the Caribbean, we could explore the possibility of implementing green infrastructure and green energy in consent-decrees and orders (for both Safe Drinking Water Act and Clean Water Act).

In the area of watershed management, the regional water program supports continuing to work with state, territory, tribal, and local partners to further integrate climate change adaptation considerations into nonpoint source management plans and programs. For example, the New York City Drinking Water Program has a robust watershed protection program that integrates climate change concerns which was developed with the help of EPA Region 2 and other state partners. This collaboration with our partners could also entail enhancing the protection and creation of buffers to rivers, lakes, wetlands and other coastal resources to build resiliency and protect water quality. Region 2 could also work with partners to prepare for increased runoff by encouraging development of infiltration basins, providing soil structure to soils compacted by development, adoption of erosion and sediment controls, increases in culvert sizes and the adoption of other BMPs that mitigate runoff. These activities could be supported in part by leveraging state and federal resources, including Clean Water Act Section 319 grant funds. Finally, Region 2 could encourage states to incorporate climate change issues when updating their nonpoint source management plans and guidance documents.

In the ocean and coastal arena, the water program will continue to promote a sustainable balance between the use of soft shorelines, living shorelines and innovative shoreline development, and hardened shorelines. The region's ability to support on-the-ground projects as it has in the past is currently limited. The dredging program seeks to work with partners to better anticipate and plan for increased demand for dredged sediments to counter the effects of sea level rise and increased erosion.

As Superstorm Sandy demonstrated, drinking water and wastewater treatment plants in Region 2 are extremely vulnerable to sea level rise, storm surge and erosion. The water program supports further collaboration with

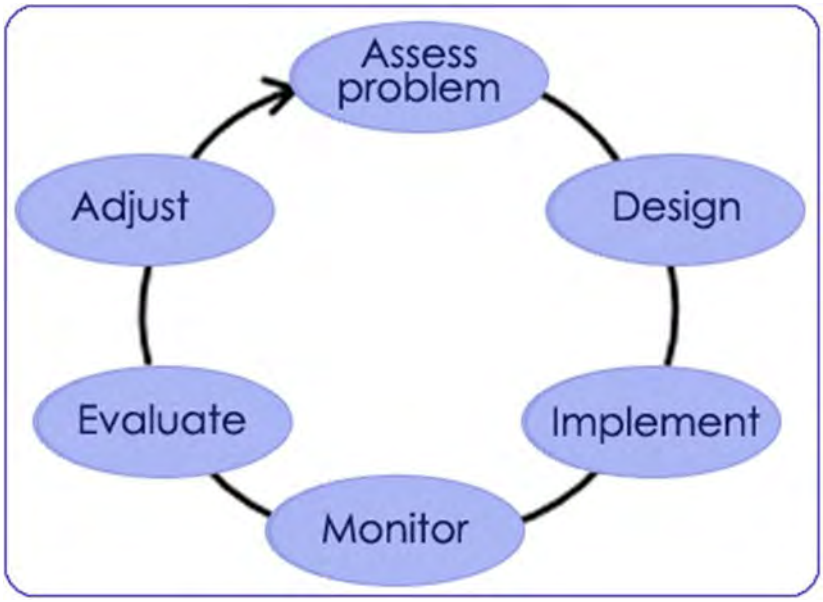
partners to support a watershed management approach to protecting source water. Activities could include introducing vegetation for flood control, increasing recharge to aquifers, including source water protection areas in local climate adaptation initiatives and identifying climate change threats to drinking water. The region plans to work more closely with facility operators and municipalities, which have a range of different capabilities and impacts of concern, to provide them with more support and better climate change information. Potential activities include training facility operators in the use of local climate projections, GIS (Geographic Information Systems) and LiDAR (Light Detection and Ranging) mapping of flood plains. The water program may be able to provide technical support to facilities and municipalities as they consider future audits, upgrades or new construction. Many communities in Region 2 rely on on-site systems like cesspools and septic systems instead of wastewater treatment plants. To support these communities, the water program intends to support state and local partners in conducting an analysis of the susceptibility of septic systems and cesspools to climate change as resources permit. To reduce the strain on facilities and on-site systems, the region seeks to expand its existing green infrastructure program to better support residential and community green infrastructure programs by promoting rain gardens, green roofs, downspouts and other tools. Finally, the water program seeks to improve climate readiness of coastal communities by supporting vulnerability assessments, hazard mitigation, pre-disaster planning and (if applicable), recovery efforts.

These additional actions will help us move toward a climate resilient Region. While Region 2 is not prepared to set a schedule for these additional actions, they will be implemented at the appropriate time and in the appropriate manner in light of multiple factors such as resources, policy, law, actions of other parties, and relationship to other non-adaptation driven work. Some of these actions might be ripe for implementation very soon and others might not be appropriate for the foreseeable future. Region 2 will use the adaptive management framework to assist us in determining if and when to implement these additional actions.

TRACKING PROGRESS OVER TIME: MEASUREMENT & EVALUATION

Adapting to climate change impacts requires an approach that can adjust over time. There is uncertainty related to the global inputs of greenhouse gas emissions that we will experience in the future and related to the resulting local impacts from the range of emissions that could potentially be anticipated. As the region develops strategies to address climate impacts, these actions may need to shift to address changing environmental conditions or we may learn from initiatives and adjust them to seek greater results. EPA will continue to strengthen coordination among programs and with partners in this shifting context. A framework for understanding this approach is **adaptive management**, which calls for developing adaptation strategies based on assessments that are monitored, revisited, redesigned and adjusted over time. This adaptive management approach, employed by the Dept. of Interior, continually calibrates strategies to respond to shifting conditions meanwhile refining and improving the efficacy of strategies over time.

Adaptive Management Process



Source: Department of Interior, 2010

EPA's mission is to protect human health and the environment. In assessing climate hazards, and developing strategies to address them, the broad vision is to ensure that EPA persists in protecting human health and the environment as we experience and adapt to global climate change. In order to track our progress toward meeting the vision of a climate resilient mission for EPA, the following key summary goals have been identified for EPA Region 2 to measure and continue to evaluate over time.

Summary Goals

- Strengthen our emergency preparedness for anticipated climate events.

- Integrate climate impacts into public health information.
- Collaborate with other federal agencies on climate adaptation initiatives.
- Incorporate climate change considerations into appropriate funding activities.
- Conduct outreach on climate impacts and best practices to promote tools and support decision-makers.
- Work with states and Indian nations to integrate climate adaptation into EPA, state and tribal environmental programs.
- Develop assessments of vulnerable infrastructure and sites to increase knowledge of potential climate risks and inform responses.
- Integrate climate adaptation as appropriate into regional programs such as permitting, enforcement and environmental review.
- Partner with communities and other stakeholders to develop and implement climate adaptation strategies that address the climate vulnerabilities of our region.

As the region implements the adaptation plan, we will measure and evaluate progress toward achieving the above goals as part of the adaptive management framework. The region will assess the progress of our priority actions under each of these goals. The lessons learned in this process will inform the adjustment and development of our future strategies as we apply adaptive management to address the risks of climate change to our region.

CONCLUSION

Getting to resilience will require a coordinated effort by an intergovernmental partnership to leverage all the tools we have with our limited program resources. This adaptation plan begins to assess our vulnerabilities and define the starting point for addressing these vulnerabilities. Much of the work will be accomplished in a sustained effort over time.

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U.S. Environmental Protection Agency
Mid-Atlantic Region III

Climate Change Adaptation Implementation Plan

Prepared by the Region III Climate Network Climate Adaptation Working Group

5/30/2014

Disclaimer

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Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the

most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

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Deputy Administrator

September 2013

US EPA Region III – Climate Adaptation Implementation Plan

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Introduction

We live in a world in which the climate is changing. Because many of the environmental outcomes that EPA is working to attain (e.g., clean air, safe drinking water) are sensitive to changes in weather and climate, these changes are posing new challenges to EPA's ability to fulfill its mission of protecting human health and the environment.

To address these challenges, EPA has developed a Climate Change Adaptation Plan. The Adaptation Plan relies on peer-reviewed scientific information and expert judgment to begin to identify vulnerabilities to EPA's mission and goals from climate change. The Adaptation Plan also presents priority actions the Agency will take to integrate climate adaptation planning into its programs, policies, rules, and operations, to ensure they are effective in a changing climate. EPA's focus on climate adaptation is part of a larger federal effort to promote a healthy and prosperous nation that is resilient to a changing climate.

EPA's vision is for the Agency to continue to fulfill its mission of protecting human health and the environment even as the climate changes. In the coming years, EPA will build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

EPA's *Policy Statement on Climate-Change Adaptation*[1], issued in 2011, called for EPA to plan for future changes in climate and to mainstream considerations of climate change into its activities. As part of that effort, the *Policy Statement* called for the Agency to develop and implement a *Climate Change Adaptation Plan*. It also called for each EPA National Environmental Program Office and Regional Office to develop Implementation Plans to explain how they will carry out the work called for in the Agency-wide Plan. To answer this call, EPA Region III has prepared the following Climate-Change Adaptation Implementation Plan. The plan will address how our Regional Office hopes to integrate climate adaptation into our planning and work, as well as, address the cross-EPA priorities identified in the Agency-wide Adaptation Plan. The information and actions listed in this plan has been based on the best available science and will reflect unique regional circumstances. The plan will updated as the Region learns by through the experience of integrating climate change adaptation planning into our activities.

[1] http://www.epa.gov/climatechange/Downloads/impacts-adaptation/adaptation-statement.pdf

Chapter 1: Regional Programmatic Vulnerability Assessment

Background / Approach

This section contains an assessment of the vulnerabilities of selected EPA Region III programs to the impacts of climate change. It builds on the work presented in Part 2 of EPA's Agency-wide Plan, as well as the individual assessments completed by various EPA National Program Offices, eg. Office of Air and Radiation. It summarizes vulnerabilities related to the goals in EPA's FY 2011-2015 Strategic Plan.

This assessment was developed by a working group within the Region III Climate Network. The assessment is based on peer-reviewed literature (climate impacts) and the professional judgment of regional staff (programmatic impacts). Vulnerability assessment is an ongoing process. This plan should be viewed as a living document that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission.

EPA's Five Strategic Goals:

1. Taking Action on Climate Change and Improving Air Quality.
2. Protecting America's Waters.
3. Cleaning Up Communities and Advancing Sustainable Development
4. Ensuring the Safety of Chemicals and Preventing Pollution
5. Enforcing Environmental Laws

Important climate change impacts in the region that will be covered within this assessment include:

- Increased tropospheric ozone pollution
- Increasing extreme temperatures
- Effects on the stratospheric ozone layer
- Increasing heavy precipitation events
- Increasing intensity of hurricanes
- Sea level rise
- Ocean acidification
- Increasing water temperatures
- Increasing risk of floods
- Increased frequency and intensity of wildfires

Regional Description

Region 3, EPA's Mid-Atlantic office, serves Delaware (DE), the District of Columbia (DC), Maryland (MD), Pennsylvania (PA), Virginia (VA), and West Virginia (WV). The Region is unique in that it straddles two different climate regions, as defined by the U.S. Global Change Research Program (USGCRP 2009) – the Northeast (DE, DC, MD, PA, WV, and northern VA) and the

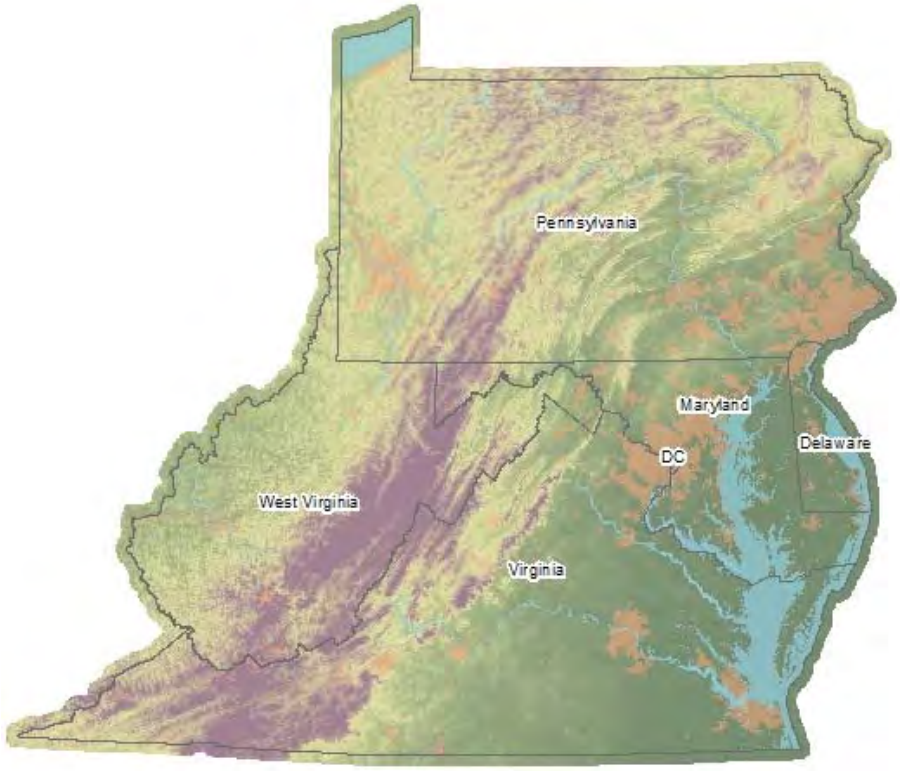
Southeast (southern VA). As a result, the Region represents a diverse climate, which includes snowy winters, vibrant autumns, and extreme events (such as nor'easters and heat waves) characteristic of the Northeast, and mild temperatures and high humidity characteristic of the Southeast. The western portions of Region III (sections of western PA and WV) sometimes mimic USGCRP's Midwest region.

There are diverse agricultural, industrial, and residential sectors within the region that use and impact resources that may be affected by climate change. In addition, the region contains various types of geographic features and sub-regions, including barrier Islands, the Appalachian Mountains, the Piedmont Plateau, the Chesapeake Bay, as well as, the Delaware Bay and Delmarva Peninsula. Coastal areas, estuaries and river systems, including the Chesapeake and Delaware Bays, comprise a significant portion of the Region's population centers. The Region contains a significant amount of coastline and a number of large urban areas (Philadelphia, Baltimore, Washington, DC), with sensitive populations that are particularly vulnerable to the impacts of a changing climate. Outside of the urban areas there are wetlands, uplands, and forested areas with both pristine and degraded ecosystems.

Figure 1. Map of Region III

Expected Changes in Climate

The following is a summary of the range of key impacts and trends that are foreseen in the Region–from the USGCRP June 2009 report.



The Region has significant geographic and climatic diversity within its relatively small area. The character and economy of the Northeast have been shaped by many aspects of its climate including its snowy winters, colorful autumns, and variety of extreme events such as nor'easters, ice storms, and heat waves. This familiar climate has already begun changing in noticeable ways. Since 1970, the annual average temperature in the Northeast has

increased by 2°F, with winter temperatures rising twice as much. Over the next several decades, temperatures in the Northeast are projected to rise an additional 2.5 to 4°F in winter and 1.5 to 3.5°F in summer. By mid-century and beyond, however, today's emissions choices would generate starkly different climate futures; the lower the emissions, the smaller the climatic changes and resulting impacts. Warming has resulted in many other climate-related changes, including:

- More frequent days with temperatures above 90°F
- A longer growing season
- Increased heavy precipitation
- Less winter precipitation falling as snow and more as rain
- Reduced snowpack
- Earlier breakup of winter ice on lakes and rivers
- Earlier spring snowmelt resulting in earlier peak river flows
- Rising sea surface temperatures and sea level

Under a higher emissions scenario:

- Winters in the Northeast are projected to be much shorter with fewer cold days and more precipitation.
- The length of the winter snow season would be reduced by a week or two.
- Cities that today experience few days above 100°F each summer would average 20 such days per summer, while certain cities, such as Philadelphia, would average nearly 30 days over 100°F.
- Sea levels in the Region are projected to rise more than the global average.

Selected Programmatic Climate Change Vulnerabilities

The following section discusses how EPA Region III environmental and human health programs may be vulnerable when faced with the impacts of a changing climate. This initial selection of programmatic vulnerabilities will be described in context of the major goals in EPA's Strategic Plan. The issues described here should not be seen as a complete listing of vulnerabilities to EPA programs. Region III, working with other EPA offices and other regional stakeholders, will periodically update the information and scope of the programmatic vulnerability assessment.

Goal 1: Taking Action on Climate Change and Improving Air Quality

EPA's Air Protection Programs are a part of protecting the Region's citizens from air pollution through implementation of the Clean Air Act (CAA). The Air Protection programs are responsible for ensuring implementation of the National Ambient Air Quality Standards which includes reviewing and enforcing State Implementation Plans and CAA permits. To complement the regulatory work, the Air Protection Programs include energy efficiency, renewable energy, clean diesel, indoor air quality and radon outreach programs to reduce emissions of criteria

pollutants, greenhouse gases and air toxics. Extreme temperatures and increased average temperatures, as well as, extreme flooding events in urban areas are the climate change impacts of most concern for the Air Protection programs. As the air quality in the Region worsens due to climate change impacts; the workload of the Air Protection Programs will increase.

A. Tropospheric ozone is likely to increase in the Mid-Atlantic due to the effects of climate change.

The Mid-Atlantic Region currently has eight nonattainment areas for the 2008 ozone standard, as well as 4 nonattainment areas and twenty-five maintenance areas for the 1997 8-hour ozone standard. With climate change, higher temperatures and weaker air circulation in the United States will lead to more ozone formation even with the same level of emissions of ozone forming chemicals.[2] Various studies project daily ozone levels to increase between two and five parts per billion across the eastern U.S. between 2020 and 2080 due to climate change if no additional emissions controls for ozone precursors are implemented.[3]

In addition to the direct impact of temperature change on ozone formation, an increase in energy demand due to increased temperatures may also lead to a worsening of air quality. Sources in or upwind of the Region may be required to implement additional control measures.

In terms of Regional resources, greater collaboration with our states will be necessary on planning and rule development to address any additional challenges in achieving or maintaining attainment. A majority of the current nonattainment areas in the Mid-Atlantic Region are urban areas with sensitive populations, including Philadelphia, Pittsburgh, Washington D.C., and Baltimore. Exacerbating the health impacts from ozone pollution on urban populations will likely be higher nighttime temperatures expected in urban areas, both as a consequence of climate change but also because of enhanced effects from urban heat islands.[4]

Climate change also has the potential to increase the length of the ozone season.[5] Currently, the ozone season runs from April through October. During this period, daily ozone levels are recorded and reviewed. An increase in the length of the ozone season would require a longer reporting period, translating to more time spent for data reviews in the Region.

B. Particulate matter levels may be affected through changes in the frequency or intensity of wildfires.

In the Mid-Atlantic Region, there are currently 8 nonattainment areas for the 2006 24-hour PM2.5 standard and 16 nonattainment areas for the 1997 annual PM2.5 standard. While the

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[2] Denman, K.L., et al. (2007). Couplings Between Changes in the Climate System and Biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
[3] IPCC Fourth Assessment, GCAQ-EPA
[4] IPCC Fourth Assessment
[5] Ibid

impact of climate change on ambient PM2.5 levels remains somewhat uncertain, there is evidence indicating that climate change will impact PM levels through changes in the frequency or intensity of wildfires.[6]

In 2008, monitors in the Norfolk area of Virginia experienced 24-hour PM2.5 levels four times (83 ug/m3) the standard due to wildfires in North Carolina. While these fires were not caused by climate change, this example portrays the impact of fires on PM levels in the region, and is indicative of the potential health and environmental concerns.

The adaptive capacity of Region 3 for this issue is limited, as this data can be treated as an "exceptional event" under the National Ambient Air Quality Standards. If determined to be due to an exceptional event, monitoring data during fire events may be ignored when determining attainment.

C. Climate change may worsen and increase the exposure to indoor air problems in the Mid-Atlantic.

Existing indoor environmental problems may worsen and new ones may be introduced as climate change alters the frequency and severity of adverse outdoor conditions.[7]

Extreme temperatures will very likely increase and heavy precipitation events will likely increase as a result of climate change[8], which, along with increased dampness, moisture, and flooding affecting homes and occupied buildings, may contribute to indoor environmental problems in the Mid-Atlantic.[9]

Frequent breakdowns in a building's protective envelope, as a result of extreme weather conditions, may lead to water infiltration into indoor space, increased dampness, and, in turn, increased exposure to mold and other biological contaminants.[10]

Changes in the emergence, evolution, and geographic ranges of pests, infectious agents, and disease vectors may lead to shifting patterns of indoor exposure to pesticides as occupants and building owners respond to new infestations.[11]

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[6] Committee on Environment and Natural Resources, "Scientific Assessment of the Effects of Global Change on the United States" (Committee on Environment and Natural Resources of the National Science and Technology Council, U.S. Climate Change Science Program, 2008), http://www.climatescience.gov/Library/scientific-assessment/Scientific-AssessmentFINAL.pdf.

[7] Institute of Medicine, *Climate Change, the Indoor Environment, and Health* (Washington, DC: The National Academies Press, 2011).

[8] IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

[9] Institute of Medicine, *Climate Change, the Indoor Environment, and Health* (Washington, DC: The National Academies Press, 2011).

[10] Ibid.

[11] Ibid.

Residents may weatherize buildings to increase comfort and save energy. Although in general these actions should be encouraged, this may lead to a reduction in ventilation and an increase in indoor environmental pollutants unless measures are taken to preserve or improve indoor air quality.[12] EPA has developed practical guidance for improving or maintaining indoor environmental quality during home energy upgrades or remodeling in single-family homes and schools. EPA's guidance and protocols may need to be revised to include state and local considerations for projected climatic changes. In addition, these programs may need to increase partnerships with other agencies to address training needs and workforce development for building owners, managers, and others, as well as develop new tracking mechanisms to assess the effectiveness of weatherization and remodeling techniques as they relate to indoor environmental quality.

The Mid-Atlantic Region is comprised of several large urban areas, which are very likely to see increases in the risk of illness and death related to extreme heat and heat waves. For example, Philadelphia is projected to jump from an average of just a few days above 100°F each summer to nearly 30 days above 100°F each summer by late this century, under a higher emissions scenario. The elderly and those with existing health problems are particularly vulnerable.[13] Increased frequency of extreme weather events may result in power outages, leading to increased exposure to potentially dangerous indoor conditions.[14]

Region III may need to build its adaptive capacity to these increasing and changing health risks through its indoor air quality programs, resources, and public outreach and assistance. Partnerships between Region III and stakeholders, such as state/local governments, non-profits, etc., will need to be strengthened in order to inform affected populations on how to adapt to higher temperatures. Strengthening ties between the Region's energy efficiency and indoor air quality programs will be necessary in order to address the relationship between building ventilation during efficiency retrofits and potential, resulting indoor air problems.

D. Climate change may alter the effects of and strategic priorities within EPA Region III regulatory and voluntary programs to help restore the stratospheric ozone layer.

Climate change will likely have effects on the stratospheric ozone layer; however, the interactions between the changing climate and ozone layer are complex. Climate change affects the ozone layer through changes in chemical transport, atmospheric composition and temperature. In turn, changes in stratospheric ozone can have implications for the weather

[12] Ibid.

[13] USGCRP, 2009: *Global Climate Change Impacts in the United States*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

[14] Institute of Medicine, *Climate Change, the Indoor Environment, and Health* (Washington, DC: The National Academies Press, 2011).

and climate of the troposphere. Climate change may exacerbate the health effects of ozone layer damage at some latitudes and mitigate them at others.[15]

In order to build adaptive capacity with respect to this vulnerability, Region III may need to heighten public awareness of the health risks of ultraviolet (UV) radiation exposure, through existing EPA partnership programs such as SunWise. Climate change may also lead to an increase in the use of cooling devices, such as air conditioners, which contain ozone depleting substances (ODSs) or ODS substitutes. Region 3 may need to make changes to its current efforts to promote programs such as GreenChill and Responsible Appliance Disposal in the Mid-Atlantic, as a result.

E. Climate change may impact energy production and efficiency in the Mid-Atlantic.

Rising temperatures, as a result of climate change, are expected to increase energy requirements for cooling and decrease energy requirements for heating. The former will result in significant increases in electricity use and higher peak demand. The electricity grid is also vulnerable to the effects of climate change, such as extreme weather events and peak demand increases resulting from rising temperatures, which could cause interruptions in the electric power supply.[16] The Mid-Atlantic's urban areas and sensitive populations, such as the elderly, are particularly vulnerable to power interruptions during extreme weather events like heat waves.

F. Extreme weather events may impact the regional monitoring systems.

Extreme weather events, including severe winds, flooding and lightning, could cause damage to the PM2.5 and RADNET monitoring systems in Region III. The standard operating procedure for deploying monitors currently includes consideration of extreme weather. The Region will need to continue following the monitoring SOP to ensure that monitors can be safely accessed and operated.

G. Scientific understanding related to ways that climate change may affect the interactions of sulfur, nitrogen, and mercury deposition with ecosystems is evolving.

While there is limited scientific evidence on this topic, additional research is underway to better understand how patterns in the atmospheric deposition of sulfur, nitrogen, and mercury with projected changes in the climate and carbon cycle will affect ecosystem growth, species

[15] World Meteorological Organization, Scientific Assessment of Ozone Depletion: 2010, Global Ozone Research and Monitoring Project—Report No. 52 (Geneva, Switzerland, 2011). Note: the word "expected" is used in the report to characterize projected climate change impacts on the stratospheric ozone layer. For purposes of this assessment, the word "likely" has been used as a proxy for "expected."

[16] USGCRP, 2009: *Global Climate Change Impacts in the United States*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

changes, surface water chemistry, and mercury methylation and bioaccumulation.[17] The potential impacts could have consequences for the effectiveness of ecosystem protection from Agency emissions reduction programs.

Goal 2. Protecting America's Waters

A. Flooding from increasingly frequent and intense storm events

In the Northeast, the annual number of days with very heavy precipitation has increased in the past 50 years. Flooding often occurs when heavy precipitation persists for days to weeks in small and large watershed. Precipitation and runoff are likely to increase in the Northeast in winter and spring. Increases in the impacts from precipitation and flooding may damage regional drinking and wastewater facilities and may exacerbate non-point source pollution water quality issues in reservoirs, wetlands, streams and rivers within the Region.

B. Coastal wetland loss

Coastal wetlands often migrate landward, disappear, or change in type in response to sea level rise through accretion. Dense coastal development is often protected by shoreline armoring, which prevents wetland migration and leads to loss of submerged wetlands. Coastal wetlands are essential for providing storm surge buffers, preserving estuarine water quality as well as supporting economically important fish and wildlife habitat.

C. Threats to coastal water-related infrastructure

The densely populated coasts of the Northeast face substantial increases in the extent and frequency of storm surge, coastal flooding, erosion, and property damage. Much of this coastline is exceptionally vulnerable to sea-level rise and related impacts.

D. Water Quality impacts from climate changes

Shallow groundwater aquifers that exchange water with streams are likely to be the most sensitive part of the groundwater system to climate change. Small reductions in groundwater levels can lead to large reductions in stream flow and increases in groundwater levels can increase stream flow. Further, the interface between streams and groundwater is an important site for pollution removal by microorganisms. Their activity may change in response to increased temperature and increased or decreased streamflow as climate changes, this may affect water quality and affect Clean Water Act goals related to water bodies in non-attainment and affect TMDL development.

A specific mid-Atlantic water quality concerns is the Delaware River Basin, which includes portions of New York, Pennsylvania, New Jersey, and Delaware that drain to the 330-mile long Delaware River and Bay. The basin's total area is over 13,500 square miles, and over 15 million people rely on its water resources for potable, industrial, and agricultural use. The main focal

[17] Burns, D.A., Lynch, J.A., Cosby, B.J., Fenn, M.E., Baron, J.S., US EPA Clean Air Markets Div., 2011: National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment, National Science and Technology Council, Washington, DC, 114 p.

points of climate change in the basin include increased temperature, changes in precipitation patterns, and sea level rise. The Delaware River Basin Commission monitors the salt line location as it fluctuates along the tidal Delaware River as stream flows increase or decrease in response to changing inflows, which either dilute or concentrate chlorides in the river. The salt line location plays an important role in the Delaware River Basin water quality and drought management programs because upstream migration of brackish water from the Delaware Bay during low-flow and drought conditions could increase sodium chloride concentrations in public water supplies, presenting a public health concern. *(Courtesy Delaware River Basin Commission State of the Basin Report 2008)* As salt-laced water moves upriver, it increases corrosion control costs for surface water users, particularly industry, and can raise the treatment costs for public water suppliers. Salinity levels also affect aquatic living resources. Normal location of the salt line is the mouth of the Delaware Bay, or river mile 67, but at times will move further north. During the summer months of 1999, the salt line moved to river mile 88 and during the 1960's 'drought of record' the salt line reached its farthest recorded upstream location at river mile 102, just 8 miles below important drinking water intakes in PA and NJ.

E. Severe flooding from sea-level rise and extreme precipitation is likely to increase

Sea-level rise is expected to increase saltwater intrusion into coastal freshwater aquifers, making some unusable without desalination. Increased evaporation or reduced recharge (drought) into coastal aquifers exacerbates saltwater intrusion. Like water quality, research on the impacts of climate change on groundwater, ecosystems, and infrastructure has been minimal and remedies may be difficult.

F. Water & Energy Infrastructure

Many water systems in the Northeast are already taxed due to aging infrastructure, population increases, and competition among water needs for agriculture, municipal use, recreation, and ecosystems. Extreme precipitation events may exacerbate existing problems in many cities in the Northeast, especially combined sewer systems. Drinking water and sewer infrastructure is expensive to build and maintain. Climate change may present a new set of challenges for designing upgrades to the nation's drinking water and wastewater infrastructure.

Also, a significant fraction of the region's energy infrastructure is located near the coasts and tide influenced Bays, from power plants, to oil refineries, to facilities that receive oil and gas deliveries. Rising sea levels are likely to lead to direct losses, such as equipment damage from flooding or erosion, and indirect effects, such as the costs of raising vulnerable assets to higher levels or building new facilities farther inland.

G. Changes in aquatic ecosystems/species composition and distribution

Various forces of climate change at the coasts pose a complex array of management challenges and adaptation requirements. For example, relative sea level is expected to rise at least two feet in Chesapeake Bay (located between Maryland and Virginia) where the land is subsiding,

threatening portions of cities, inhabited islands, most tidal wetlands, and other low-lying regions. Climate change also may affect the volume of the bay, salinity distribution and circulation, as will changes in precipitation and freshwater runoff. These changes will affect seasonal oxygen depletion and efforts to reduce the agricultural nitrogen runoff into water bodies.

	Impacts in Northeast (DE,DC,MD,PA,WV) and in Southeast (VA)				
		Northeast		***Southeast***	
		DW	**WW**	**DW**	**WW**
Drought	Reduced Groundwater recharge	√		√ √	
	Lower Lake and Reservoir Levels	√		√ √	
	Changes in seasonal runoff & loss of snowpack	√ √		√	
Water Quality	Low flow conditions & altered water quality		√ √		√
	Saltwater intrusion into aquifers	√		√ √	
	Altered surface water quality	√	√	√ √	√ √
Floods	High flow events and flooding	√ √	√ √	√	√
	Flooding from coastal storm surges	√ √	√ √	√ √	√ √
Ecosystem Changes	Loss of coastal landforms / wetlands	√ √	√ √	√ √	√ √
	Increased fire risk & altered vegetation	√	√	√ √	√ √
Service Demand &	Volume & temperature challenges	√ √	√ √	√	√
	Changes in agricultural water demand	√		√	
	Changes in energy sector needs	√		√	
	Changes in energy needs of utilities	√ √	√ √	√ √	√ √

Figure 2: Comparison of potential Climate Change impacts for the North and Southeast on water infrastructure, specifically, Drinking Water (DW) and Waste Water (WW).

Warmer Chesapeake Bay waters will make survival difficult for northern species such as eelgrass and soft clams, while allowing southern species and invasive species transported in ships' ballast water to move in and change the mix of species that are caught and must be managed. Additionally, more acidic waters resulting from rising carbon dioxide levels will make it difficult for oysters to build their shells and will complicate the recovery of this key species.

H. Vulnerability & Uncertainty related to impacts to Water in the Region:

Water temperature, precipitation, and sea level are critical variables in almost everything the Region does in the water program, from setting water quality standards, developing TMDLs, and issuing NPDES permits to helping build drinking water and wastewater treatment infrastructure. Having better data and information on how much and how fast water temperature will increase, how extreme storms may be, and how high and fast sea level will rise will enable Region to fulfill statutory and regulatory responsibilities. Developing consistent scientific methods and robust datasets to support long-term policy decisions on climate change vulnerability assessments and adaptation planning will help inform these decisions.

Goal 3. Cleaning Up Communities and Advancing Sustainable Development

EPA's waste and land clean-up programs play a crucial role in protecting public health and the environment from exposure to hazardous materials, remediating contaminated property, and

making these properties available for reuse. Changes in climate should be taken into consideration in order for the Region to continue to serve these important functions. It may be necessary to design site-specific clean-up or remedy that can withstand the projected climate change impacts and which may impact the Region's ability to exercise statutory authority and may add cost. Sea-level rise, storm and flood events, and increased ambient temperatures are climate change impacts of particular concern for the programmatic focus areas – Restoring and Preserving Land and Emergency Response.

A. Restoring and Preserving Land

Increased flooding and sea-level rise may increase the risk of contaminant releases from vulnerable RCRA Corrective Action sites, Superfund sites, Brownfield sites, LUST sites, other contaminated sites, and landfills. Flooding from more intense and frequent storms and extreme storm events could affect the migration and management of contaminants. Sea-level rise can lead to inundation and salt water intrusion which may impact the performance of the remedies and cause the transport of contaminants at sites in coastal areas. Contaminant migration could also occur after prolonged power loss at cleanup sites with pump and treat systems dependent on grid electricity.

Impacts may be most severe for cleanup sites that are not yet completed; however sites with waste in place following a cleanup and permitted facilities that manage hazardous materials may also be vulnerable. Sites with on-site containment or treatment remedies within the 100 or 500 year flood plain of a surface water body and/or within the sea-level rise zone 1.5 meters above high tide are of particular concern in Region III. Sediment sites with in situ capping remedies are vulnerable to flood regime changes and re-suspension and deposition of contaminated sediment. Flooding from storms and inundation due to sea level rise could jeopardize land revitalization efforts including renewable energy generation, greener cleanups, and ecological revitalization projects, as well as other site reuse or redevelopment plans at Brownfield sites and completed Superfund Sites.

Increased ambient temperatures and extreme heat may impact the design and operation of remediation systems. Cleanup sites with waste in place phytoremediation, or a vegetative cap may be vulnerable in areas that experience drought or changing plant hardiness zones. Slowed growth rates during heat waves could impact the success of the remedy or revitalization effort, and excessive vegetation loss could lead to erosion. Coastal, stream, and mountain ridge top habitats are examples of ecosystems in Region 3 that are vulnerable to increases in ambient temperature.

B. Emergency Response

As storm and flood events increase in frequency and severity, emergency responses to hazardous materials release and oil spills may also increase. Financial constraints and response capacity for Emergency Response staff and Response Support Corps are potential vulnerabilities in Region III. Existing emergency planning and chemical containment strategies at oil and chemical facilities may not be sufficient. Current landfill capacity may also be insufficient to handle surges in disposal of hazardous and municipal wastes generated from extreme storm

events. Availability of utilities and transportation infrastructure may be limited as a result of increased impacts to those systems. Power loss and blocked roads can hamper emergency responses.

Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution

A. Use of Toxic chemicals:

A changing climate will likely result in changes in the timing and location of planting crops, which in turn affects the volume and timing of agricultural chemical use. This change in agricultural chemical use could impact the appropriate risk management decisions made by EPA Pesticides and Toxic Substances Program, particularly with regard to the protection of migrant farm workers.

Changes in temperature and precipitation levels are expected to lead to the increase in mosquitoes and other pests controlled by regulated pesticides. An increase in cases of the West Nile Virus and other diseases carried by mosquitoes may lead to an increase in calls by the public for the use of pesticides to control these disease vectors. This may in turn affect the workload of the EPA Pesticides program.

B. Storage of Toxic Chemicals:

Flooding from more intense and frequent storms and extreme events could compromise chemical containment strategies at oil facilities and toxic chemical and pesticide storage facilities. Facilities located in coastal areas and/or within the 100-500 year flood plain of a surface water body are of concern to Region III. If these facilities do not properly manage the storage of these chemicals and/or store them at higher elevations, the extreme weather events that are expected as a result of climate change may result in the release of toxic chemicals into the environment, including to surface waters via storm water discharges.

C. Exposure to Toxic Chemicals from Demolition/Renovation Activities:

The extreme weather events that are likely to occur as a result of climate change (e.g., high winds, heavy precipitation events) may damage community infrastructure (e.g., schools and child care facilities) and residential homes. As a result, there may be an increased risk of exposure to lead, asbestos, and PCBs if buildings are renovated or demolished as part of the recovery efforts.

Assessment of Potential Vulnerabilities for Region III Managed Facilities and Operations

Results from climate change include an increase in extreme temperatures, droughts, intensity of precipitation and ground level ozone pollution which will affect Region III facilities and employees to varying degrees depending on their location. Employee impacts such as an

increase in heat-related illness, absenteeism, exposure to vector-borne diseases and mold could result. In addition, localized flooding of roads and infrastructure could affect the commute and business travel of our employees resulting in tardiness and reduced efficiency. Facility impacts such as an increase in electricity use and decrease in indoor air quality are also possible.

As discussed in the Expected Changes in Climate section of this plan, Philadelphia could average more than thirty days over 100˚ F in the future. This could lead to an increase in heat-related illnesses for our employees especially, older employees and workers doing field work who do not or can't reduce their exposure by limiting exertion and time outdoors due to mission requirements. More frequent hot summer days can also worsen air pollution, especially in urban areas and threaten the health of vulnerable employees. This could increase absenteeism and/or reduce the productivity of our staff. Higher temperatures will likely cause an increase in electricity use and cost in our building to power air conditioning. This increased use could stress the power supply grid resulting in brown outs, black outs and the need to use backup power generators.

As discussed in more detail in the Goal 1 section of this plan, climate change may worsen and increase exposure to indoor air quality problems in our buildings from dampness and mold, and expose occupants to different pests, infectious agents and disease vectors, as well as any pesticides applied to address these infestations. As discussed in more detail in the Goal 2 section of this plan, an increase in the frequency and intensity of heavy precipitation events, that have already been experienced, is projected to be worse in the future, leading to more frequent flooding and impact our road and mass transit systems. Climate change impacts, including increased severe weather, may affect the Region's Continuity of Operations Plan (COOP) that describes efforts to prepare and react to issues affecting the operation of our facilities. Unique or site specific vulnerabilities are described below.

Philadelphia Office located at 1650 Arch Street, Philadelphia, Pennsylvania

Over 90% of our approximately nine hundred Philadelphia based employees use mass transit to commute to work. Any impact to this system is a large vulnerability that on any given day will affect hundreds of our employee's ability to get to work and for the Region's ability to function and carry out its mission. A recent example of this vulnerability occurred when our office was closed on October 29 -30, 2012 as a result of a shutdown of mass transit in Philadelphia due to impacts from Hurricane Sandy.

Past periods of drought in the Delaware watershed have resulted in salt water intrusion causing concern for the Philadelphia drinking water supply intake on the tidal Delaware River north of the city. Expected sea level rise from climate change may exacerbate this vulnerability in the future.

Environmental Science Center (ESC) located at 701 Mapes Road, Fort Meade, Maryland

Vulnerability to flooding of the Environmental Science Building should not be an issue since building site has a very robust stormwater runoff system that directs rain water falling on approximately 70% of the site to a large capacity infiltration basin that can capture all the volume produced by a two year storm and almost all the volume of a ten year storm before there would be any discharge. However, localized flooding of area roads could still be an issue for the approximately one hundred sixty employees who must commute to the laboratory to do their work and have little if any ability to work from alternate locations.

Wheeling Office located at 1060 Chapline Street, Wheeling, West Virginia

Despite its location which is less than a one quarter mile from the Ohio River with an upstream drainage area of approximately 25,030 square miles, flooding of the Wheeling office is not expected to be a problem. The office is over fifty feet above the river level and has never been impacted by historic flood events associated with hurricanes in the drainage area or other severe weather. As discussed above, localized flooding of area roads could still be an issue for the approximately 25 Wheeling office employees on their commute to work and for business travel.

Chesapeake Bay Office located at 410 Severn Avenue, Annapolis, Maryland

Our Chesapeake Bay office is located in a marina office complex directly on the water in a watershed that contains over one hundred fifty major rivers and streams and drains approximately 64,000 square miles. An increase flood risk is likely at this facility but mostly impacting storage and parking areas that are at a lower elevation. The offices in the building are approximately eleven feet above the Bay water level. A predicted increase in the intensity of hurricanes could impact the office directly due to its proximity to the coast and through storm surge impacting the Chesapeake Bay. As discussed in more detail in the Goal 2 section of this plan, sea level rise is also a threat to this facility as it will compound the effect of heavy precipitation, increase in flooding and storm surge.

Vulnerable Populations

Certain parts of the population, such as children, the elderly, minorities, the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society.

This Implementation 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 Plan is

conducted, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events (e.g., Hurricane Katrina and Superstorm Sandy) and the subsequent recovery efforts.

An important facet of climate adaptation are potential impacts to the health of the Region's vulnerable populations. In areas where populations carries a heavy burden of disease or poverty, the populations have less resiliency and the effects of climate change may be more severe. The connections between our climate and human health have been known for years, although now the changing climate has compelled scientist to re-examine these relationships (Jonathan A. Patz 2000).

Populations such as children may be more vulnerable to both direct and indirect health effects of climate change (Shea and Health 2007). Other vulnerable populations include the elderly, the poor, individuals with co-morbidities, and the disabled.

These key impacts to the environment involve most of the programs in the Region (EPA. 2010). Warmer temperatures will increase morbidity and mortality associated with both extreme heat and cold weather patterns. This changing climate is also expected to affect air quality, threatening the health of vulnerable populations, including the very young, the elderly, outdoor workers, and those without access to air conditioning or adequate health care (USGCRP 2009). An increase in the strength and frequency of extreme events (droughts, storms, and floods) will likely increase the threat to overall human health and safety (EPA. 2010). These patterns of temperature and precipitation can affect the seasons for pollen and the range of specific diseases in the Region including Lyme disease and West Nile virus. The inner cities within Region 3 will also pose many challenges to EPA as well as our partners in local government due to urban heat island effect. The vulnerability of urban areas to climate change involves consideration of the sensitivity of urban systems and people living within them to climate change and other interacting stressors, their exposure to those stressors, and the ability of systems and people to adapt to present and future changes.

Chapter 2: DRAFT Regional Priority Actions for Climate Adaptation

Introduction

Based on the vulnerabilities described in the previous chapter, existing Regional priorities, and the current understanding of potential adaptation opportunities, the Region's Climate Adaptation workgroup identified "Priority Actions" that may assist EPA in accomplishing its mission and operate at multiple locations in the face of a changing climate. Priority Actions are listed below and categorized according to their relevance to programmatic goals in EPA's current strategic plan. An additional list of cross-cutting actions are also proposed and will support multiple strategic plan goals or build general capacity for future work on climate

adaptation. Proposed actions or activities will be reviewed by the Office of Regional Counsel to assure compliance with existing statutes, regulations, and guidance.

The Region will continue to identify other vulnerabilities that may occur and may need to change the scope or focus of ongoing priority actions over time. The workgroup used a simple set of criteria to identify and prioritize potential actions either developed from the vulnerability assessment or suggested by a diverse set of stakeholders. The workgroup developed criteria to *qualitatively* rank possible actions. The following is a summary of the criteria used to determine the priority actions included in this plan:

Criteria for EPA Mid-Atlantic Region Climate Adaptation Implementation Plan Priority Actions

- Likelihood, timeframe, and anticipated severity of specific projected impacts to regional programs or objectives.
- Ability to successfully implement a proposed action.
- Alignment with any existing environmental priorities (i.e. national, regional, divisional, programmatic).
- Alignment with priorities of key external partners and/or stakeholders (i.e. State and municipal governments).
- Ability for the action to build institutional capacity within EPA to better identify vulnerabilities and actions that will successfully address those vulnerabilities over time.
- Actions that may directly support one or more of the Agency-wide Strategic Measures for Climate Adaptation.

Priority Actions, Cross-Cutting:

- Develop an interactive Climate Knowledge Base, including GIS maps and data based on information from the Programmatic Vulnerability Assessment, training materials, project descriptions, and staff contacts for use by the region.
- Engage with local government stakeholders in the region to better understand the adaptation planning needs of cities and urban areas. Develop, maintain, and promote a simple “adaptation toolkit” with consolidated information and resources for urban areas within the region.
- Work with EPA HQ to develop general Climate Impacts and Adaptation training materials and make them widely available.
- Continue to develop the existing Region III Climate Change Strategy and Workplan and align it with this Climate Adaptation Implementation Plan.
- Work with the Office of Federal Activities to determine how to address climate adaptation issues under the National Environmental Policy Act (NEPA).

- Develop a continuous improvement process for climate adaption implementation planning using the "Plan Do Check Act" framework currently used in the Region's multi-site Environmental Management System (EMS).
- Build capacity internally through general education as well as targeted training to ensure that all employees are aware of climate change impacts on EPA programs and begin to integrate adaptation measures into their work.
- Participate in EPA regional and national workgroups as appropriate to assist the national program in revising EPA guidance and regulations and implement as appropriate.

Priority Actions, Goal 1: Taking Action on Climate Change and Improving Air Quality:

- Strengthen and form partnerships to increase outreach on indoor air quality, ultraviolent radiation exposure, and energy efficiency to respond to increased risks due to climate change impacts.
- Train additional staff to respond to indoor air quality calls/questions from the public due to the increased number of calls after extreme events and flooding.
- Build internal capacity to be able to incorporate climate change data into modeling and emissions analyses. Examples include 1) determining emission trends for sources associated with climate change impacts (frequent and more intense storms, more high temperature days), such as portable electric generators and peaking power plants, and 2) updating current datasets used for dispersion modeling to take into account human activities like sprawl and meteorological datasets (rainfall patterns, temperatures, etc).
- Strengthen partnerships to encourage ozone-tolerant urban tree planting, as well as, white and green roofs, to reduce pollution and the urban heat island.
- Work with other Regions and HQ air program managers to develop a strategy, in context to other programmatic priorities, on how to incorporate climate adaptation into air quality programs (e.g., SIP, permits).
- After discussions with HQ and Regions, incorporate climate change impacts into comments on permit applications, where appropriate.
- Consider integrated modeling approaches to incorporate new research on changes in air deposition to water bodies and land due to climate changes.
- Leverage existing climate and energy partnership programs, such as ENERGY STAR, Green Power Partnership, and Combined Heat and Power (CHP) Partnership to build adaptive capacity to address energy related vulnerabilities to climate impacts and extreme weather.

Priority Actions, Goal 2 Protecting America's Waters:

- Include climate change parameters in next Chesapeake Bay TMDL and associated implementation plans.

- Work with states and source water protection partners to raise awareness of climate change impacts and assist states and water protection partners in incorporating climate adaptation actions into source water assessments and protection plans.
- Promote awareness and encourage use of the Climate Ready Water Utilities Tools with an aim toward incorporating climate change impacts into resiliency planning by drinking water and wastewater utilities.
- Messaging to decision makers to encourage utilities to make sustainable investments, including improvements to prepare utilities for extreme weather events.
- Continue work in the Anacostia area of DC, Patapsco area of Baltimore and greater Philadelphia Area/lower Delaware River watershed through the Urban Waters Federal Partnership (UWFP) to assist with and leverage our partners' ongoing climate adaptation planning activities.
- Support Maryland Inland Bays and Delaware Coastal Bays as they incorporate climate change and adaptation into their amended Comprehensive Management Plans.
- Incorporate adaptation and resiliency principles into ongoing "greening" discussions with the U.S. Department of Transportation.
- Host climate change workshops for Region III water utilities to broaden the need for resiliency and awareness of available planning tools.
- Begin discussions with state water quality standards managers on possible climate change impacts on current and future water quality standards.
- Work with the EPA's Office of Water (OW) as a pilot region to develop a framework and inventory of relative wetland vulnerabilities, at multiple scales, based on integration of information on vulnerability assessment methods and wetlands classification systems. This framework will use relevant information from OW's CWA Section 404, HWI, and NWCA program efforts, and the results will be framed to inform on best approaches for development of further guidance for integrating climate change considerations into each of these program's practices.
- Work with the EPA's Office of Research and Development (ORD), along with regional state bioassessment scientists, to lay the foundation for a regional reference/climate change monitoring network in the Mid Atlantic, including a vulnerability analysis for streams.
- Work with the EPA's Office of Wetlands, Oceans, and Watersheds to include adaptation actions in the future work plans for our Wetlands permitting and enforcement programs.
- Continue efforts with the Partnership for the Delaware Estuary on climate change adaption planning by expanding upon the work of the climate change adaptation plan of 2010 developed through Climate Ready Estuaries Funding.

Priority Actions, Goal 3 Cleaning Up America's Communities & Advancing Sustainable Development:

- Educate staff to incorporate changing climate into decision making and long term planning (Removal & Remedial cleanups, RE-Powering America, Brownfields grants, Response Support Corps, Emergency Response, RCRA, Oil and Risk Management Program).

- Work with EPA's Office of Solid Waste and Emergency Response to develop a national strategy to ensure Oil and Risk Management Program facilities prepare for climate change and ensure that spill prevention and response strategies at facilities are sufficient for extreme events.
- Prepare to dedicate additional resources including funding and staffing for Emergency Response and Response Support Corps.
- Work with states to assess landfill capacity for surges in disposal of hazardous and municipal waste generated by extreme storm events.
- Identify RCRA Corrective Action, Superfund, Brownfields, LUST, Oil and Risk Management Program facilities, and other OSWER sites within 100 and 500 year FEMA flood plains; within the sea level rise zone 1.5 meters above high tide; and within NOAA "SLOSH" (Sea, Lake and Overland Surges from Hurricanes) model storm surge zones to assist in preparedness for extreme storm events.
- Identify sites within the region that have vulnerable ecosystems—coastal, stream, mountain ridge top habitats.
- Perform vulnerability analyses during site investigation, cleanup design, operations and maintenance, five year reviews, etc. Encourage states to consider doing the same for state-led states.
- Incorporate other OSWER adaptation implementation priorities, as applicable to Region III.
- Begin work to integrate climate adaptation into pertinent financial assurance mechanisms.

Priority Actions, Goal 4 Ensuring Safety of Chemicals & Preventing Pollution:

- Consider climate change in the administration of Pollution Prevention (P2) and associated sustainability initiatives. Assist the Region in identifying the most sustainable approaches for mitigating and adapting to climate change through emphasizing the lifecycle and risk reduction aspects of P2.
- Participate in EPA regional and national workgroups on such issues as appropriate to assist the national program in revising EPA guidance and regulations.
- Develop and deliver targeted training on Climate Adaptation to staff and managers working on EPA pesticide programs.
- Train staff and managers working on demolition, renovation, and disaster debris programs on climate adaptation and chemical risk issues.
- Incorporate other OSCPP adaptation implementation priorities, as applicable to Region III.
- Integrate climate adaptation into pertinent financial assistance mechanisms.

Priority Actions; Region III Managed Facilities and Operations:

- Determine if policy, guidance or email notification is warranted to those employees and contractors conducting field work during excessive heat warning or ozone action days.

- Determine the number of employees that are currently using flexiplace and can work from alternate locations.
- Determine the number of employees who lack the ability to use flexiplace due to resources or their job function.
- Determine if a COOP is needed for the Chesapeake Bay Program Office and Wheeling Office.
- Determine if special criteria should be developed for the Chesapeake Bay Program Office employees to warn them of the potential for office or localized flooding.

Chapter 3: Measurement and Evaluation

This section will describe how Region III will update the information and analysis in this implementation plan, evaluate the success of any activities undertaken, and continually improve the process of programmatic climate adaptation over time. Since one of the goals of the plan is to build adaptive capacity within EPA Region III programs the initial measurement and evaluation plan will focus on the capacity building elements of the plan, as well as, developing and refining the Region's approach to evaluation. This approach utilize along three pathways and use existing systems and workgroups whenever possible.

Adaptive Management through Continuous Improvement

The central task will be to create a Continuous Improvement Process, similar to the *Plan, Do, Check, Act* process used in our regional Environmental Management System, to adaptively manage the execution and management of the Implementation Plan. This process will seek to include a schedule for updates to the climate vulnerabilities, adaptation objectives, and activities in the plan, a set of measurable goals, a management review, and a method for sharing the results of the plan with our stakeholders.

Integration with Existing Regional Climate Strategy

The second pathway will be the integration of this implementation plan within the existing (internal) Region III Climate Change Strategy. In practical terms, this means the objectives and activities will be the same for both and all activity tracking and measurement will occur using the existing the workplan process developed for the Strategy. Oversight will be the responsibility of the Climate Change Senior Steering Committee and the cross-divisional Regional Climate Network Workgroup will work to implement the plan. The current workplan includes individual project management tracking and metrics for each activity. Currently, these metrics focus on the outputs of work. For example, we will track the number of training programs offered to regional staff and the number of participants. The workgroup responsible for this actions contained in this implementation plan will revise the plan annually.

One objective of future work for the planning process will be to identify metrics that measure outcomes. For example, a questionnaire was provided to regional employees to determine their level of understanding regarding climate change to determine appropriate training. We have used the information from the questionnaire to create a qualitative baseline to eventually measure the outcomes of our ongoing capacity building efforts.

Develop Tools for Evaluation and Engagement

The third pathway will be the creation or use of specific tools to help with the important task of evaluating progress, measuring the results of activities, and making changes and improvements as necessary. This toolbox will need to include improvements to vulnerability analyses in addition to tools focused on helping individual programs implement priority actions. Tools under consideration include: Developing Logic Models similar to those used by EPA's Office of Water, an Interactive Knowledge Base for mapping expected impacts and vulnerabilities, and the use of decision support tools developed by EPA national program offices.

Another key aspect of the plan will be a robust engagement process with key external stakeholders to both understand their approaches to measurement and evaluation and collaborate on the development of evaluation methodology and tools for our shared priorities. In addition, this engagement process will include targeted efforts to engage with representatives from vulnerable populations with the Region.

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US EPA Region 4

Adaptation Implementation Plan

Disclaimer

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Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

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PART 1

INTRODUCTION & BACKGROUND

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I. Background and Direction

Pursuant to Executive Order 13514, *Federal Leadership in Environmental and Energy Performance*, all federal agencies are tasked with evaluating agency climate-change risks and vulnerabilities to manage short- and long-term climate-change effects on each agency's mission, programs, and operations.[1] Federal agencies are required to evaluate climate risks, identify program vulnerabilities, and prioritize activities to reduce their climate risk.[2]

Consistent with EO 13513, EPA issued its first Policy Statement on Climate-Change Adaptation in June 2011[3] calling for EPA to develop and implement an agency-wide Climate Change Adaptation Plan to integrate climate adaptation into its programs, policies, rules and operations. Every EPA Program and Regional Office was directed to develop their own, independent, stand-alone Climate Change Adaptation Implementation Plan to identify how priorities will be met and the agency-wide plan implemented. These Program and Regional Office-identified priorities are to be reflected in annual budget submissions.

The Agency's draft Climate Change Adaptation Plan includes a national-level qualitative assessment of EPA-program vulnerabilities. The Regions are tasked with using this plan to guide their adaptation planning.[4] Each Region is to capture its regional uniqueness, identify vulnerabilities of greatest importance including its vulnerable people and places. EPA expects the severity and importance of identified program vulnerabilities to vary reflecting projected regional climate-change impact projections. The Regions' plans are expected to describe how climate change adaptation is to be integrated into their planning and work in a manner consistent and compatible with their own circumstances and objectives. The following provides Region 4's *texture* called for in the Agency's Climate Change Adaptation Plan.

II. Description of EPA Region 4

The eight states comprising Region 4 make it EPA's most southeasterly region. Alabama, Georgia, Florida, Kentucky, North and South Carolinas, and Tennessee plus six federally-recognized tribes comprise Region 4, see Figure 1 below. EPA Region 4's borders are primarily large water-bodies: the Mississippi River to the west, the Ohio River to the north, the South Atlantic Ocean to the east, and the Gulf of Mexico to the south. The Region is dissected by several major river basins. Nine of these basins drain into the South Atlantic while eight drain into the Gulf of Mexico. Consequently, the Region is rich with aquatic ecosystems, barrier islands, beaches, estuaries, and wetlands supporting important industries of fishing, recreation, transportation, and tourism. The Region has numerous coastal and inland ports with associated transportation hubs. Every state has a port. The Region has more river ports than sea ports, for example the State of Mississippi has four Gulf ports and 12 river ports.[5] Florida has 15 seaports, the most of any Region 4 state.[6]

A. Climate Patterns

Region 4's climate is predominately mild, humid, and subtropical, with southern Florida being primarily humid subtropical to tropical savanna. The Region is characteristically hot and humid in the summer with mild winters. The Central Appalachian, Western Allegheny, and portions of the Blue Ridge and the Ridge and Valley ecoregions (see the next section, *EPA Region 4's Ecoregions*) can experience cold winters and have the least number of frost-free days, ranging from 125 - 200.

For most of Region 4, the number of frost-free days ranges from 170 to 360, with the coastal areas experiencing the most. The southern part of Florida is nearly frost free and is the only ecoregion in the continental U.S. to have the climate, hydrology, vegetation, and terrain characteristics of tropical wet forests.[7] The annual mean temperature for Region 4 ranges from 55 to 77°F with the more mountainous ecoregions having the coolest, ranging from 55 to 63°F. Precipitation ranges from 35 to 59 inches in the Piedmont, Ridge and Valley, and Western Allegheny ecoregions, to between 43 and 65 inches for the rest of the Region.

1. Climate Factors

a) Weather Phenomena

(1) The Bermuda High

The Bermuda High is a semi-permanent high-pressure area usually centered in the vicinity of Bermuda during the spring and summer. Prolonged heat waves in the East are attributed to the Bermuda High. Weather fluctuates in response to its east - west migrations. The Bermuda High can move high-moisture tropical air masses west over land causing showers and thunderstorms. When it is east over the Atlantic Ocean, hurricanes tend to curve out to sea avoiding land. When it is west toward land, hurricanes tend to impact the nation's East and Gulf Coasts.

(2) El Niño-Southern Oscillation

The El Niño-Southern Oscillation is a cyclic Pacific Ocean weather pattern in which the sea-surface temperature cycles between abnormal warming (El Niño) and cooling (La Niña) conditions, influenced by changes (oscillations) in atmospheric pressure between the tropical east and west Pacific (the Southern Oscillation (SO)).

(3) North Atlantic Oscillation

The North Atlantic Oscillation (NAO) describes fluctuations in atmospheric pressure differences between permanent low- and high-pressure systems. While the NAO directly influences Western Europe's climate, it may impact much of eastern North America's weather.

b) Large water bodies

(1) Mississippi and Ohio Rivers

The Mississippi and Ohio Rivers delineate EPA Region 4's western and most of its northern geographic borders, respectively. Two major coastal water bodies, the Atlantic Ocean and the

Gulf of Mexico, delineate its eastern and southern borders, respectively. These water bodies strongly influence the Region's climate. Large water bodies take longer to heat up and cool down than land, such that land areas in the vicinity of large water bodies remain cooler in summer and warmer in winter.

(2) Gulf Stream

The Region's climate is strongly influenced by the Gulf Stream, which flows seven hundred miles north from Key West, FL, to Cape Hatteras, NC. It is a strong, fast moving, warm ocean current. The Gulf Stream's surface temperature ranges 80°F and above due to the solar heating of tropical Atlantic and Caribbean waters. The Gulf Stream system's warm surface-temperature causes Florida and much of the Southeast to be mild all year round. The warm sea-surface temperature also aids the formation and strengthening of hurricanes moving through the Gulf of Mexico.

c) Topography

Lastly, the Region's topography is highly diverse, ranging from the Mississippi River Valley Plain to the west, the southeastern and southern coastal plains of the Atlantic and Gulf Coasts, the interior Piedmont's rolling low plateaus, the Southern Appalachian Mountains, and the inland, elevated, and severely eroded Cumberland Plateau extending from Alabama through Tennessee to Kentucky. Various weather patterns intersect with this diverse topography to create numerous microclimates, facilitating the variety of ecosystems and species diversity characteristic of EPA Region 4.

B. EPA Region 4's Ecosystems

Because of its climate, proximity to large water-bodies, and topography, EPA Region 4 has tremendous aquatic ecosystems and associated biodiversity. It is overlain by fourteen ecoregions.[8] Half are in the Southern Appalachians where the mountains interact with local weather patterns in complex ways, creating numerous local microclimates. Precipitation responses are especially sensitive to the shape of mountain ranges and wind flow direction.[9] Two of the Region's ecoregions are riverine in character: one is the Piedmont, and the other coastal, including the Everglades' subtropical wetlands.

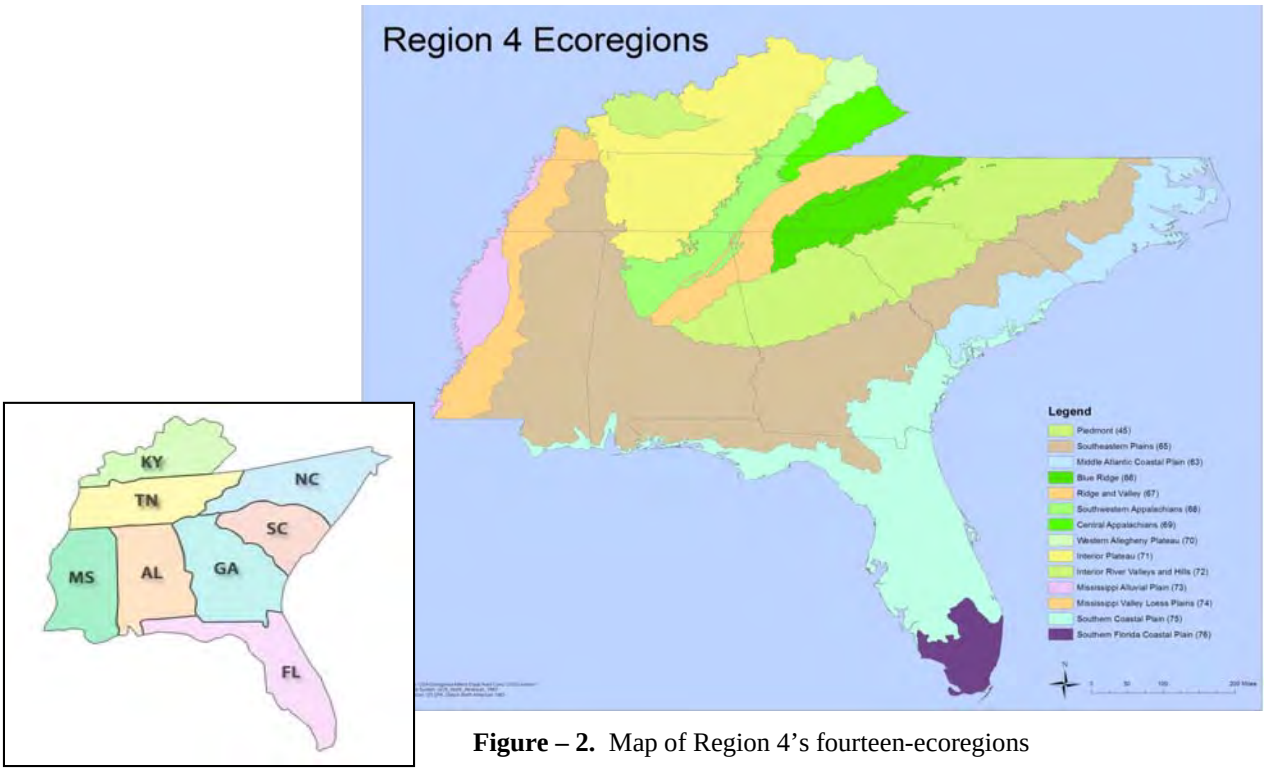

Figure – 2. Map of Region 4's fourteen-ecoregions

1. Overview of Ecosystems

Most of EPA Region 4's land area lies within the *Piedmont*, *Southeast Plains*, and the *Southern Coastal Plain* ecoregions, see Figure 2.[10] Three ecoregions, the *Piedmont*, *Mississippi Alluvial Plain*, and the *Southern Florida Coastal Plain* (the Everglades) have undergone extensive land-use changes. The Piedmont has experienced several major land-cover transformations over the past 200 years: forest to farm, back to forest, and spreading urban- and suburbanization. The *Mississippi Alluvial Plain* is one of the nation's most altered ecoregions, extensively cleared for cultivation where bottomland hardwood forests once dominated. The Everglades, or the *Southern Florida Coastal Plain*, has undergone extensive hydrological and biological alterations.[11]

Mountain top, surface, and underground bituminous coal mining occurs within four of the southern Appalachians ecoregions. Mining is extensive in the *Interior River Valleys and Hills* and the *Western Allegheny Plateau* ecoregions, common in the *Central Appalachians*, and occurs in several parts the *Southwestern Appalachians* ecoregion. Significant habitat loss and water-quality degradation, particularly sedimentation and acidification of many the ecoregions' water bodies are coal mining's legacy.[12] Within Region 4, the *Interior River Valleys and Hills* and the *Western Allegheny Plateau* ecoregions only occur within the Commonwealth of Kentucky.[13]

Agriculture occurs in 11 of the Region's ecoregions in the form of pulpwood and lumber pine plantations, beef pasture, cropland (planted with wheat, blueberries, corn, cotton, soybeans, peanuts, onions, sweet potatoes, melons, tobacco, or rice), citrus groves in the south, poultry and hog livestock, and dairy farming. In the *Mississippi Alluvial Plain*, extensive agricultural land-use occurs with most of the ecoregion planted in soybeans, cotton, corn, rice, wheat, and pasture, and some sugarcane in the south. Pine plantations are common in the *Southeast Plains* and the *Middle Atlantic Coastal Plain* ecoregions, and occasional in the *Ridge and Valley*. The *Middle Atlantic Coastal Plain* has a high density of chicken, turkey, and hog production in some areas, with North Carolina the second-largest hog producing state in the nation. The *Southeast Plains* ecoregion also supports poultry and hogs.[14]

The 2007 Census of Agriculture counted 6,409 farmers and ranchers reporting aquaculture sales in the United States; the three states with the largest number of operations with sales were Florida, Louisiana and Mississippi. Catfish and crawfish are commercially produced in ponds in the *Mississippi Alluvial Plain*.[15] More than 50 percent of the total value of sales from aquaculture come from the top five states, including Mississippi ($237.9 million).[16]

The Region's forests are mostly located within 5 ecoregions. The *Blue Ridge* ecoregion contains one of the richest temperate broadleaf forests in the world, with a high diversity of plants within the large areas of National Forest, National Parks and state-owned lands. The *Western Allegheny Plateau* ecoregion is mostly forested, with public national forest lands, and logging a predominant activity. Forest uses prevail within the *Central Appalachians* and *Southwestern Appalachians* ecoregions. The *Mississippi Alluvial Plain*'s floodplain forest ecosystems include river and hardwood swamp forests. The ecoregion is still a major bird migration corridor despite the widespread loss of forest and wetland habitat. The *Interior River Valleys and Hills* ecoregion is partially forested.[17]

Between 1973 and 2000, the Southeast Climate Region had the highest rate of change due to active forest timber harvesting and replanting.[18] In this region, forests, not cropland, are expected to be lost.[19] Projected land-use and land-cover changes likely will depend upon population rates and economic growth.[20] The exurban and suburban areas generally are projected to expand by 15 to 20 percent between 2000 and 2050.[21] Climate change will cumulatively impact the existing and projected land-use changes to the Region's ecoregions. Aquatic ecosystems in those ecoregions where mining already provides significant stress and where forests are converted to other uses may likely be less resilient to climate-change impacts.

2. Determining Climate Change Impacts to Aquatic Ecosystems

EPA and its state partners use aquatic bio-assessments to evaluate biological criteria to determine whether CWA-regulated surface waters are maintaining their biological integrity consistent with their designated use, e.g., cold-water fishery.[22]

To monitor stream health, states are delineated into bioregions to organize similar sampling sites together; i.e., those having similar stream physical, chemical, and biological attributes. These bioregions often mirror ecoregion boundaries. Since all of the streams within a bioregion generally have similar attributes, the differences in aquatic organism assemblages between reference sites (which receive high biological index scores) and stressed sites (which receive low index scores) are typically expected to reflect human impacts, e.g., land-use changes.

Table 1. The Number of Ecoregions and Bioregions by State

State	Level III Ecoregions[1]	Level IV Ecoregions[2]	Macroinvertebrate bioregions	Fish Bioregions	Algae Bioregions
AL	6	29	2 (high and low gradient streams)	NA[3]	NA
FL	3	16	3	NA	NA
GA	6	28	24	4	NA
KY	7	25	4	6	4
MS	4	21	4	NA	NA
NC	4	28	3	5	NA
SC	5	12	3	NA	NA
TN	8	31	15	NA	3

1: Ecoregions along the coast (Southern Florida Coastal Plain (76), Southern Coastal Plain (75), Mississippi Alluvial Plain (73), and Middle Atlantic Coastal Plain (63)) do not have aquatic communities that currently support index development and are not included in any bioregions.
2: Level IV Ecoregions are subunits of Level III, see: http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm#Level IV
3: All "Not Applicable" cells represent a state that does not use that index for making regulatory decisions (though most states are in the process of developing new indices or may use that assemblage for other monitoring purposes, like evaluating best management practices.) Information was gathered from Standard Operating Procedures for biomonitoring and index development papers that states operated under in 2011.

If climate change were to cause streams in the same bioregion to become dissimilar, it could hinder EPA and the states' ability to determine low index-score causes, i.e., human versus climate-change induced impacts. Biological monitoring and assessment program success will require an understanding of what and how climate-associated changes are occurring and how monitoring programs can account for them.[23] Likely climate-change impacts to Region 4's freshwater aquatic ecosystems are described below but further research is necessary to determine actual impacts.

a) Climate-Change Induced Temperature Impacts

In EPA Region 4, climate change-associated warmer water temperatures are expected to drive aquatic species to cooler waters, either north or to higher elevations. Local extinctions are expected where migration barriers exist, e.g., dams, reservoirs, logging, mountain-top mining,

etc., and a lack of higher elevations. In Region 4, cold-water habitat is generally associated with its mountain and high-elevation plateau ecoregions of the Southern Appalachians, i.e., the Piedmont, Ridge and Valley, Blue Ridge, Central Appalachian, Western Allegheny and Interior Plateau, Interior River Valley and Hills ecoregions.[24] For example in North Carolina, the mountain ecoregion and higher elevation sites generally have the highest cold-water taxa richness, which are expected to shift either north or to higher elevation as temperatures increase.[25] While the cold-water tax either migrate to cooler water conditions or are subject to local extinctions, those species thriving in warm temperatures or which are tolerant to warmer temperatures, will likely increase their populations at their current location and extend their range into formerly colder-water habitat.[26]

At this time, it is uncertain where the greatest climate change-induced impacts to aquatic organisms and their ecosystems within the Region may occur: in the transitional areas aquatic species may already be close to their temperature tolerance limits, while species may be more sensitive in those coldwater habitats expected to experience warming. Within Region 4, the Piedmont (the transitional area) and Mountain (coldwater habitat) ecoregions are expected to see the greatest climate-change impacts to its aquatic ecosystems.[27] Predictions are further confounded by the probability that temperature change likely will not occur evenly across the Region. The Region finds it difficult to predict how warm- and cold-water taxa will respond to changing water temperatures since other environmental factors, e.g., land-use changes, also strongly influence species' population densities and geographic distributions

b) Climate-Change Induced Water Flow Impacts

Biological integrity is strongly correlated with stream flow.[28] Expected climate change-related impacts to the Region 4's aquatic ecosystems include longer durations of low summer stream flows, average stream flow decreases, higher flooding incidences, and increased periods of extremely high and low flows (greater flashiness), with resultant scouring. Scouring and sedimentation already negatively impact habitat and biota in Piedmont streams, and more frequent severe precipitation events may exacerbate those impacts.

Insect-rich habitat-diversity tends to decrease with decreasing flow.[29] Under lower flow conditions, non-flowing (lakes and ponds) fish and insect community populations tend to increase while those requiring flowing water to survive decrease. Additionally, drought or flood-related stream-flow changes can change nutrient and sediment loadings and habitat availability.[30] Moreover, lower flow results in less dilution facilitating higher in stream concentrations of potentially harmful chemicals and aquatic toxicity. Overall, climate change-induced flow changes are expected to cause significant changes to the Region's aquatic communities.[31]

At a reduced flow of 20-90%, the Region could lose 3 to 38% of its fish species.[32] The North Carolina Department of Environment and Natural Resources (NCDENR) researched invertebrate responses to the 1999 to 2002 drought experienced by both North and South Carolina. The study found a decline in invertebrate communities. NCDENR found stream flow, drainage area,

underlying geology, and the tributary stream type and size appeared to influence invertebrate species' degree of impact and resiliency, i.e., speed of recovery to drought.[33]

NCDENR also studied tropical and hurricane storm-related flooding impacts to invertebrate species and stream health. In 2004, North Carolina experienced five tropical Storms (Bonnie, Frances, Gaston, Ivan, and Jeanne) and two hurricanes (Alex and Charley) during a two-month period (August 3 – September 27). During its study, NCDENR documented a decline in biological index scores associated with the invertebrate species' responses to the storm-related flooding.[34]

C. EPA Region 4's Communities

Region 4's mild climate, extensive coasts, and large river basins attract people, both for residential and recreational purposes. Within its geographic borders, the Region is home to a population of 61,762,344.[35] The State of Florida's population, 19,057,542, is greater than the individual populations of four EPA regions (see figure 3 below). The Region's population of children and elderly comprise approximately 6.1 and 14 percent, respectively, of the Region's total population. The Region is home to six federally-recognized tribes, with a population of 33,500 enrolled members.

All eight states had positive growth from 2000 through 2010, with the overall regional population growing by 8.9 million people, about 13%.[36] The population grew fastest in North Carolina (18.5%), Georgia (18.3%), Florida (17.6%), and South Carolina (15.3%). Most of this growth has been in urban and peri-urban areas. Population growth is expected to compound climate-related impacts. For example, increasing urban and suburban competition for finite water resources likely will affect agriculture, aquatic ecosystems, energy production, fisheries, and natural ecosystems.[37]

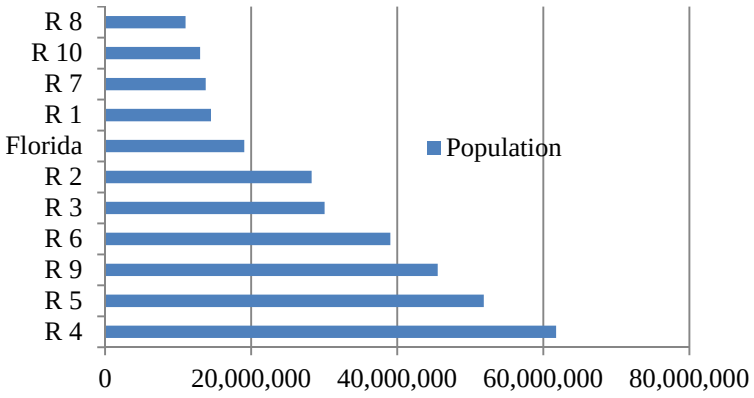

Figure-3. EPA Region population comparisons.

By 2030, Florida, Georgia, and North Carolina are projected to have some of the largest elderly American populations.[38] All three states are in the top ten projected to have the largest numbers of Americans aged 60 and older. Florida, with 9,737,256 elderly, is projected to be second only to the State of California, with a projected elderly population of 10,595,771 by 2030.

Most of Region 4's population lies within the *Piedmont*, *Southern Coastal Plain*, *Southeastern Plains*, *Interior Plateau*, and *Southern Florida Coastal Plain* ecoregions. Within the *Southern Florida Coastal Plain* (the Everglades), urban areas are extensive along the Atlantic Coast and include Miami, Fort Lauderdale, West Palm Beach, and other adjacent coastal cities.[39]

The Southeast Climate Region (see the following section, *Observed and Projected Climate Change in Region 4*) includes 28 of the top 100 metropolitan statistical areas by population, and is the second most urbanized region after the Northeast, having 131 persons-per-square mile. Miami (#8), Atlanta (#9), Tampa (#18), and Orlando (#26) all rank in the top 30 of U.S. urban centers.[40] The Region has three of the ten fastest-growing areas: the Florida areas of Palm Coast and Cape Coral-Fort Meyers, and Myrtle Beach, SC.[41] All three areas are along the coast and vulnerable to sea-level rise and storm surge.[42] Since 1980, the Southeast has had more billion-dollar weather disasters (hurricanes, floods, and tornadoes) than any other region.[43]

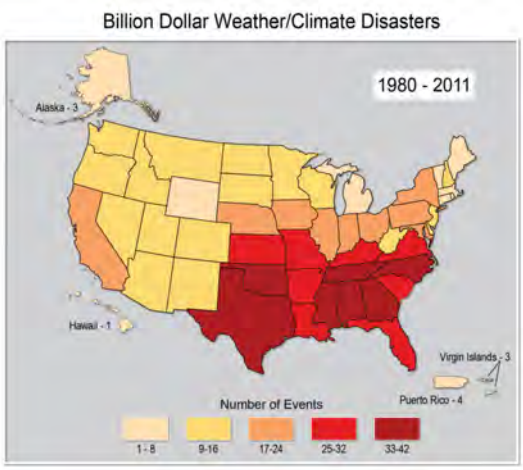

Figure 4.[44]

Billion Dollar Weather/Climate Disasters (1980-2011). This map summarizes the number of weather and climate disasters over the past 30 years that have resulted in more than a billion dollars in damages.

III. Observed and Projected Climate Change in Region 4

This section summarizes climate change impacts anticipated for EPA Region 4. The climate change literature defines the Southeast Climate Region differently than EPA defines its southeastern region. The Southeast Climate Region is defined to include all of the EPA Region 4 states plus Arkansas, Louisiana, two of EPA Region 6 states, and Virginia, one of EPA Region3's states.

Figure 11. - Map of EPA Region 4

Figure 12. – Map of the Southeast Climate Region

The Southeast Climate Region is exceptionally vulnerable to sea-level rise, extreme heat events, and decreased water availability. Within this Region the spatial distribution of these impacts and vulnerabilities is uneven, since it encompasses a wide range of ecoregions, from the Appalachian Mountains to the coast.[45] The high variability of the Region's climate makes it difficult to assess the impacts of variability from climate change.

The Southeast Climate Region is home to more than 80 million people, drawing hundreds of million visitors every year.[46] Located in low-lying coastal areas particularly vulnerable to flooding, extreme storms, and sea-level rise, this Region has a disproportionate number of the country's fastest growing metropolitan areas and important economic sectors.[47] Palm Coast, FL, Cape Coral-Fort Meyers, FL, and Myrtle Beach, SC, are all vulnerable to sea-level rise and storm surge.[48]

Sea-level rise and temperature and precipitation changes are expected to be the most severe and widespread anticipated impacts to the Region, which ultimately may affect water availability.[49] The vulnerable Gulf and Atlantic coasts are major producers of seafood and home to several ports.[50] The Southeast Climate Region is a major energy producer of coal, crude oil, and natural gas, and the highest energy user of any of the National Climate Assessment regions.[51] Changes in land use and land cover, more rapid in the Southeast than most other areas of the country, often interact with and serve to amplify the effects of climate change on southeastern ecosystems.[52]

A. Temperature

1. Observed

Average annual temperature during the last century cycled between warm and cool periods across the Southeast Climate Region.[53] A warm peak occurred during the 1930s and 40s, followed by a cool period in the 60s and 70s, and warmed again from 1970 to the present by an average of 2°F, with more warming occurring during summer months.[54] Since 1970, the number

of days above 95°F and nights above 75°F have increased, while the number of extremely cold days has decreased.[55]

2. Projected

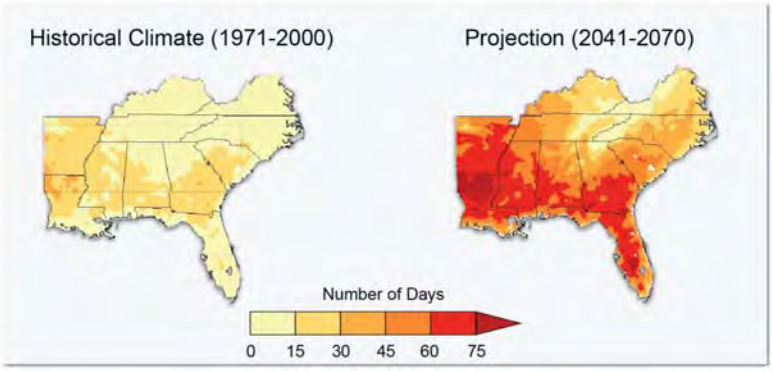

Figure 13. The projected number of days exceeding 95°F.

Temperatures across the Southeast Climate Region are expected to increase during this century, fluctuating over time because of natural climate variability (annually and decade-to-decade).[56] Major warming consequences include significant increases in the number of hot days exceeding 95°F and decreases in freezing events.[57] Projections for the region by 2100 include increases of 10°F for interior states of the Region with a regional average increase ranging from 2°F to 6°F.[58]

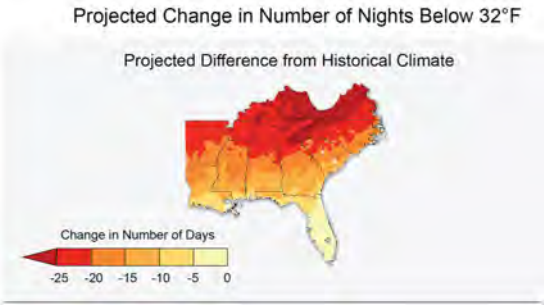

Figure 14. Projected Number of Nights below 32°F[59]

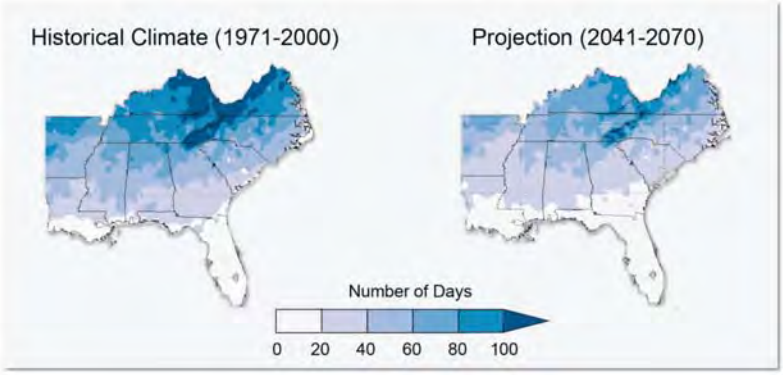

Figure 15. Projected annual number of days with temperatures less that 32°F for 2041-3 2070 compared to 1971-2000, assuming emissions continue to grow (A2 scenario). [60]

Summer heat stress is projected to reduce crop productivity, especially when coupled with increased drought. The 2007 drought cost the Georgia agriculture industry $339 million in crop losses, and the 2002 drought cost North Carolina $398 million.[61] A 2.2ºF increase in temperature could reduce overall productivity for corn, soybeans, rice, cotton, and peanuts across the South – although rising CO_2 levels might partially offset these decreases, based on a crop yield simulation model. [62] In Georgia, climate projections indicate corn yields could decline by 15% and wheat yields by 20% through 2020.[63]

3. Extreme Heat Events

Rising temperatures and the associated increases in frequency, intensity, and duration of extreme heat events are expected to affect public health, natural and built environments, energy, agriculture, and forestry.[64] The negative effects of heat on human cardiovascular, cerebral, and respiratory systems have been established.[65] Within EPA Region 4, Atlanta, Miami, and Tampa have already seen increases in the number of days with temperatures exceeding 95ºF, during which the number of deaths was above average.[66] The expected increase in elderly population of the Region enhances the health risks of extreme heat events. By 2100, the Southeast Climate Region is expected to have the highest increase in heat index, the measure of comfort combining temperature and relative humidity, of any region of the country.[67] Additionally, higher temperatures can contribute to the formation of harmful air pollutants and allergens, with associated health impacts.[68] Ground-level ozone is projected to increase in the Southeast Climate Region's largest urban areas, potentially leading to increased deaths. [69] Hospital admissions for respiratory illnesses, emergency room visits for asthma, and lost school days may increase. [70]

A. Precipitation

1. Observed

The Gulf Coast regions of Mississippi, Alabama, and the Florida Panhandle receive over 60 inches of precipitation, while much of northern Kentucky, the central sections of the North and South Carolinas, and Georgia receive between 40 and 50 inches of precipitation annually.[71] Higher amounts of precipitation are found along the Atlantic coast and across the Florida

Peninsula due in part to the lifting of the air associated with sea breeze circulation.[72] Tropical cyclones also contribute significantly to annual precipitation totals in the Region, especially over the Southeast Atlantic coast.[73] The Southeast Climate Region's wettest locations occur in southwestern North Carolina.[74] The Region's daily and five-day rainfall intensities have increased while summers have been either extremely wet or increasingly dry.[75] Only along the northern Gulf Coast has precipitation increased during the last 100 years.[76]

Across the Southeast Climate Region's northern tier, the average annual snowfall ranges from 5 to 25 inches, except at the higher elevations of the southern Appalachians in North Carolina and Tennessee.[77] These locations can receive up to 100 inches of snowfall annually, comparable to annual snowfall amounts experienced in New England.[78] The Region's southern extent experiences very little snowfall (i.e., less than 1 inch per year) and several years may elapse before any measurable snowfall occurs.[79]

2. Projected

Future precipitation-pattern projections are more uncertain than temperature projections.[80] Under a *high* greenhouse-gas-emission scenario, average changes in annual precipitation range from nearly 10% reduction in the far southern and western portions of the Region – with most of that reduction in the summer – to about 5% increases in the northeastern part of the Region by later this century.[81] Average annual precipitation is projected to decrease by 2% to 4% over South Florida, while increases in precipitation of up to 6% are projected across North Carolina.[82] Precipitation is expected to increase across most of the Southeast Climate Region in all seasons except summer, where a decrease of 15% is noted for South Florida.[83]

3. Extreme Events

a) Precipitation

The extreme-precipitation-event frequency has been increasing across the Region, particularly pronounced over the last two decades.[84] This increase is pronounced across the lower Mississippi River Valley and along the northern Gulf Coast.[85] Despite a long-term increase in extreme precipitation events, no discernible trend exists in flood magnitude for the Region.[86] An increased risk of flooding of the Region's urban areas is expected from increases in extreme-precipitation events and the associated increased runoff, compounded by the magnitude of impervious surface that has resulted from increased urbanization.[87]

The annual number of days with extreme precipitation is expected to increase across most of the Region by the mid-21st century, particularly along the southern Appalachians as well as parts of Tennessee and Kentucky.[88]

b) Severe Thunderstorms & Tornadoes

Thunderstorms are frequent across the Southeast Climate Region, especially during the warmer months. Severe thunderstorms, i.e., characterized by winds in excess of 58 mph, hail a

minimum one inch in diameter, or a tornado, occur most frequently in the late winter and spring months.

Within EPA Region 4, damaging winds and large hail occur most frequently across Alabama, Mississippi, and western Tennessee.[89] These states also experience the highest number of strong tornadoes (F2 and greater) and experience more killer tornadoes than the notorious "Tornado Alley" of the Great Plains.[90]

Cloud-to-ground lightning is a significant hazard. The greatest lightning-strike frequency within the nation occurs across the Gulf Coast and the Florida Peninsula.[91] Additionally, eight of the eleven states comprising the Southeast Climate Region rank in the top 20 for lightning-related fatalities from 1959 to 2006.[92] Cloud-to-ground lightning has started house fires and wildfires.

c) Tropical Storms and Hurricanes

In the Southeastern Climate Region, tropical storms and hurricanes frequently make landfall along North Carolina's Outer Banks and south Florida and rarely appear to land along the concave portions of the coastline, the western bend of Florida and the Georgia coast.[93] Major hurricane (categories 3 to 5) landfalls have been most frequent in South Florida (once every 15 years) and along the northern Gulf Coast (once every 20 years).[94] While these storms primarily impact the coast, significant effects are experienced several hundred miles inland.[95] Storms with wind gusts exceeding 75 mph have occurred every five to 10 years across portions of the Region's coastal plain and every 50 to 75 years across portions of the Carolina Piedmont, central Alabama, and Mississippi.[96]

Tropical storm and hurricane-associated precipitation contribute significantly to the Southeast Climate Region's precipitation, surface and ground water levels, water supply, and soil moisture.[97] Heavy rainfall also periodically causes deadly inland flooding, especially when a storm is large or is stalled by a weather front.[98] Hurricane landfalls appear to have declined slightly over the past century from a decadal frequency perspective.[99]

B. Sea-level rise in Region 4

The National Water Level Observation Network's 150-years database consistently depicts a rise in sea level. From this data, a 0 to 3 millimeter-per-year sea-level rise rate has been estimated off the west Florida, Alabama, and Mississippi coasts.[100] Two data sources, the historical tide-gauge records over the past century and geologic evidence over the past several centuries, indicate steadily rising sea level off North Carolina's coast. The NC Coastal Resources Commission's Science Panel on coastal hazards recommended a projected sea-level rise of one meter by 2100 be adopted for policy development and planning purposes.[101]

Large portions of the Region are highly vulnerable to sea-level rise, although how much sea-level rise is experienced in any particular place depends upon whether and how much the local land is sinking (i.e., subsidence) or rising, and offshore-current changes.[102] Global sea-level rise

over the 20th century has averaged approximately eight inches. The rise rate is expected to accelerate through the end of this century.[103]

Figure 16 below depicts the relative risk, as determined by the Coastal Vulnerability Index, that physical changes will occur as sea-level rises. The Coastal Vulnerability Index is based on tidal range, wave height, coastal slope, shoreline change, landform and processes, and historical rate of relative sea-level rise. The index estimates a coastal system's susceptibility to change and its natural ability to adapt to changing environmental conditions to formulate an estimation of a system's natural sea-level rise vulnerability or risk.[104]

Figure 16. [105] The Southeast Climate Region's Vulnerability to Sea-Level Rise

In the Southeast Climate Region, numerous cities, roads, railways, ports, airports, oil and gas facilities, and water supplies are in low-elevation areas, making them vulnerable to sea-level rise. The North Carolina Department of Transportation is raising U.S. Highway 64's roadbed by four feet; 18 inches of which is to address sea-level rise projections.[106] The major cities of Miami and Tampa, FL, are among those most at risk. [107]

Sea-level rise impacts upon agriculture may decrease freshwater availability and increase land loss and saltwater intrusion. Salt-water intrusion is projected to reduce the availability of groundwater for irrigation, thereby limiting crop production in some areas.[108] Agricultural areas around Miami-Dade County with shallow groundwater tables are at risk of enhanced inundation and associated cropland loss; an estimated 37,500 acres in Florida are projected to be lost to production with a 27-inch sea-level rise.[109]

Additionally, higher sea levels are expected to accelerate saltwater intrusion into rivers, streams, and groundwater sources of freshwater in coastal areas. In areas with porous aquifers, groundwater is particularly vulnerable to saltwater intrusion. Salt water intrusion impacts water

quality for agriculture, drinking water, and industrial purposes. In the City of Hallandale Beach, FL, officials have already abandoned six of the city's eight drinking water wells due to salt-water intrusion.[110]

C. Drought trends in Region 4

1. Watersheds

Several watersheds within EPA Region 4 cross multiple state boundaries with growing populations needing water for agriculture, energy production, navigation, drinking, and other needs. Alabama shares most of its major streams with neighboring states.[111] Five rivers originate in Alabama and flow through Florida before draining into the Gulf of Mexico. Both the Coosa and Tallapoosa Rivers originate in Georgia and flow into Alabama where they join the Alabama River. The Tombigbee River originates in Mississippi and flows into Alabama, becoming a tributary to the Mobile River. The Escatawpa River originates in southwest Alabama and becomes a tributary to the Pascagoula River, straddling the AL-MS state line before draining into the Mississippi Sound. The Tennessee River, the largest tributary to the Ohio River, is formed at the confluence of the Holston and French Broad Rivers in northeast Tennessee. It flows through Alabama forming a small section of the AL – MS border before flowing back into Tennessee via Kentucky, then discharging into the Ohio River. Additionally, the Catawba River originates in North Carolina eventually forming approximately 10 miles of the NC-SC border before becoming a tributary to the Wateree River of SC. The Savannah River flows along the GA – SC border before draining into the Atlantic Ocean.

2. Population Effects

The Region's rapid population growth and development has greatly increased water demand and drought vulnerability. Yet, drought is a *normal* component of the Region's climate system.

EPA Region 4, its state, local and tribal government partners and stakeholders face challenges in managing drought conditions in light of the Region's growing population and the anticipated climate change impacts.

3. Dams and Basins

Within EPA Region 4 the Tennessee Valley Authority (TVA) and the U.S. Army Corps of Engineers (US ACOE) operate a number of dams on significant waterways. According to US ACOE's National Inventory of Dams,[112] the federal government operates 404 dams within Region 4. The TVA operates 47 dams for hydropower within a region primarily encompassing Alabama, Georgia, Kentucky, North Carolina, and Tennessee (see figure 23 below).

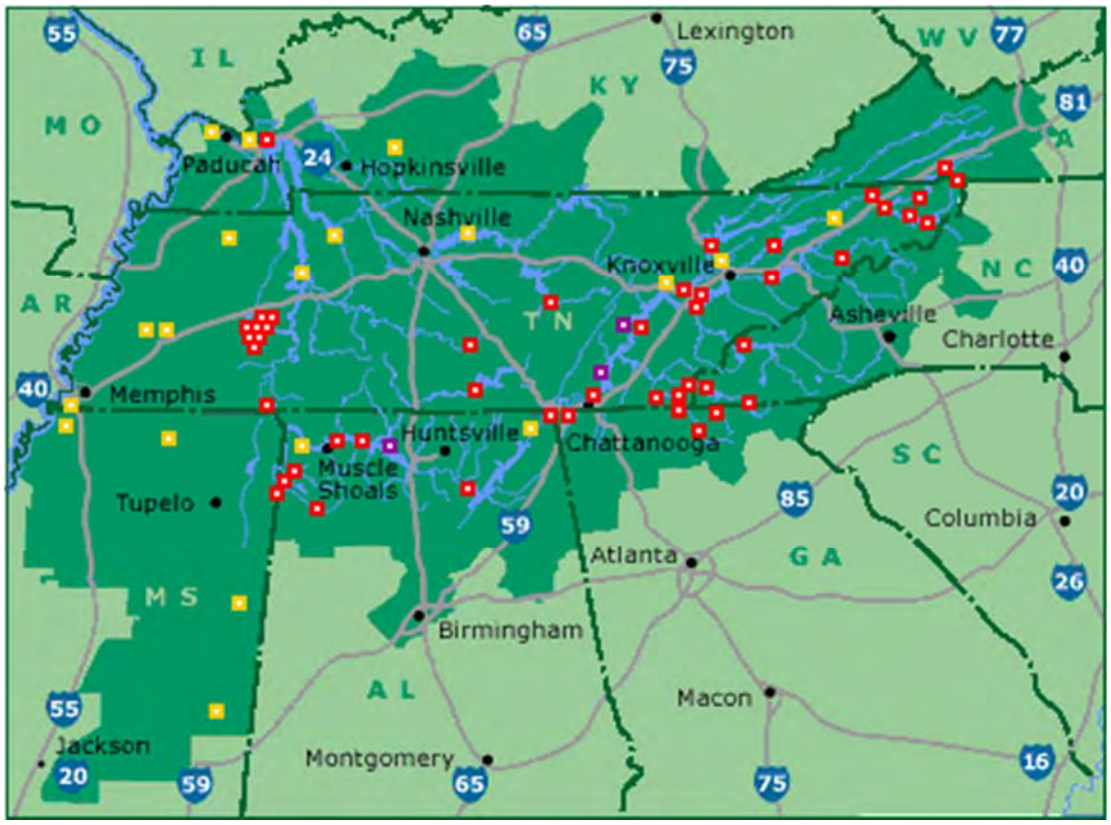

Figure 23. Map of TVA's reservoirs and dams.[113] The red boxes identify 45 of the 47 hydro dams. The yellow boxes identify coal-power plants. The purple boxes identify nuclear-power plants.

.

a) Apalachicola-Chattahoochee-Flint River Basin

The Apalachicola-Chattahoochee-Flint River (ACF) Basin is an important part of the socioeconomic structure of Georgia, Alabama, and Florida's urban population, agriculture, power generation, recreation economy, and North Florida's commercial fishery. This Basin overlies 19,800 square miles of southwestern Georgia and southeastern Alabama. The Centerpiece of the Basin is the Chattahoochee River. Its headwaters are in northeast Georgia in the Blue Ridge Mountains. It flows southwest to Columbus, GA, then south along much of the AL-GA border, before crossing into Florida where it confluences with another Georgia river, the Flint River, creating the Apalachicola River which discharges into the Gulf of Mexico at the Apalachicola Bay.

Despite human alterations to most of the ACF Basin, it still supports a rich and abundant diversity of plants and animals. The Chattahoochee's headwaters (the Blue Ridge ecoregion) are the only cold-water fishery habitat. The Apalachicola Bay lies within the Southern Coastal Plain ecoregion while the rest of the Basin is within the Southeastern Plains ecoregion. These ecoregions represent areas where unique and localized natural processes have facilitated the Basin's noteworthy aquatic biodiversity: amphibians, fish, reptiles, and invertebrate fauna

(crayfish, insects, mussels, worms).[114] Ninety-nine species of breeding birds, including migratory water fowl and 52 species of mammals depend upon its water resources.[115]

The Basin has the largest fish-species diversity of all the river basins draining into the Gulf of Mexico east of the Mississippi River.[116] Seven fish species live only in the Basin (endemic). Sixteen fish species have been listed for protection by Federal or State agencies. And the Apalachicola River Basin has the largest freshwater-fish assemblages in Florida.[117]

Living in the Basin are 16 species of freshwater aquatic turtles, 21 species of salamanders, 26 species of frogs, and the American alligator. All require freshwater to complete or sustain their lifecycles.[118] Numerous snake and lizard species inhabit streams and wetlands. Fifteen species of amphibians and reptiles are noteworthy because of their rarity or protected status: two are designated as threatened and five are designated Endangered Species Act candidate species.[119] The Apalachicola River Basin's upper reaches have the highest amphibian and reptile species density on the continent north of Mexico, and 116 plant species are found; 17 are listed as endangered, 28 threatened, and 30 are rare; with 9 plant endemic species.[120]

The source of the Apalachicola River's flow is primarily the Chattahoochee and Flint Rivers (80 percent), the Chipola River (11 percent) and the remaining from groundwater and overland flows. Because of rainfall-distribution patterns, the Chattahoochee River's average annual runoff exceeds the Flint and makes a greater contribution to the Apalachicola River's peak flows than the Flint. During droughts because the Flint River's base flow is sustained by groundwater, it contributes the greater flow into the Apalachicola River.[121] However, agriculture is the primary land use within the Flint, which depends heavily upon groundwater. Agricultural irrigation can and has depleted the lower Flint River's base flow. Drought combined with high irrigation demand, e.g., high crop prices, can cause the Flint River's component of the Apalachicola River's flow to be nonexistent.

Apalachicola Bay produces 90 percent of Florida's and 13 percent of the Nation's oyster harvest. It is a nursery for shrimp, blue crab, and a variety of fish species. The largest National Estuarine Research Reserve is located in the Bay. The State of Florida has declared both the Apalachicola River and Bay to be an Outstanding Florida Water. The United Nations has designated Apalachicola Bay as an International Biosphere Reserve.[122]

Figure 11.[123] - The ACF Basin in Georgia.

b) Alabama, Coosa, and Tallapoosa Basin

The Alabama, Coosa, and Tallapoosa (ACT) Basin has 16 reservoirs of significance. Its series of dams are operated by the Corps of Engineers and the Alabama Power Company primarily to meet for navigation and hydropower production. Lake Martin, managed by the Alabama Power company, is the largest reservoir with 60.6 percent of the conservation storage. Lake Allatoona, managed by the Corps, is the second largest reservoir in the ACT basin with 11.4 percent of the conservation storage.[124]

The ACT has been called a hotspot of aquatic biodiversity but it has lost some of its diversity. The Coosa River in Georgia historically included 36 native mussel species; today the US Forest Service knows of only four. The Etowah River once included 43 mussel species, now none are known. The Oostanaula River once included 43 mussel species, now only 12 are known. The Conasauga River once included 43 mussel species, now only six are known. The Coosawattee River once included 20 mussel species, today only 11 are known.[125] Changes in the Coosa Basin are just as dramatic. The extinction rate in freshwater snails in the Coosa Basin is second only to some of the rainforest in South America.[126] Since the early 1900's, more than 40 species of freshwater snails and several mussel species are now presumed extinct. Other species being affected by the 2007 – ongoing drought include striped bass fishery, a world-class spotted bass fishery, and in Mobile Bay, recreational fisheries and commercial shrimp and oyster fisheries.[127] Since the ACT's 16 reservoirs and associated dams are operated primarily to meet navigation and hydropower production needs, the ACT Basin's aquatic ecosystems may not prove resilient to climate change.

[1] http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation

[2] Chapter 28 – Adaptation (V. 11 Jan. 2013, p. 987) in the U.S. Global Change Research Program draft 2013 National Climate Assessment.

[3] U.S. Environmental Protection Agency, *Policy Statement on Climate-Change Adaptation* (Washington, DC, June 2, 2011). Available at http://www.fedcenter.gov/programs/climate/

[4] Final draft *U.S. Environmental Protection Agency Climate Change Adaptation Plan* (June 29, 2012).

[5] http://www.mississippi.org/assets/docs/library/ms_port.pdf

[6] http://www.worldportsource.com/ports/index/USA_FL.php

[7] North American Terrestrial Ecoregions – Level III (April, 2011) Commission for Environmental Cooperation, available at ftp://ftp.epa.gov/wed/ecoregions/pubs/NA_TerrestrialEcoregionsLevel3_Final-2june11_CEC.pdf

[8] These are defined in: Ecoregions of North America as Level III ecoregions, see: http://www.epa.gov/wed/pages/ecoregions/na_eco.htm#Downloads. The focus here is on the Level 3 sub-ecoregions. Level 3 ecoregions are a subset of Level 2 ecoregions which are in turn a subset of a broader Level 1 Ecoregion.

[9] Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C.G. Menéndez, J. Räisänen, A. Rinke, A. Sarr and P. Whetton, 2007: Regional Climate Projections. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA., available at http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter11.pdf

[10] These are defined in: Ecoregions of North America as Level III ecoregions, see: http://www.epa.gov/wed/pages/ecoregions/na_eco.htm#Downloads. The focus here is on the Level 3 sub-ecoregions. Level 3 ecoregions are a subset of Level 2 ecoregions which are in turn a subset of a broader Level 1 Ecoregion.

[11] North American Terrestrial Ecoregions – Level III (April, 2011) Commission for Environmental Cooperation, available at ftp://ftp.epa.gov/wed/ecoregions/pubs/NA_TerrestrialEcoregionsLevel3_Final-2june11_CEC.pdf

[12] Id.

[13] Id.

[14] Id.

[15] Id.

[16] http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Fact_Sheets/Practices/aquaculture.pdf

[17] Id.

[18] Chapter 13 – Land Use and Land Cover Change (V. 11 Jan. 2013, p. 423) in the U.S. Global Change Research Program draft 2013 National Climate Assessment.

[19] Id.

[20] Id.

[21] Id.

[22] CWA section 101(a) states: "The objective of this Act is to restore and maintain the chemical, physical, and biological integrity of the nation's waters."

[23] Id., pp. 1-2.

[24] Ecoregions of North America as Level III ecoregions, see: http://www.epa.gov/wed/pages/ecoregions/na_eco.htm#Downloads.

[25] U.S. Environmental Protection Agency (U.S. EPA). (2012) Implications of climate change for bioassessment programs and approaches to account for effects. Global Change Research Program, National Center for Environmental Assessment, Washington, DC; EPA/600/R-11/036A. Available from the National Technical Information Service, Springfield, VA, and online at http://www.epa.gov/ncea. pp. 7-21.

[26] Id., pp. 7-21.

[27] Id., pp. 5-69.

[28] Id., pp. 1-11.

[29] Id.

[30] Id.

[31] Id.

[32] Id.

[33] Id.

[34] Id., pp. 5-23.

[35] April 2011 US Census estimates (http://quickfacts.census.gov).

[36] P. 3.

[37] Id.

[38] Aging, Administration on. "projected future growth of the older Population ." http://www.aoa.gov/AoARoot/Aging_Statistics/future_growth/future_growth.aspx#age

[39] Ecoregions of North America as Level III ecoregions, see: http://www.epa.gov/wed/pages/ecoregions/na_eco.htm#Downloads.

[40] Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, Part 2. Climate of the Southeast U.S., NOAA Technical Report NESDIS I42-2. Available at http://www.nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_Report_142-2-Climate_of_the_Southeast_U.S.pdf

[41] U.S. Census Bureau 2010.

[42] Id.

[43] Chapter 17, Southeast and the Caribbean, of the Federal Advisory Committee Draft Climate Assessment Report Released for Public Review (volume 11 Jan 2013) see: http://ncadac.globalchange.gov/

[44] Id.

[45] *The Southeast and the Caribbean* (Chapter 17) of the Federal Advisory Committee Draft Climate Assessment Report released for public review (volume 11, January 2013), see: http://ncadac.globalchange.gov

[46] Id.

[47] Id.

[48] Id.

[49] Id.

[50] Id.

[51] Id.

[52] Id.

[53] Id.

[54] Id.

[55] Id.

[56] Id.

[57] Id.

[58] Id.

[59] Id.

[60] Id.

[61] Id.

[62] Id.

[63] Id.

[64] Id.

[65] Id.

[66] Id.

[67] Id.

[68] Id.

[69] Id.

[70] Id.

[71] Southeast Region Technical Report to the National Climate Assessment (Revised July 23, 2012) available at http://downloads.usgcrp.gov/NCA/Activities/NCA_SE_Technical_Report_FINAL_7-23-12.pdf

[72] Id.

[73] Id.

[74] Id.

[75] *The Southeast and the Caribbean* (Chapter 17) of the Federal Advisory Committee Draft Climate Assessment Report released for public review (volume 11, January 2013), see: http://ncadac.globalchange.gov

[76] Southeast Region Technical Report to the National Climate Assessment (Revised July 23, 2012) available at http://downloads.usgcrp.gov/NCA/Activities/NCA_SE_Technical_Report_FINAL_7-23-12.pdf

[77] Id.

[78] Id.

[79] Id.

[80] Id.

[81] Southeast Region Technical Report to the National Climate Assessment (Revised July 23, 2012) available at http://downloads.usgcrp.gov/NCA/Activities/NCA_SE_Technical_Report_FINAL_7-23-12.pdf

[82] Id.

[83] Id.

[84] Id.

[85] Id.

[86] Id.

[87] Id.

[88] Southeast Region Technical Report to the National Climate Assessment (Revised July 23, 2012) available at http://downloads.usgcrp.gov/NCA/Activities/NCA_SE_Technical_Report_FINAL_7-23-12.pdf

[89] Id.

[90] Id.

[91] Id.

[92] Id.

[93] Id.

[94] Id.

[95] Id.

[96] Id.

[97] Southeast Region Technical Report to the National Climate Assessment (Revised July 23, 2012) available at http://downloads.usgcrp.gov/NCA/Activities/NCA_SE_Technical_Report_FINAL_7-23-12.pdf

[98] Id.

[99] Id.

[100] Id.

[101] North Carolina Department of Environment and Natural Resources report, *North Carolina Sea-level rise Assessment Report* (2010) P. 12 and available at http://dcm2.enr.state.nc.us/slr/NC%20Sea-Level%20Rise%20Assessment%20Report%202010%20-%20CRC%20Science%20Panel.pdf

[102] Id.

[103] Id.

[104] *The Southeast and the Caribbean* (Chapter 17) of the Federal Advisory Committee Draft Climate Assessment Report released for public review (volume 11, January 2013), see: http://ncadac.globalchange.gov

[105] Id.

[106] Id.

[107] Id.

[108] Id.

[109] Id.

[110] Id.

[111] *Water Management Issues In Alabama*, by the AL Water Agencies Working Group (August 1, 2012) available at http://www.adem.state.al.us/programs/water/waterforms/WaterIssueReport.pdf

[112]Available at http://geo.usace.army.mil/pgis/f?p=397:12:

[113] http://www.tva.com/sites/sites_ie.htm

[114] Couch, C.A., Hopkins, E.H., and Hardy, P.S., *Influences of Environmental Settings on Aquatic Ecosystems in the Apalachicola-Chattahoochee-Flint River Basin*. (1995) USGS Water-Resources Investigations Report 95-4278. Available at www.pubs.usgs.gov/wri/1995/4278/report.pdf

[115] Id.

[116] Id.

[117] Id.

[118] Id.

[119] Id.

[120] Id.

[121] Id.

[122] Id.

[123] *The Southeast and the Caribbean* (Chapter 17) of the Federal Advisory Committee Draft Climate Assessment Report released for public review (volume 11, January 2013), see: http://ncadac.globalchange.gov

[124] Alabama-Coosa-Tallapoosa Basin, US FWS, available at http://www.fws.gov/southeast/drought/archive/pdf/ACT-BasinQ-A.pdf

[125] Id.

[126] Id.

[127] Id.

PART 2

VULNERABILITY ASSESSMENT

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I. Introduction

The Agency's draft Climate Change Adaptation Plan has defined "vulnerability" as *the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes*.[128] EPA's systems are the various programs implementing its strategic plan goals and statutory mandates. Region 4 is an extension of these systems into the nation's southeastern eight states and the fourteen ecoregions described earlier. This chapter contains an assessment of the vulnerabilities of key EPA Region 4 Programs to the impacts of climate change. It builds on the work presented in Part 2 of EPA's agency-wide Plan, and is structured by the goals in EPA's FY 2011-2015 Strategic Plan. The following begins the discussion of Region 4's program vulnerabilities to climate change in context of the Agency's five strategic plan goals:[129]

Goal 1 - Taking Action on Climate Change and Improving Air Quality within Region 4

Goal 2 - Protecting EPA Region 4's Waters

Goal 3 - Cleaning Up Communities and Advancing Sustainable Development within Region 4

Goal 4 - Ensuring the Safety of Chemicals and Preventing Pollution within Region 4

Goal 5 - Enforcing Environmental Laws within Region 4

Note that EPA Region 4 has not conducted a quantitative vulnerability assessment, but has qualitatively evaluated the nature and magnitude of risks associated with climate change impacts.

II. Goal 1: Taking Action on Climate Change and Improving Air Quality

A. Overview of Potential Climate Change Impacts

Communities within the Southeast face public health and environmental challenges from ambient and indoor air pollution. Climate change will increase these challenges. EPA Region 4 partners with federal, state, tribal and local agencies to protect public health and the environment by directly implementing programs that address air quality (indoor and outdoor), toxic pollutants, climate change, energy efficiency, pollution prevention, industrial and mobile source pollution, radon, acid rain, stratospheric ozone depletion, and radiation protection. Several program areas are vulnerable to future climate conditions that may be characterized by elevated baseline temperatures, increased frequency and duration of heat waves, more extreme swings in weather conditions (drought and precipitation events), and more severe hurricanes and coastal storms. These future conditions will present challenges to EPA to achieve its core mission.

The Clean Air Act (CAA) requires EPA to establish National Ambient Air Quality Standards (NAAQS) for six criteria pollutants. EPA is required to review and consider revisions to these criteria pollutant standards every five years. Once a NAAQS has been established or revised, the

CAA requires states to develop specific plans, State Implementation Plans (SIPs), to attain the standards for each area designated as "nonattainment" for that NAAQS. In other words, the states must demonstrate how its areas will achieve and maintain compliance with standards.

Two criteria pollutants, ozone and particulate matter (PM), appear to be at risk for future ambient level increases caused by a warming climate. Tropospheric (ground-level) ozone pollution is likely to increase due to meteorological conditions that would become more favorable to ozone formation, particularly in the southeastern U.S.[130] Ambient particulate matter levels would likely be affected in some areas by an increase in frequency or intensity of wildfires.[131] Another area of vulnerability to climate change is indoor air quality.

1. Ozone

The current health-based ozone NAAQS is 0.075 parts per million (ppm) on an 8-hour average. While most areas of Region 4 currently meet that standard, the EPA is set to begin considering an even more protective ozone standard sometime this year (2013), which would be followed by a new round of area attainment/ nonattainment designations.

Impacts on ozone programs

- A warming climate could induce ambient ozone level increases, which would in turn may require more stringent pollution controls to attain and maintain the ozone NAAQS than would be necessary under the present-day climate.
- Ground-level ozone is projected to increase in the largest urban areas of the Southeast (Chang et al. 2010).[132]
- Emissions of ozone precursors, such as nitrogen oxides (NOx), are expected to increase from fossil-fuel burning power plants due to increased demand that accompanies increased ambient temperatures.
- Complying with the ozone NAAQS may become more difficult for some Region 4 states, especially those with areas already facing existing ozone problems. Figure 8 presents the results of a modeling study which predicts increases of ground-level ozone concentrations across the southeast up to approximately 3 parts per billion in some urban areas.

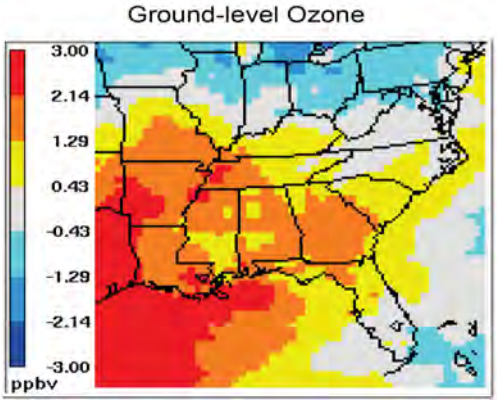


Figure 8. Map showing projected increases in ground level ozone pollution in 2050 as compared to 2001, using a mid-range emissions scenario (A1B, assuming some decrease from current emissions growth trends).

(Adapted from Tagaris et al. 2009)[133]

2. Particulate Matter (PM)

The current PM NAAQS comprise standards for fine particulate matter ($PM_{2.5}$) and coarse particulate matter (PM_{10}). The existing health-based $PM_{2.5}$ NAAQS are a short-term (24-hour average) standard of 35 micrograms per cubic meter ($\mu g/m^3$) and a long-term (annual average) standard of 15 $\mu g/m^3$. In December 2012 the EPA strengthened the annual $PM_{2.5}$ NAAQS by finalizing a new standard of 12 $\mu g/m^3$.[134] The health-based PM_{10} NAAQS is a short-term (24-hour average) standard of 150 $\mu g/m^3$. All areas of Region 4 currently meet the existing $PM_{2.5}$ and PM_{10} NAAQS. EPA will designate areas as being in attainment or nonattainment with the 2012 $PM_{2.5}$ NAAQS in December 2014.

While the impact of climate change on ambient PM levels remains somewhat uncertain, existing evidence suggests that climate change may cause increasing frequency or intensity of wildfires.[135] This potential is particularly important in Region 4, where the Southeast leads the nation in the rate of wildfire occurrences, averaging approximately 45,000 fires per year from 1997 through 2003.[136] Wildland fires contribute an estimated 15 percent of total PM and 8 percent of carbon dioxide (CO_2) emissions over the southeastern USA.[137] An increase in wildfire activity would cause more frequent elevated PM events, which would be hazardous to human health. For example, a study conducted in the Carolinas showed that peat bog wildfires pose a health hazard, with even brief exposure to smoke associated with these types of wildfires has being associated with negative respiratory and cardiovascular outcomes.[138]

Impacts on PM program

- The potential for greater PM concentrations due to wildfire activity may need to be considered when preparing SIPs to demonstrate attainment with the PM NAAQS. For example, increasing background $PM_{2.5}$ levels when modeling future $PM_{2.5}$ concentrations may need to be assumed.
- More information is needed with regard to the potential for increases in both short-term exposure and long-term exposure to PM due to an increase in wildfires.
    - For a short-term exposure assessment, more data is needed on the human population in areas that are most likely to be in close proximity to wildfire activity.
    - To assess the vulnerability to long-term exposure, additional data is needed on how many wildfires per year can be expected, the expected total $PM_{2.5}$ emissions from those wildfires, and modeling to estimate the impact of those emissions on ambient $PM_{2.5}$ levels. This data gap has been identified as a research need by the federal land management agencies.[139]
    - Funding has been made available by the federal Joint Fire Science Program (JFSP) for research on the potential increases in wildfires and resulting air pollution and human health impacts at a regional level. The results of this research are expected to be available in 2015.[140]

3. Indoor Air

The Agency's Indoor Air Program is a non-regulatory program. While Program staff share information, there are no metrics of control and few methods of monitoring results. In Region 4, Program staff largely focus on mold, radon, and asthma, and work with state and local agencies with indoor air quality interest or legislation. Regional staff also tries to be aware of emerging issues in indoor air quality.

Due to the nature of Region 4's hot and humid climate and the nature of the work place, the Region estimates most its population spends 92 percent of its time indoors, consistent with the national population.[141] The anticipated climate change attributes of heavy rains, increased temperatures and high humidity cycles will likely facilitate this trend to continue whereupon the population will be exposed to poorer indoor air quality (from lower ventilation levels, carbon monoxide from emergency power generators); dampness, moisture, and flooding; infectious agents and pests (which may also increase pesticide use); thermal stress; and building ventilation, weatherization, and energy use.[142]

Impacts on Indoor Air program

- The Region expects its population to have increased exposure with identified indoor air agents of concern: heat and biological materials – pollen, molds and infectious agents associated with climate change and associated health concerns.[143] See also the section on impacts to vulnerable populations.

III. Goal 2: Protecting America's Waters

Region 4's waters include the Gulf Coast; Florida Keys; South Atlantic Coast; and the Coastal Plain, Southern Appalachian Mountains, Tennessee River, lower Ohio River, and the southeastern Mississippi River watersheds. The region includes a wealth of ecological and economic resources, such as rivers and streams, barrier islands, extensive estuaries, coral reefs, coastal and freshwater wetlands, busy shipping ports, major metropolitan cities, extensive agricultural production and important commercial and recreational fishing resources. The Southeast has over 434,000 farms on more than 80 million acres, over 138 million acres of timberland, and is home to over one third (1,935 miles) of the lower 48-states' continental coastline, 33 percent of U.S. coterminous estuaries, and nearly 30 percent of all U.S. wetlands.[144,145,146,147,148] Pressures from the continuing population and business growth in the southeastern states on the coastal, piedmont and mountain zones of this region are compounded by increased incidence of drought as well as increased flooding, sea level rise, intense tropical storms and heat-related stress on aquatic ecosystems and human health.

A. Overview of Potential Climate Change Impacts

In March 2012, EPA published the draft *2012 National Water Program Climate Change Strategy*,[149] which described impacts that were documented in reports of the

Intergovernmental Panel on Climate Change (IPCC). These impacts are relevant to the Southeast and can be summarized as follows. [150]

- *Increases in Water Pollution Problems*: Warmer air temperatures will result in warmer water that will hold less dissolved oxygen making instances of low oxygen levels and hypoxia more likely, foster harmful algal blooms and change the toxicity of some pollutants, and could cause an increased number of waters to be recognized as "impaired".
- *More Extreme Water-Related Events*: Heavier precipitation in tropical and inland storms will increase the risks of flooding, expand floodplains, increase the variability of stream flows (i.e., higher high flows and lower low flows), increase the velocity of water during high flow periods and increase erosion. These changes will have adverse effects on water and wastewater management facilities as well as water quality and aquatic system health. For example, increased intense rainfall will result in more nutrients, pathogens, and toxins being washed into water bodies.
- *Changes to the Availability of Drinking Water Supplies*: In some parts of the Southeast, droughts, changing patterns of precipitation, and increased water loss due to evaporation as a result of warmer air temperatures will result in changes to the availability of water for drinking and for use for agriculture and industry. In other areas, sea level rise and salt water intrusion will have a similar effect. Warmer air temperatures may also result in increased demands on community water supplies and the water needs for agriculture, industry, and energy production are also likely to increase.
- *Water body Boundary Movement and Displacement*: Rising sea levels will move ocean and estuarine shorelines by inundating lowlands, displacing wetlands, and altering the tidal range in rivers and bays. Changing water flow to lakes and streams, increased evaporation, and changed precipitation in some areas, will affect the size of wetlands and lakes.
- *Changing Aquatic Biology*: As waters become warmer, the aquatic life they now support will be replaced by other species better adapted to the warmer water (i.e., cold water fish will be replaced by warm water fish). This process, however, will occur at an uneven pace disrupting aquatic system health and allowing non-indigenous and/or invasive species to become established. In the long-term (i.e., 50 years), warmer water and changing flows may result in significant deterioration of aquatic ecosystem health in some areas.
- *Collective Impacts on Coastal Areas*: Most areas of the Southeast will see several of the water-related effects of climate change, but coastal areas are likely to see multiple impacts of climate change. These impacts include sea level rise, increased damage from floods and storms, changes in drinking water supplies, and increasing temperature and

acidification of the oceans. These overlapping impacts of climate change make protecting water resources in coastal areas especially challenging.

- *Indirect Impacts:* The Southeast is susceptible to impacts due to unintended consequences of human response to climate change, such as those resulting from carbon sequestration and other greenhouse gas reduction strategies.

B. Program-Specific Vulnerabilities and Potential Actions

1. Watershed Management

EPA Region 4, working with its state, local and tribal partners, is responsible for managing regulatory and non-regulatory programs to protect and improve water quality in the Southeast's watersheds and estuarine, coastal and ocean waters. As better information is developed for local decision making, changes may be needed in how EPA Region 4 and our partners implement water quality programs, including Water Quality Standards, monitoring and assessment, Total Maximum Daily Loads (TMDL), Effluent Guidelines, National Pollutant Discharge Elimination System (NPDES), nonpoint pollution control programs, stormwater management and other watershed management programs. Potential vulnerabilities to Region 4 Watershed Management efforts include:

- Higher air and water temperatures combined with nutrient pollution may result in increased growth of algae and microbes that threaten aquatic ecosystems.
- Higher air and water temperatures may increase pollutant concentrations and lower dissolved oxygen levels, potentially resulting in additional water bodies not meeting water quality standards and being listed as impaired.
- Areas experiencing periods of less precipitation, drought, lower stream flow and limited ground water recharge may result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments.
- Areas with increased intensity of drought or that may experience increases in events such as wildfires may see alterations in the structure and function of watersheds potentially affecting regional and state wetlands delineation and protection programs.
- Increased intensity of rainfall events and storms may cause an increase in the number of sewer overflows and wastewater bypasses, fouling streams and requiring increased water quality enforcement.

2. Water Quality Standards

Water Quality Standards are the foundation of the Clean Water Act – they designate the goals and uses for water bodies, setting criteria to protect those uses, and establishing provisions to protect water bodies from pollutants. States, territories, and authorized tribes establish water quality standards, and EPA reviews and approves those standards. Potential vulnerabilities to Region 4 Water Quality Standards efforts include:

- Warmer waters and other ecological shifts will threaten aquatic habitats and aquatic species, such as cold water fisheries and potentially requiring changes in State stream classifications. Rising stream temperatures could significantly reduce viable habitat for several species of cold-water fish in North Carolina, including brook trout.
- Salinity changes due to seal level rise may create a need to reclassify some water bodies from fresh to salt water. Sea-level rise may also result in a shifting from fresh water communities to salt water communities, such as is happening in the Chassohowitzka River System in Florida. Increased anthropogenic use of freshwater upstream may be a significant contributor in converting fresh to salt water.

3. Monitoring, Assessing, and Reporting

Our nation's waters are monitored by state, federal, and local agencies, universities, dischargers, and volunteers. Water quality data are used to characterize waters, identify trends over time, identify emerging problems, determine whether pollution control programs are working, help to direct pollution control efforts to where they are most needed, and respond to emergencies such as floods and spills. Potential vulnerabilities to Region 4 Monitoring efforts include:

- Stream ecosystems will be affected directly, indirectly, and through interactions with other stressors. Biological responses to these changes will vary regionally and could include altered community composition, interactions, and functions. .
- Monitoring locations may need to be re-located in order to effectively monitor and assess changes in stream ecology or water quality.
- Timing of monitoring may need to change in order to pick up seasonal shifts and the full range of climate vulnerability, especially for recreational and aquatic life uses.

4. Total Maximum Daily Loads

Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop Total Maximum Daily Load ("TMDLs") for these waters. A TMDL is a calculation of the maximum amount of a pollutant a waterbody can receive and still safely meet water quality standards. Potential vulnerabilities to Region 4 TMDL efforts include:

- Some areas may experience periods of less precipitation, drought, lower stream flow and limited ground water recharge resulting in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments; these considerations will need to be taken into account in the development of new TMDLs, and potentially result in the need for revision of existing TMDLs.
- Some areas may experience episodes of increased intense precipitation resulting in increased runoff of pollutants; these considerations will need to be taken into account in

the development of new TMDLs, and potentially result in the need for revision of existing TMDLs.

5. National Pollutant Discharge Elimination System

Water pollution degrades surface waters making them unsafe for existing uses, including drinking water, fishing, swimming, and other water recreation. As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. NPDES permits have a five-year permitting cycle. Potential vulnerabilities to Region 4 NPDES efforts include:

- Areas experiencing periods of less precipitation, drought, lower stream flow and limited ground water recharge will result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments. National Pollutant Discharge Elimination System (NPDES) permits will need to take these factors into consideration during permit renewal or new permit issuance. These precipitation changes are compounded in certain areas by increased human uses of the water resources.
- Increased intensity of rainfall events and storms may cause an increase in the number of sewer overflows and wastewater bypasses, fouling streams and requiring increased water quality enforcement.
- Increased aquatic temperatures may result in the need to modify existing discharge limits.

6. Nonpoint Source Management

Nonpoint source pollution comes from many diffuse sources and is caused by rainfall runoff that picks up natural and human made pollutants and deposits them in lakes, rivers, wetlands, coastal waters and ground water. State nonpoint source programs, developed under the Clean Water Act (CWA) Section 319 Program, are working to meet this challenge. Potential vulnerabilities to Region 4 Nonpoint Source Management efforts include:

- Increased intensity of rainfall events and storms will cause increased pollutant loads in runoff, and the velocity of runoff will scour and erode creek beds.
- Accounting for greater quantities of runoff and pollutants, with more variability, from both urban and suburban stormwater and agricultural sources will stress existing nonpoint source best management programs.

- Decreasing frequency of precipitation days and more concentration of runoff in intense storms, which is likely to be more damaging to aquatic habitats, and carry more erosion-related pollutants into water bodies will stress existing nonpoint source best management programs.

7. Wetlands

Section 404 of the Clean Water Act requires EPA concurrence before the U.S. Army Corps of Engineers may issue permits to allow dredging or filling of wetlands. Wetlands function to

protect ecosystems, streams and other aquatic resources. Wetlands provide crucial climate change functions including: 1) coastal protection in the face of sea level rise and increased hurricane intensity, including the ability to reduce wave energy; 2) protection of water supplies in the face of increased drought conditions by providing groundwater recharge and maintaining minimum stream flows; 3) flood mitigation in the face of increased precipitation and storm frequency; and 4) carbon sequestration. The capacity of wetlands and headwater streams to reduce flood peaks, detain stormwater, and filter pollutants is critical to the protection of life, property, and water quality. Potential vulnerabilities to Region 4 Wetlands Program efforts include:

- Areas with increased intensity of drought or that may experience increases in events such as wildfires may see alterations in the structure and function of wetlands and watersheds potentially affecting regional and state wetlands delineation and protection programs.
- Sea-level rise combined with coastal development will challenge the ability of coastal wetlands to migrate, potentially affecting coastal wetland protection programs. This migration will likely result in loss of coastal wetlands where development has encroached on natural migration pathways.
- Drying out of seasonal wetlands with increased drought could affect wetland delineations and programs.
- Physical damage or elimination of wetlands and dune structures that protect them due to hurricanes and other seasonal changes could affect wetland delineation and restoration efforts.

8. Dredging/Ocean Dumping

The Ocean Dumping and Dredged Materials Management programs established by Congress in 1972 prohibit ocean dumping of materials that would unreasonably degrade or endanger human health or the marine environment. Potential vulnerabilities to Region 4 Dredging/Ocean Dumping efforts include:

- Increased need and frequency of ocean dumping due to increased precipitation and rainfall intensity that cause erosion and sedimentation of rivers, channels and harbors.
- Shifting sediments and forming of shoals due to higher intensity storms that impede safe navigation in harbors and channels may require increased use of emergency dredging.
- Need for dredged materials to protect shorelines, beaches, dunes and marshes from sea level rise may stress existing regulatory programs.

9. National Estuary Program and South Florida

The National Estuary Program (NEP) was established in 1987 to restore and protect the physical, chemical, and biological integrity of “estuaries of national significance” by focusing our Clean Water Act authorities in these highly productive ecosystems. There are 28 NEPs across the country, six of which are entirely or partially within EPA Region 4. Region 4 NEPs promote collaborative actions and best management practices to accelerate and embellish implementation of “core” Clean Water Act programs. Lessons learned by the NEPs are shared

across the network of 28 programs nationally, as well as with other coastal watersheds facing similar water pollution and water quality impairments. This approach has proven to be a success over the past 25 years and the NEP is seen as a model for other comprehensive watershed and community-based programs.

The Florida Keys Water Quality Protection Program (FKWQPP), established in 1994, is administered by EPA and FL DEP, and includes a working group consortium of local, state, federal agencies and non-government representatives. The FKWQPP works to recommend and implement management activities designed to maintain and restore the water quality needed for healthy native plant and animal populations in the FL Keys National Marine Sanctuary waters. Through the Water Quality Protection Program, water quality, seagrass meadows, and coral reefs have been monitored in the sanctuary since the mid-1990s.

Potential vulnerabilities to Region 4 NEP and South Florida Program efforts include:

- Successful implementation of NEP Comprehensive Conservation and Management Plans may be adversely affected. Efforts to restore or enhance water quality, habitat, living resources, hydrologic alterations, and human uses may be affected.
- Increased ocean temperatures and acidification resulting from the absorption of CO_2 will continue to stress coral reefs potentially affecting coral reef protection programs.

10. Drinking Water, Wastewater, and Stormwater Infrastructure

Much of the Southeast has enjoyed the benefits of clean and safe water resulting from an extensive network of drinking water, wastewater and storm water infrastructure. EPA recognizes that this infrastructure is aging and is being further taxed by the impacts of climate change. As state, local and tribal governments face more demands for increasingly limited resources, the ability to respond to these growing infrastructure pressures becomes more complicated. Potential vulnerabilities to Region 4 Drinking Water, Wastewater, and Stormwater Infrastructure Program efforts include:

- Higher air and water temperatures combined with nutrient pollution will result in increased growth of algae and microbes that affect drinking water treatment needs.
- Increased intensity of rainfall events and storms could contribute to additional infiltration/inflow in wastewater conveyance systems, which could cause an increase in the number of sewer overflows and wastewater treatment plant overloads, requiring expensive modifications and improvements to both wastewater conveyance and treatment systems.
- Increased drought will place demands on both surface and ground water resources resulting in water supply problems.
- Reduction in assimilative capacity of existing surface waters due to reduced stream flows and/or increased temperatures could lead to more stringent discharge limits on existing wastewater facilities, resulting in the need for expensive improvements or upgrades to maintain permit compliance.
- Sea level rise could result in: 1) saltwater intrusion into the collection system of wastewater treatment systems; 2) wet wells in pumping systems leading to increased

corrosion damage to pumping equipment, and treatment plant tankage and equipment; and 3) malfunction of gravity conveyance systems and discharges.

- Increases in flooding from extreme precipitation, storm surges, and loss of wetlands could cause damage to infrastructure resulting in increased needs for SRF funding.
- Source water intake changes may be needed due to droughts and summertime extreme heat. Coastal aquifers may experience salt water intrusion where withdrawals are outstripping recharge and increased pressure head from higher sea levels may worsen this problem resulting in the need for relocation of water and wastewater facilities.
- Drinking water and wastewater utilities emergency planning for extreme weather events may need to be reviewed and modified to account for climate change. Vulnerable and economically deprived communities may be particularly at risk, both for access to clean and safe water as well as for their ability to respond to emergencies during extreme events. Coastal and mountain communities will be particularly vulnerable.
- Changes in rainfall patterns may lead to additional water supply infrastructure, with associated impacts on ecosystem fragmentation, aquatic life, physical stability, water quality, disruption of sediment and nutrient dynamics, downstream users, and system losses due to increased evaporation from impoundments. CWA Section 404 permit applications for reservoir creation in response to drought have increased in some states.

11. Drinking Water Quality

The Safe Drinking Water Act (SDWA) is the main federal law that ensures the quality of Americans' drinking water. EPA sets standards for drinking water quality and oversees the state, local, and water suppliers who implement those standards. EPA Region 4 ensures that the public water supply systems comply with national drinking water quality standards and underground sources of drinking water are protected from contamination.

Potential vulnerabilities to Region 4 Drinking Water Quality efforts include:

- Higher air and water temperatures will promote increased growth of algae and microbes, which will increase the need for drinking water treatment and potentially affect the aesthetic quality of drinking water supplies.
- Increased storm water runoff will wash sediment and other contaminants into drinking water sources, requiring additional treatment.
- Sea-level rise could increase the salinity of both surface water and ground water through saltwater intrusion, encroaching upon coastal drinking water supplies. Additionally, extreme weather events such as hurricanes and extreme droughts could impact and potentially permanently affect both the availability and quality of drinking water sources. In southeastern areas with saltwater intrusion, Region 4 states may receive more permit applications and issue more permits for Class V aquifer recharge injection wells under the Underground Injection Control (UIC) program in an attempt to combat the effects of saltwater intrusion caused by sea-level rise.
- Reduced annual precipitation or increased intensity and duration of drought in some regions will affect water supplies, causing drinking water providers to reassess supply plans and consider alternative pricing, allocation and water conservation options.
- In areas with less precipitation, public water supply systems water demand may rely more heavily on underground aquifers or development of underground storage of treated water

to supplement existing sources. Changes in the salt front of estuaries and tidal rivers due to sea level rise and over use of fresh surface and ground water resulting in flow changes may result in increased pressure to manage freshwater reservoirs to increase flows and attempt to maintain salinity regimes, in order to protect estuarine productivity and drinking water supplies.

IV. Goal 3: Cleaning up Communities and Advancing Sustainable Development

Contaminated site cleanup occurs under a variety of EPA programs, most commonly Superfund (i.e., remedial, time-critical removal, emergency response programs), the Resources Conservation and Recovery Act (RCRA), the Toxic Substances Control Act (TSCA) (e.g., PCBs), Brownfields, Underground Storage Tanks (UST)/Leaking Underground Storage Tanks (LUST) and the Oil Pollution Act (OPA). A high percentage of cleanups, including most brownfields sites, are regulated through State programs.

The potential climate change impacts described in Section IV.A below broadly apply to each of these programs; however, the implications of these climate change impacts may differ by program. Potential program-specific focus areas and vulnerabilities are discussed in Section III.B.

A. Overview of Potential Climate Change Impacts

For the Southeast, the impacts that could most likely pose risks to contaminated site cleanups and waste management facilities are sea level rise, extreme storm events (precipitation and wind), temperature extremes, wildfires, decreasing precipitation days and increasing drought intensity. Ocean acidification and increased water temperatures may also pose additional risks to coastal facilities and affect the natural bio-degradation of chemicals released to the environment. Potential environmental conditions arising from these impacts and specific examples illustrating how they could potentially influence contaminated sites are described below. The likelihood and severity of climate change impacts can also be expected to vary considerably from site-to-site depending on the location, cleanup technologies and approaches, and many other factors.

1. Sea Level Rise

As discussed previously, sea level rise is expected to impact coastal areas affecting every state in the Region 4 except for Tennessee and Kentucky. This impact on contaminated sites and petroleum storage facilities may be partially mitigated because it is expected to occur gradually over the course of several decades. This allows additional time to appropriately plan for and respond to sea level rise (e.g., construction of berms, removal of wastes, and completion of shorter-term treatment activities). Contaminated sites and petroleum storage facilities located in vulnerable areas could experience impacts due to inundation and salt water intrusion. Examples

include flooding of petroleum storage facilities, long-term waste management areas, and uncontrolled (or undiscovered) contamination leading to the release and dispersal of contaminants; corrosion of underground tanks, piping, and other equipment; and degradation of coastal aquifers that impacts cleanup performance goals. Saltwater intrusion may impair habitat restoration efforts of impacted surface areas (like wetlands); and may change soil and water chemical and biological properties, thereby impacting toxicity, transport, natural degradation of contaminants, and treatment efficacy. For example, intrusion may impact the ability of native microorganisms to play a role in bioremediation of petroleum-impacted soils.

2. Extreme Storm Events

Existing climate studies suggest that Region 4 has been experiencing more intense storm events. Unlike sea level rise which predominantly affects coastal areas, extreme storm events can impact a much wider range of contaminated sites. These impacts could include:

- flooding of surface water bodies and surrounding land areas due to heavy precipitation events (i.e., regional drainage)
- flooding of coastal areas and rivers from storm surge due to higher intensity hurricanes,
- increased local surface runoff,
- increased infiltration of storm water into soils and elevation of water tables, and
- increased wind damage and dispersion of contaminants.

Prior to the enactment of environmental laws, industrial wastes were routinely discharged to rivers, streams and other water bodies. As a result, many contaminants may exist within the layers of sediment that accumulated over the years. One potential impact of extreme storm events is the spread of contaminants through erosion, exposure of formerly buried contaminants, dissolution or suspension of contaminants, and deposition of contaminated soils or sediments. River flooding that breaches dams may result in the spread of contaminated sediment previously contained by the dams. Flooding of chemical facilities may mobilize contaminants through stormwater runoff. Increased precipitation events and hurricanes can potentially impact sites even if they are remote from coastal areas and rivers.

Extreme weather can delay or impair active removal and remedial operations, and complicate a remedy due to such impacts as flotation of tanks or drums, , damage of engineered sediment caps, damage to treatment systems, impacts to contaminated structures, and damage to containment systems by the forces of wind and water – all of which can create risks to human health and the environment.

3. Temperature Change

The direct consequence of elevated temperatures on contaminated site cleanups is not expected to be significant. However, elevated temperatures could lead to increased pressurization of storage containers, volatilization of hazardous materials, and other factors which may affect design and operation of remediation systems and emergency response actions.

Worker health and safety concerns during site operations may also be impacted by higher temperatures (e.g., handling of pressurized drums, heat stress to responders).

4. Wildfires

The increase in wildfires may impact treatment facilities and above ground storage units. The disruption of treatment will impact costs and restoration time frames.

5. Ocean Acidification

The acidification of sea water may adversely impact the corrosion and degradation of pipelines and construction materials (e.g. concrete pads/berms) used to convey, store, or contain petroleum products at coastal facilities.

6. Increased Water Temperatures

Increased water temperatures may lead to a change in native or endemic organisms available for biotic degradation of petroleum released to the environment.

B. Program-Specific Vulnerabilities and Potential Actions

1. Longer-term Cleanups (e.g., Superfund Remedial, Superfund Time-Critical Removal, RCRA Corrective Action, TSCA, Brownfields Cleanup Sites, and Polychlorinated Cleanup)

Longer-term response cleanups such as the Superfund remedial program and the RCRA corrective action program are intended to protect human health and the environment, maintain protection over time, minimize the amount of untreated waste, and reduce ecological risks to levels that will result in the recovery and maintenance of healthy local populations and communities of biota. These cleanups are generally viewed as "permanent" solutions. Other cleanup programs such as the Superfund time-critical removal program address more immediate threats; however, in many cases these may also result in long-term cleanup remedies.

2. Impacts on Longer-term Cleanups:

Cleanups where waste is left in place (e.g., landfills, cap-in-place remedies) or cleanups that involve treatment that occurs over a long period of time (e.g., ground water pump & treat systems) could be especially vulnerable to changes in climate. For cleanup operations that are typically of much shorter duration (e.g., soil vapor extraction, enhanced thermal treatment), the impacts of climate change are more predictable and easier to factor into the selection and design of a particular remedy.

a) Programmatic Vulnerabilities

- Physical impacts to Superfund actions of all durations are likely to include the following:
  - Both removals and remedial actions may involve labor-intensive operations, sometimes for an extended length of time, and are therefore vulnerable to the acute impacts of climate change: e.g. flooding, ground water hydrology, temporary or long-term power outages, extreme heat, wind impacts.
  - Such impacts may complicate assessment phases.

- There may be heightened risk of physical damage to buildings and other components of the existing site and the remedy, such as storm movement of drums or other containers, or damage to booms and other containment structures.
- Off-site disposal, waste transport, equipment capabilities and laboratory capabilities may be overwhelmed by extreme storm events. Temporary on-site staging of hazardous materials may be compromised.
- Extreme storm events may provide increased hazards for EPA staff and contractors on site.
- Climate impacts to infrastructure may hamper response time and capability, including but not limited to the ability to move equipment and to transport hazardous materials for disposal.

- Programmatic impacts to the Superfund program include an ability to adequately plan for and execute in a changed environment:
  - The preliminary assessment/site investigation (PA/SI) phase of time-critical removal actions or an Remedial Investigation/Feasibility Study (RI/FS) are based on existing information -- typically historical information, not future predictions. Without incorporating potential climate change impacts, an accurate risk may not be factored into planning or prioritization. Assumptions and modeling previously relied upon in an area may no longer be valid
  - The remedy selection process must also adequately consider climate impacts. Precipitation records and floodplain maps used for remedy selection and design may not account for future climate change impacts, for example.
  - More robust remedies such as excavation and removal of wastes may be required for sites potentially vulnerable to sea level rise and flooding, increasing short-term costs.
  - Climate change may increase the mobility of contaminants and reduce the effectiveness of containment as a remedy.
  - Designs may have to be based on conservative assumptions to reflect uncertainty over future environmental conditions, including extreme storm events that increase surface water runoff or infiltration.
  - Future population growth will most likely result in people living in areas near Superfund sites previously less occupied, contributing to a need for reassessment of scoring, risks and protectiveness of existing sites and remedies. Reevaluation of sites previously considered for the NPL may be necessary.
  - Changes in exposure pathways for both human and ecological receptors will result from sea level rise, coastline alteration and other factors. These may include such aspects as changes to drinking water system intakes, floodplain reach to residential areas, and rates of erosion. Remedy design and standards may need to reflect projections.
  - Climate impacts may also alter the biological communities impacted by a Site, such as increasing risk to seafood sources.
  - Health and Safety Plans should adequately anticipate extreme storm events.
  - Not only will potential impacts on ecological receptors differ from past experience, but also the ecological receptors themselves may differ due to migration of species and habitat alteration. Remedies should anticipate additional future impacts.
  - Increased sophistication of modeling and planning may raise engineering costs as well as execution costs.

b) State by State Assessment

- *Alabama*: Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in Alabama, only Mobile is located on the coast. Most other large cities are located on or near waterways may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 15 Superfund or Superfund Alternative Sites are located in the State; 10 of these sites have ongoing five-year reviews required by residual waste.
- *Florida*: Most of the state will be susceptible to flooding and coastal areas will be susceptible to saltwater intrusion. Seven out of 10 of the largest population centers in Florida are located on the coast (Jacksonville, Miami, Tampa, St. Petersburg, Ft. Lauderdale, Port St. Lucie, and Coral Gables). Because of population and groundwater impacts, there are more Superfund Remedial sites in Florida than other Region 4 states. Currently 66 Superfund or Superfund Alternative Sites are located in the State; 39 of these sites have ongoing five-year reviews required by residual waste.
- *Georgia*: Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in Georgia, only Savannah is located on the coast. Most other large cities are located on or near waterways and may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 15 Superfund or Superfund Alternative Sites are located in the State; 9 of these sites have ongoing five-year reviews required by residual waste.
- *Kentucky*: There are no coastal areas, and saltwater intrusion will not be a concern. Large cities located on or near waterways, such as the Ohio River, may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 14 Superfund or Superfund Alternative Sites are located in the State; 12 of these sites have ongoing five-year reviews required by residual waste.
- *Mississippi*: Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in Mississippi, only two (Gulfport and Biloxi) are located on the coast. Most other large cities are located on or near waterways and may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 8 Superfund or Superfund Alternative Sites are located in the State; 1 of these sites has ongoing five-year reviews required by residual waste.
- *North Carolina:* Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in North Carolina, only Fayetteville, Wilmington and Greenville are located in the coastal plain. Most other large cities are located on or near waterways and may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 41 Superfund or Superfund Alternative Sites are located in the State; 25 of these sites have ongoing five-year reviews required by residual waste.
- *South Carolina:* Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in South Carolina, only Charleston and Mount Pleasant are located on the coast. Other large cities are located on or near waterways and may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 30 Superfund or Superfund Alternative Sites are located in the State; 22 of these sites have ongoing five-year reviews required by residual waste.
- *Tennessee:* There are no coastal areas, so saltwater intrusion is not a concern. Large cities located on or near waterways, e.g., the Cumberland and Mississippi Rivers may be

more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 25 Superfund or Superfund Alternative Sites are located in the State; 10 of these sites have ongoing five-year reviews required by residual waste.

Table 4. State Comparisons of Coastline and Superfund Sites

	AL	GA	FL	KY	MS	NC	SC	TN
General Coastline[1] (statute miles)	53	100	1350	0	44	301	187	0
Tidal Coastline[2] (statute miles)	607	2344	8426	0	359	3375	2876	0
Superfund and SAS Sites	15	15	66	14	8	41	30	25
Five-Year Review Sites	10	9	39	12	1	25	22	10
Population	4,822,023	9,919,945	19,317,568	4,380,415	2,984,926	9,752,073	4,723,723	6,456,243
Climate-Change Impact Rank	5	4	1	8	6	2	3	7

Notes:

1. Figures are lengths of general outline of seacoast. This does not include freshwater coastlines. Measurements are made with unit measure of 30 minutes of latitude on charts as near scale of 1:1,200,000 as possible. Coastline of bays and sounds is included to point where they narrow to width of unit measure, and distance across at such point is included.
2. Figures were obtained in 1939–1940 with recording instrument on the largest-scale maps and charts then available. Shoreline of outer coast, offshore islands, sounds, bays, rivers, and creeks is included to head of tidewater, or to point where tidal waters narrow to width of 100 feet.

**Source:* Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service.

3. Emergency Response Programs

EPA coordinates and implements a wide range of activities to ensure that adequate and timely response measures are taken in communities affected by hazardous substances and oil releases where state and local first responder capabilities have been exceeded or where additional support is needed. EPA's emergency response program responds to chemical, oil, biological and radiological releases and large-scale national emergencies, including homeland security incidents. EPA conducts time-critical and non-time-critical removal actions when necessary to protect human health and the environment by either funding response actions directly or overseeing and enforcing actions conducted by potentially responsible parties.

EPA Region 4 has an approximate total coast line of 2,035 miles that may be impacted by large weather events, such as hurricanes. An increase in storm severity and sea level rise may cause large storm surge damage in communities and industrial facilities along Region 4's coast line. In addition, inland flooding due to intense and frequent storms may cause extensive flood damage in communities and industrial facilities that were not predicted to be affected under current flood maps. These large events will require the need of ample resources of On Scene Coordinators, Remedial Project Managers and Response Support Corps (RSC) members to be deployed to respond in the following areas:

a) Impacts on Emergency Response Programs

- Smaller entities with hazardous materials may lack resources for emergency planning, which may increase the risk of abandoned hazardous materials during a flooding or storm event.
- Local capacity to treat and dispose of hazardous and municipal waste may be overwhelmed by surges in mixed waste from climatic events.
- Releases of hazardous materials or chemicals through high winds, flooding, and storm surge may create a need for increased frequency and intensity of emergency response for both hazardous materials and oil. Current response resources, including laboratory requirements, may not be adequate for responses to extreme events. Specific impacts include:
  - Increased number of brown/black outs will potentially lead to impacts on facility processes (i.e. runaway reactions, heat reactions, failure of chemical processes)
  - Coastal hazardous material and oil facilities may be impacted by extreme events and storm surge. The United States Coast Guard (USCG) has jurisdiction over hazardous material and oil spills along the coast, but EPA has interagency agreements in place to support the USCG during responses.
- Extreme storm and flooding damage to homes will produce an increase in the amount of household hazardous waste and white goods (i.e., refrigerators, air conditioners, etc) that may need to be collected and placed in landfills. An increase in household hazardous and industrial waste collected during disaster events may strain waste landfill capacity and require the construction of additional landfill capacity.

- Storm surge caused by coastal storms, hurricanes and sea-level rise may adversely impact industrial facilities located along the coast and cause releases of chemicals, discharges of oil and mobility of orphan containers (i.e., above-ground storage tanks, drums, and totes) in the affected area.
  - Oil facilities that are required to have Facility Response plans or Spill Prevention, Control, and Countermeasure (SPCC) plans may experience large impacts due to extreme rain fall events.
  - The Region will need to maintain the Response Support Corps concept to provide for additional personnel during the Agency response to FEMA disaster declared responses. This will require the continued recruitment of RSC members, training and exercises.
- Pest type and range may change with climate change, and there may be an increase or change in type of pesticides stored and transported across the region, resulting in a potential increase in releases.
- Twenty-seven percent of the major roads, 9 percent of the rail lines, and 72 percent of the ports in Region 4 area are built on land at or below 4 feet above sea level in elevation, a level within the range of projections for relative sea-level rise in this century. Increased storm intensity may lead to increased service disruption and infrastructure damage. More than half of the area's major highways (64 percent of interstates, 57 percent of arterials), almost half of the rail miles, 29 airports, and virtually all of the ports, are below 23 feet in elevation and subject to flooding and damage due to hurricane storm surge.
- Additional planning for emergency response may be needed:

- Brown and black-outs may cause releases and the frequency and intensity of storms may need to be incorporated into current national and area contingency plans.
- Facility Response Plans (FRP) and SPCC plans may not consider climate change impacts.
- Current regional debris management plans rely on historical climate assumptions and do not address the increasing uncertainty in climatic extreme events.
- Additional planning may be needed as Stafford Act declaration (federal emergency declaration) may be more frequent with a changing climate.
- Current energy infrastructure (oil, natural gas, nuclear) in South East may not include climate change assumptions for emergency planning.

b) State by State Assessment.

- *Alabama:* Mobile is the largest city on the State's coast and it is the 27th busiest container port in the U.S. Areas surrounding Mobile Bay have various chemical and oil facilities that may be impacted by the storm surge caused by a very large hurricane.
- *Florida:* Of the 10 largest population centers in the State, seven (Jacksonville, Miami, Tampa, St. Petersburg, Ft. Lauderdale, Port St. Lucie, and Coral Gables) are located on the coast. The Ports of Miami, Jacksonville, Everglades, Palm Beach and Tampa, are ranked as the 13th, 14th, 15th, 23rd and 34th busiest container ports in the nation, respectively. These cities have a significant industrial and population base that has the potential to produce a large amount of household hazardous waste and industrial waste resulting from storm surge impacts due to a large hurricane.
    - Additionally, the State has a large phosphate mining and phosphate fertilizing processing industry mostly concentrated in the central Florida region. One of the byproducts of phosphate fertilizer production is phosphogypsum. There are currently about 1 billion tons of phosphogypsum stored in 24 stacks in Florida and about 30 million new tons are generated each year. One of the concerns is a large weather event (hurricane) could affect the stability of one of these stacks and may cause a release of low acidic process water to the environment.
- *Georgia:* The City of Savannah is the nation's fourth busiest container port and the second busiest in the East Coast. A large hurricane can be devastating to the area and produce a large amount of hazardous materials and debris to be spread through the area. The State has two CCR Surface Impoundments that were determined to be a High Hazard Potential by EPA.
- *Kentucky:* The State has experienced flooding in the past and increase in the severity of rain fall events will continue to cause flooding in the State.
- *Mississippi:* The State's coastline has three cities: Pascagoula, Gulfport and Biloxi. These cities were affected heavily by Hurricane Katrina and produced large amounts of household hazardous waste and industrial debris from the hurricane's storm surge. The Port of Gulfport is the 21st busiest container port in the U.S. and was heavily affected by Hurricane Katrina. A large amount of the port's cargo was dispersed by the storm surge into the bordering community.
    - The Pascagoula coast has one of the largest refineries in the U.S. and a direct hit by a large hurricane may cause the release millions of gallons of oil and gasoline to the Gulf of Mexico. Also, the area has a large phosphate fertilizer

manufacturing plant that contains large stacks and may release low pH waste water due to heavy rain events.

- *North Carolina:* The Port of Wilmington is the 19th busiest container port in the nation and may be vulnerable to storm surge damage resulting from a hurricane. The State is prone to large flooding associated with rains caused by Hurricanes passing through the State.
    - In 1999, Hurricane Floyd caused extensive flood damage in eastern North Carolina. In 2004, Hurricane Ivan caused extensive flooding in the Appalachian Mountain region of western North Carolina. These extreme events produced large amounts of orphaned containers and household hazardous waste.
    - Due to groundwater contamination, Region 4's Superfund Removal program has had to supply an alternative water source to various communities in the State. Because of an increase in extreme rainfall events, additional contaminated groundwater wells may be identified by the State and may require EPA to provide these communities an alternative water source.
- *South Carolina:* The coastal zone of the State is described as the Low Country and includes City of Charleston. This city is also a major port and is ranked the 10th busiest container port in the nation. The area is a flat and is susceptible to flooding, and could be heavily impacted by coastal storm surge from a major hurricane.
- *Tennessee:* Even though the State does not have a coast line, heavy rainfall can cause major flooding events. During May of 2010, Nashville and surrounding counties experienced large rainfall over a two day period that caused extensive flooding in the area. EPA Region 4 Emergency Response program responded to the area and conducted assessments of major oil and industrial facilities and recovered orphan containers that were dispersed by the flood waters. The increase of the severity of rain fall events due to climate change will produce flooding in the State.

4. RCRA Hazardous Waste Management Facilities

RCRA regulates, among other things, the treatment, storage, and disposal of hazardous wastes. Owners/operators of these treatment, storage, and disposal (TSD) facilities must generally obtain a permit for those activities. Facilities that generate hazardous waste and store it for less than 90 days are also regulated under RCRA. In Region 4, the individual states are authorized to implement this program in lieu of EPA.

In order to operate as a TSD facility, the owner/operator must comply with numerous technical requirements, which ensure that covered activities are conducted in a manner that is protective of human health and the environment. These requirements apply to on-going hazardous waste management units (e.g., drum and tank storage, surface impoundments, waste piles), as well as to the closure (i.e., cleaning and decommissioning) of those units that are no longer in use. TSD facilities must also conduct cleanup of past and present releases of hazardous constituents.

a) Impacts on RCRA Hazardous Waste Management Facilities

The same climate change impacts that could affect contaminated site cleanups may also affect the management and operation of hazardous waste facilities. Some examples are:

- Flooding may disrupt the transportation system in place to handle waste. For example, flooding may disrupt the pick-up of waste in neighborhoods and business or the work performed at transfer stations. Cities with transfer stations along waterways are at particular risk.
- A major storm event may increase the amount of solid waste generated and lead to the release of fuel or hazardous materials.
- Changes in precipitation may impact waste management practices such as composting by affecting biological processes.
- Vegetative cover on landfills may be compromised due to dry soil conditions.
- Tanks containing hazardous waste could be damaged by high winds or flying debris during hurricanes.
- Integrity of drums and drum storage areas could be compromised by flooding, allowing drums to be floated out of containment barriers, or cause intermingling of incompatible wastes, etc.
- The potential for failure of process equipment (e.g., pressure relief valves, emergency vent fans and pumps) could increase with increases in winter rain and ice storms.
- Over-pressurization of tanks containing volatile wastes and the emergency venting of these wastes could occur with extreme ambient temperatures.
- Buildings or other structures used for indoor storage of waste piles could be damaged or flooded in a hurricane causing the release of this material.
- Emergency evacuation routes for facility personnel and the surrounding community, as well as facility access by fire and other emergency response vehicles, could be flooded or otherwise restricted due to an extreme storm event.
- States may need to alter selected financial assurance remedies to ensure protection.

While Region 4 states are authorized to implement the RCRA hazardous waste management program, EPA retains oversight authority to ensure compliance with the statute and regulations and there may be a need for increased coordination to respond to climate change impacts. Region 4 will work with state programs and industry to modify operating facility permits to include enhanced emergency preparedness requirements appropriate for climate change impacts.

b) Programmatic Vulnerabilities for EPA's oversight role

- Uncertainties in the underlying assumptions that could affect the design, operation and management of hazardous waste facilities, including contingency planning (e.g., RCRA TSD facilities must meet specific requirements if waste management units are located within a 100-year floodplain).
- Financial assurance estimates for closure/post-closure may not reflect changing climate change impacts on those activities.

5. Oil Program and Underground Storage Tanks

OPA was signed into law in August 1990. The OPA improved the nation's ability to prevent and respond to oil spills by establishing provisions that expand the federal government's ability, and provide the money and resources necessary, to respond to oil spills. To reduce the likelihood

of a spill, regulations issued under CWA Section 311(j) (published at 40 CFR Part 112) require facilities that store oil in significant amounts to prepare SPCC plans and to adopt certain measures to keep accidental releases from reaching navigable waters. Certain types of facilities that pose a greater risk of release must also develop plans to respond promptly to clean up any spills that do occur.[151]

EPA created the Office of Underground Storage Tanks to carry out a Congressional mandate to develop and implement a regulatory program for UST systems. EPA works with its state, territorial, and tribal partners to prevent and clean up releases from UST systems. The greatest potential threat from a leaking UST is contamination of groundwater, the source of drinking water for nearly half of all Americans. EPA, states, and tribes work together to protect the environment and human health from potential UST releases.[152]

a) Impacts on the Oil and Underground Storage Tank Programs

- Region 4 has a universe of USTs, which may be vulnerable to flooding events. Of particular concern is groundwater contamination from leaks from at risk tanks and damage to the supporting piping.
- Secondary containment and flooding of coastal facilities may be compromised by sea level rise.
- Alterations in shoreline geology and/or sea level rise may increase exposures of USTs or underground pipeline, increase pressure differences and gradients, and/or alter the flow of oil and hazardous substances in pipelines.
- Increase in precipitation and floods may have many impacts, as follows:
    - Decrease the effectiveness of secondary containment.
    - Increase flow and pressure to underground infrastructure/structures i.e. pipelines, wastewater treatment facilities, power plants, and paper mills. Increased flow and pressure to containment systems may result in back feed and flow of product resulting in increased discharges of oil.
    - Decrease tank headspace thereby displacing buffer space available to prevent overflow/ overfill, potentially leading to increased oil spills.
    - Increase weathering of underground and aboveground storage tanks (ASTs and USTs).
    - Increase flow and changes of navigable water depth, thereby increasing difficulty in preparing and implementing planning distance, booming strategies, and cleanup strategies.
- Failure of infrastructure (e.g. pipelines, and secondary containment) and damage or displacement of tanks due to increased intensity of hurricanes and resulting winds and storm surges. Damage to storage tanks would increase the likelihood of spills to navigable waters, coastlines and oceans.
- Increased degradation and weathering of pipelines and infrastructure due to ocean acidification resulting in oil spills.

- As SPCC facilities are regulated solely on the probability that an oil spill from that facility will impact navigable waters, decreasing precipitation days and increasing drought intensity may reduce the number of facilities that fall under the jurisdiction of the SPCC program.
- Change in native or endemic organism availability for biotic degradation of oil due to increase in water temperatures.

6. Brownfield Program

While Brownfields Cleanup Sites will potentially be impacted much the same as Superfund, RCRA Corrective Action, and TSCA sites will be (discussed in section i), effects of climate change may also be felt by other aspects of the Brownfields Program.

a) Impacts on Brownfield Program

- Brownfield Grantees may have to make changes to their Master Plans as shorelines and flood zones change. Applicants who receive brownfield grant funds are encouraged to follow a community-developed Master Plan for redevelopment. Developing such a plan is an eligible grant expense but preference is generally given to communities who already have such a plan in place. Region 4 Project Officers should be prepared to allow changes as needed for climate adaptation.
- Development of a climate adaptation strategy for a brownfield site is an eligible grant expense. EPA Project Officers will have to become familiar with these types of plans so they can properly advise grantees.
- More sites may enter the brownfields inventory as natural disasters lead to release of hazardous substances and petroleum. EPA may begin experiencing even more competition for the already dwindling brownfields grant funding.
- Flooding could disrupt or delay work at existing Brownfield sites.

V. Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution

A. Pesticides

EPA and the states (usually the State Department of Agriculture) register or license pesticides for use in the United States. In addition, anyone planning to import pesticides for use in the U.S. must notify EPA. EPA receives its authority to register pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

EPA's Pesticides program covers:

- Evaluating Potential New Pesticides and Uses
- Providing for Special Local Needs and Emergency Situations
- Reviewing Safety of Older Pesticides
- Registering Pesticide Producing Establishments
- Enforcing Pesticide Requirements

- Risk assessment
- Pesticide Field Programs

Climate change may lead to an increase in pesticide use, due to an increase in pests and diseases which favor warm and humid climates. In the southeast, pesticides are widely used currently as the climate is hot and humid, and in most areas there is not a cold winter to kill off pests, thus pest problems tend to be a year-round issue. Many models now show the winter months in the southeast will become warmer as time goes on. The freeze-free seasons are lengthening and may result in the cessation of freezing in some areas, which may only increase the already high pest populations particularly in the northern areas of the region.[153] The southeast region has 12 major marine ports,[154] and thus the introduction of non-native pest species is a constant concern.

Currently the southeast is riddled with invasive pest species and it is likely that climate change will only continue to exacerbate this problem. The potential impacts of increasing pesticide usage include concerns about human exposure as well as concerns about non-target organism impacts, such as impacts to pollinators and beneficial insects, endangered species, aquatic organisms and others. Concerns for groundwater contamination will continue to be an issue especially in Florida, where the water table is high and soils are permeable. Karst topography is dominant in the southern part of the region and in parts of Kentucky and Tennessee.

B. Impacts on Pesticides Program

- Region 4 will experience new pest problems, many of which will be from exotic invasive species.
- Changes in pests and pest pressures will result from increases in temperatures and variations in rainfall patterns.
- There would be a potential increase in the need for emergency exemptions (FIFRA Section 18). These FIFRA exemptions are granted when an emergency pest problem appears which cannot be controlled effectively by the current pesticides registered for that pest or commodity, allowing temporary use of chemicals which are not registered for that use. The Section 18 requests are approved by EPA Headquarters. The regional role is to provide technical assistance to the states as needed.
- Urban populations have spread out into areas which at one time were largely rural which may increase citizen complaints from individuals living near farms. Region 4 may need to increase enforcement and compliance monitoring efforts to protect both farmworkers and residents living near farms.
- Increasing pesticides usage to control pests could also lead to increased resistance of the pest to the chemical being used. Resistance management will therefore become increasingly important.

- The increase in amount and variability of precipitation projected for Region 4 can create an expanded mosquito habitat, which could increase exposure to more diseases like dengue fever and malaria.
- The Region will need to be prepared to address needs for aggressive mosquito control as well as support continued local monitoring of mosquito populations, which is currently being done by most large mosquito control districts in the southeast. Emergency exemptions for mosquito control may increase, especially after major weather events such as floods and hurricanes, which tend to spur populations of *A. aegypti* and *A. albopictus*.
- As more Section 18 requests may be anticipated, and more pesticides may be used in response to climate change, impacts to non-target endangered species will need to be considered and monitored.
- There will likely be an increase in fungal organisms in agricultural and non-agricultural settings due to extreme rainfall.
- Climate impacts may change chemical and non-chemical agricultural practices due to extreme storms and farmers' inability to work in their fields (e.g. increases the likelihood of run-off and off target movement of chemical products; limits on the potential use of certain non-chemical methods such as cultivation because it may not be possible to bring heavy farm equipment onto wet fields and saturated soils).
- Increased use of aerial applications are likely to result in increased pesticide drift due to extreme storm events.
- Drought may lead to an increase in dry condition pests (e.g. mites that feed on a variety of field, vegetable and fruit crops).

These changes in pesticide choices and quantities will require changes to the pesticide applicator certification and training programs. Changes in chemical selection could result in new and increased chemical exposures, especially for indoor applications. Types of new pest problems could include:

- Indoor and outdoor molds and microorganisms which are controlled by disinfectant pesticide products;
- Public health pests such as mosquitoes and ticks;
- Forest pests,
- Aquatic pests including weeds; and
- Various agricultural pests including weeds, insects and plant diseases.

VI. Goal 5 - Enforcing Environmental Laws within Region 4

Region 4 anticipates that in the future, climate change related issues may be raised in the context of EPA's enforcement program across the media – whether it be as part of a settlement

negotiation, compliance issue, a mitigation project, a clean-up, or in another enforcement related context. EPA is already beginning to evaluate objectives associated with assuring compliance with the greenhouse gas reporting rule, encouraging greenhouse gas emissions reductions through settlements, and targeting the energy sector compliance with air, water and waste rules. *See, e.g.*, http://www.epa.gov/enforcement/data/goals.html. Region 4 will continue to work closely with its EPA HQ counterparts at EPA's Office of Enforcement and Compliance Assurance (OECA) to evaluate and determine appropriate options for considering and incorporating climate change adaptation principles into the Region 4 enforcement programs.

VII. Facilities and Operations

Climate change poses a range of risks to EPA Region 4's facilities and operations. The following sections detail the general risks and then delve into the risks specific to each facility. Note that each facility does not operate in isolation; the climate impacts experienced by each facility will be greatly influenced by the larger systems (utilities, transportation, communities) of which it is a part.

A. Severe Weather Preparedness

In response to severe weather conditions that may be attributed to Climate Change, EPA Region 4 has worked with the Federal Agencies at the Sam Nunn Atlanta Federal Center, the Atlanta Federal Executive Board (FEB), the Fulton County Emergency Management Agency, and FEMA to develop procedures to monitor severe weather and provide emergency alert notifications to Federal Agency Heads in the metro Atlanta area.

EPA and FEMA co-chair the Emergency Preparedness Committee of the Atlanta FEB. When potentially hazardous weather approaches the Metro Atlanta area the FEB convenes a weather alert committee by conference call to discuss the potential impact on Federal Buildings and employees. These calls include representatives for many Federal, State, and Local emergency and law enforcement agencies to provide the latest projection and assessment of weather impacts on the Atlanta areas.

The FEB Emergency Preparedness Special Weather Committee issues emergency advisory notices via phone, email, and telephone message line on early dismissal, delayed opening, and /or closure of Federal Offices. These alerts may be issued during the work day or after early morning conference calls at 4:00 am.

The EPA lead Interagency Occupant Emergency Command team at the Sam Nunn Atlanta Nunn Atlanta Federal Center (SNAFC) has incorporated weather emergencies into the building's Occupant Emergency Plan. For the past 3 years the SNAFC has conducted Shelter in Place exercises as part of Georgia's annual state-wide Tornado Drill. Over 5000 Federal employees and visitors participate in these exercises at the SNAFC each year.

EPA Region 4 has established a Continuity of Operations (COOP) site at the SESD facility in Athens Georgia. A limited number of essential personnel will report to and work out

of this primary COOP site if the SNAFC were to be damaged by severe weather. The Region has a secondary site established at the Emergency Response Warehouse in Norcross Georgia in case the SESD facility in Athens is not operational. In this instance the executive leadership team would work out of the Norcross facility. Other employees would work remotely as needed using established Telework procedures.

EPA, FEMA, and the Atlanta FEB have joined together to plan and conduct a Multi Agency Continuity of Operations Exercise scheduled for May 2013. The event scenario for this exercise which will include all federal Agencies in the metro Atlanta area is severe catastrophic Tornado damage throughout the Atlanta and East Georgia areas. Planning for this event included a Home Security Executive Education Seminar held on March 19, 2013 attended by Agency Heads and senior executives from 28 Federal Agencies and representatives from the US District Courts. The continuity related incident used as the foundation for this executive seminar was a catastrophic tornado event approaching and then striking the metro Atlanta area. Discussion included operational roles and coordination between federal Agencies, State and local governments, and the private sector.

The Continuity of Operations exercise in May 2013 will include all of the Region 4 program offices working in cooperation with their counterparts in EPA Regions 3 and 5. Specific exercise injects are being developed to test each program's response to damage from the tornados. This will also be a Devolution of Operations exercise and program managers from the 3 EPA partner regions will work to test our readiness to continue mission essential functions by staff from another Region if Region 4 cannot functions due to the damage.

B. Overview of Potential Climate Change Impacts

From the facilities and operations perspective, the vulnerabilities associated with climate change encompass issues of energy, security, water quality and supply, severe weather damage, personnel safety, physical security, and communication interruptions. These facilities and operations support the broader agency mission of protecting air, water, and human health through the provision of functional, appropriate, and safe working spaces for personnel. Beyond the infrastructure and utilities that serve EPA rented or owned facilities and the operations that support the function of those facilities, broader impacts of climate change on transportation and communication systems are also vulnerabilities that EPA Region 4's could experience while meeting agency goals. While telework policies are in place to address these vulnerabilities, the magnitude of these impacts may extend to those alternate work locations, causing significant disruption to employee work and ultimately the EPA Region 4 mission.

However, while operations may be vulnerable in the areas described above, EPA Region 4 has developed a Continuity of Operations Plan (COOP) to maintain emergency functions should any particular facility or location be compromised. This plan provides guidance for continued uninterrupted operations and the performance of essential functions during emergency situations. The COOP includes provisions for physical relocation from current facilities and resource planning for up to 30 days.

C. Region 4 Property Details

1. The SNAFC Building/Complex

The SNAFC Building is located on four acres in downtown Atlanta on the edge of the central business district, at the MARTA (Metropolitan Atlanta Rapid Transit Authority) Five Point Station mass transit train system. SNAFC houses 1.1 million sq. ft. of office space and 103,000 sq. ft. of joint use spaces (daycare, fitness center, health Unit, cafeteria, conference spaces, parking garage) occupied by 23 Federal Agencies. The complex consists of four connected structures: a twenty-four story high-rise tower, a ten story mid-rise tower, a six story, historic department store, restored to office use, and an eight story "Bridge" that spans the street and links the high-rise and mid-rise office buildings. EPA Region 4 is housed in the high-rise structure, occupying 330,000 rentable sq. ft. (RSF), on floors 9 through 16 and a 3rd floor bridge Conference Center. The building is serviced by underground utilities for domestic water and power/electricity and the natural gas is above. All building mechanical systems are on the roof and the Bridge building has the exhaust and fresh air exchange with two air handler units per floor in the Tower. Chillers are located in the basement.

2. SESD Laboratory

The Regional 4 laboratory, located at 980 College Station Road, Athens, Georgia, is built on a hill at an elevation of 714 feet above mean sea level, obviating any risks of direct flooding. Located on approximately eleven acres of land and is a single story structure of 57,760 RSF and open parking with covered boat/trailer parking structures. The SESD Laboratory is Region 4's COOP site, located approximately 50 miles North of the SNAFC Complex. For COOP preparedness, this Laboratory has been equipped with an emergency generator for back-up power that provides power to all private offices and training room, library and TS rooms. The emergency power is estimated to last 48 hours between refueling requirements. This time can be extended by minimizing the laboratory operations and additional fuel deliveries. Water reclamation systems and interstitial service corridors for serve and utilities between back-to-back laboratories located adjacent to the ORD Laboratory. The Laboratory is connected to well water. This Laboratory houses a mail and supply room for continued support during COOP activation.

3. SESD FEC

Located approximately 15 miles from the SESD Laboratory is a single story metal structure, occupying 13,800 RSF. This is SESD's Field Equipment and Laboratory cleaning and sterilization Center. This metal structure building has large bay doors and open parking.

4. ERRB Warehouse

Co-located property with connected structures in single-story building with open parking and large bay doors. The space is a combination of office and warehouse space 15,120 RSF. The Warehouse is approximately 20 miles North of the SNAFC Complex and is Region 4's secondary COOP location for the executive leadership team.

5. WPD S. FL Office

Region 4 occupies 3,011 RSF on the first floor of the three-story structure that was the former Florida Power and Light Hurricane Command Center. Region 4 is in the process of downsizing this space to approximately 500 RSF for two remaining employees. All the utilities and power lines are external, above ground utilities and power lines and often lose electricity with limited emergency back-up power. EPA has an emergency battery UPS to maintain server,

LAN and router connections. There is a Water Supply Lake approximately 1000 feet away and an Intercoastal waters about 1 mile away that do not pose high threats for flooding.

6. Gulf of Mexico Program

The Gulf of Mexico Program, an EPA geographic program, occupies office space leased from NASA at Stennis Space Center (SSC) in Hancock County, Mississippi. The leased space is located on the 2nd floor of NASA Building 1100 (Main Administrative Bldg). NASA operates and maintains the office building we occupy, as well as all other facilities and operations, inclusive of security, fire and emergency services, police, highways, parking, power, water, sewer, and climate control. NASA has redundant power supply to the Stennis Space Center from two separate power grids located in the region. In 2012, we participated on a NASA SSC Stakeholder Conference focused on understanding potential climate change impacts to the SSC and beginning the adaptation planning process for the facility.

7. EPA's Gulf Ecology Division Laboratory campus

In the wake of Hurricane Ivan in 2004, six of the EPA's Gulf Ecology Division Laboratory campus' 40 buildings were destroyed. Located on the 16-acre Sabine Island, off the Florida Panhandle coast, it was especially vulnerable to Ivan's devastating winds and rain. The destroyed buildings were rebuilt incorporating sustainable technologies to protect it from coastal hazards and minimize its environmental footprint. Aluminum was chosen as the primary roofing material since shingles tend to come loose in high winds. Its light color reflects sunlight to keep cooling costs down. Local building codes required windows to be equipped with storm shutters or made of high-impact glass. EPA selected high-impact glass to provide safety and durability and added skylights to reduce artificial lighting use. Because the buildings are exposed to frequent rain, high humidity, and corrosive ocean spray, EPA selected a sturdy wood pulp, sand, and cement composite made of recycled material for the building's siding. The siding is a reflective, UV-resistant, white color. And a large porch lines the front to lower the building temperatures.[155]

VIII. Climate Change Impacts on the Most Vulnerable People

Certain parts of the population, such as children, the elderly, minorities and the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society.

This Implementation 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

Plan is conducted, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events (*e.g.*, Hurricane Katrina and Superstorm Sandy) and the subsequent recovery efforts.

EPA values its unique government-to-government relationship with Indian 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* and the *2011 Policy on Consultation and Coordination with Indian Tribes*. These policies recognize and support the sovereign decision-making authority of tribal governments.

Supporting the development of adaptive capacity among tribes is a priority for the EPA. 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 to develop adaptation strategies that promote sustainability and reduce the impact of climate change on Indian tribes.

EPA engaged tribes through a formal consultation process in the development of the Agency's *Climate Change Adaptation Plan*. Tribes identified some of the most pressing issues as erosion, temperature change, drought and various changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. At the same time, tribes challenged EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative burdens are reduced.

This Implementation Plan identifies specific steps that will be taken to partner with tribal governments on an ongoing basis to increase their adaptive capacity and address their adaptation-related priorities. These collaborative efforts will benefit from the expertise provide by our tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change and has been used by tribes for millennia as a valuable tool to adapt to changing surroundings. Consistent with the principles in the 1984 Indian Policy, TEK is viewed as a complementary resource that can inform planning and decision-making.

Networks and partnerships already in place will be used to assist tribes with climate change issues, including Regional Tribal Operations Committees, the Institute for Tribal Environmental Professionals and the Indian General Assistance Program (IGAP). Additionally, efforts will be made to coordinate with other Regional and Program Offices in

EPA, since climate change has many impacts that transcend media and regional boundaries. Transparency and information sharing will be a focus, in order to leverage activities already taking place within EPA Offices and tribal governments.

A. Children

Children are likely to suffer disproportionally from both the direct and indirect adverse health effects of climate change.[156] Children are more vulnerable to environmental health risks resulting because of their developing systems, immature body organs, and weaker immune systems. Young children breathe more rapidly and inhale more air relative to their body weight than adults. Their metabolic rate is faster and they proportionately consume more fluids and food than that of adults. Their kidneys excrete toxicants and wastes at a slower pace compared to adults. Children are less able to protect themselves and their behavior, such as crawling on the ground and putting hands and foreign objects into their mouths, exposes them to different environmental hazards.

The Region's CEH Program goals are aligned with EPA's strategic goals of improving air and water quality, cleaning up communities, ensuring the safety of chemicals and preventing pollution. With the support of the Region's Program Offices and partnership with other organizations, the CEH program has conducted education and outreach and supported interventions at schools, daycare centers and in communities throughout the Region. The program has also provided support to address children's health hazards associated with environmental disasters or in higher risk communities.

1. Air Quality

The climate-change aspect of rising temperatures may detrimentally impact air quality in Region 4 by increasing ground-level or "bad" ozone formation, formed by nitrogen oxides chemically reacting with volatile organic compounds in the presence of sunlight.[157] Ground-level ozone is the major ingredient of smog and may lead to detrimental effects to children's health, particularly asthmatics. When children spend time outdoors during high-level ozone days, they may become more vulnerable to ozone health effects,[158] which include wheezing and coughing, inflammation of airways, lung function impairment, and infections in the lower respiratory tract.[159]

Changes in long-term weather patterns may result in more wildfires and drier soils, and increased emissions of smoke and dust-related particulate matter. When inhaled, fine particles associated with wildfire smoke and dry-soil dust can cause serious respiratory health problems of coughing and breathing difficulty, lung-function impairment, asthma attacks, and chronic bronchitis.[160] Rates of preterm births, low birth weight, and infant mortality have been found to increase in those communities with high particulate pollution exposure.[161]

2. Indoor Air

In the United States, children spend an estimated 90 percent of their time indoors.[162] The anticipated climate change attributes of heavy rains, increasing temperatures, and high-humidity

cycles will facilitate this trend. Consequently children will likely have increased exposure with identified indoor air agents of concern: heat and biological materials – pollen, molds and infectious agents, and air pollutants.[163]

3. Infectious Diseases

The expected changes in temperatures and rainfall in Region 4's climate is likely to facilitate the growth, survival, and transmission of vector-borne infectious diseases. Vector-borne is a term used to describe disease transmission by insects, animals, birds, and other living organism. Emergence of new infectious diseases, and changes in the evolution and geographic ranges of pests, infectious agents, and disease vectors, may lead to shifting patterns of indoor pesticide use and creation of new pesticides. The Region anticipates children may be detrimentally affected by anticipated changes in both indoor and outdoor pesticide use.

4. Flooding

The Atlantic and Gulf coasts are vulnerable to storms and hurricanes. Six of the eight states that have the experienced highest number of hurricanes are in Region 4.[164] Vulnerable populations, such as children, the elderly, and pregnant women could experience both direct and indirect consequences of floods. Direct exposures result in risks for drowning, injuries from debris, chemical contamination, and hypothermia. There are also risks associated with the damage done by the water to the natural and built environments which include infectious diseases, carbon monoxide poisoning, respiratory problems, malnutrition, physical and mental trauma, poverty related diseases, and diseases associated with displaced populations.

5. Clean Water

Warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms. Harmful algal blooms also occur in freshwaters, and as these waters warm it is expected algal blooms will increase in frequency and intensity. Children are especially vulnerable when they swim in surface waters, and eat contaminated shellfish because their immune systems are developing and they consume more food and drink more water-per-pound of body weight than adults.

6. Safe Drinking Water

Lack of safe drinking water may cause gastrointestinal diseases that may be fatal for some or detrimentally impact other children's health.[165] The climate change aspects of extreme and severe weather may result in the breakdown of sanitation and sewer systems resulting in exposure to unsafe flood and storm water exposure and unsafe drinking water increasing the potential for children's exposure to disease-causing organisms, such as gastroenteritis and infectious diarrhea.

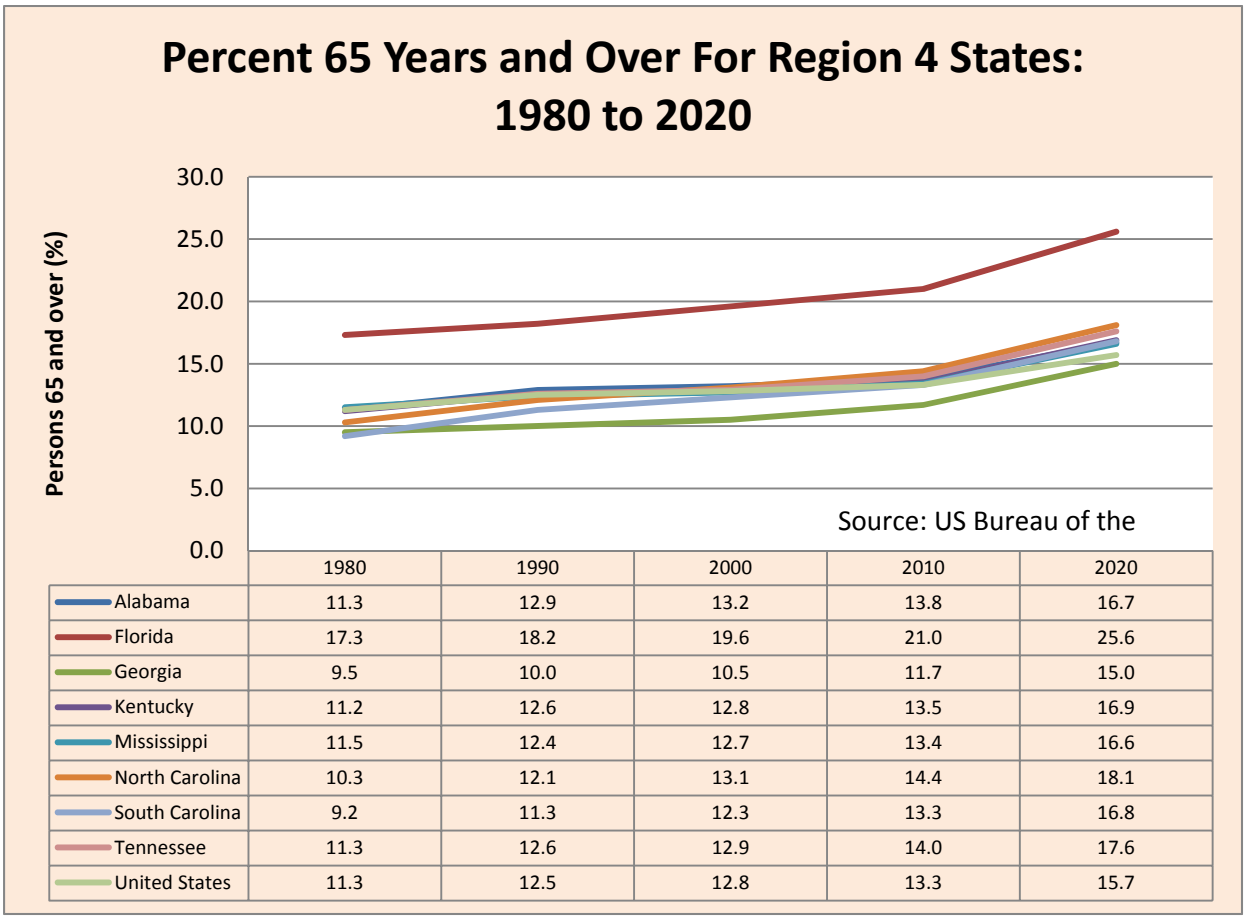
7. Impacts on Region 4 Children's Environmental Health (CEH) Program

While the CEH program focuses on reducing environmental health threats to our most vulnerable populations, adequate resources and regulatory authority may present impediments in addressing the multitude of potential environmental health issues that may result from the

impacts of climate change. Region 4's CEH Program has some tools and resources to conduct or promote limited educational, outreach and intervention activities addressing CEH issues associated with climate change. The CEH program will have to develop additional tools and resources to address the unique concerns facing the most vulnerable groups in the most vulnerable communities.

B. Elderly Population

The vulnerable population, in addition to children, includes the elderly. Elderly is usually defined as those adults who are 65 years of age or older. Approximately 13.8 % of the population within Region 4 is elderly according to the 2010 US Census with Florida having the largest number of elderly. The projections for 2020 show an increasing trend in population growth for every state.



	1980	1990	2000	2010	2020
Alabama	11.3	12.9	13.2	13.8	16.7
Florida	17.3	18.2	19.6	21.0	25.6
Georgia	9.5	10.0	10.5	11.7	15.0
Kentucky	11.2	12.6	12.8	13.5	16.9
Mississippi	11.5	12.4	12.7	13.4	16.6
North Carolina	10.3	12.1	13.1	14.4	18.1
South Carolina	9.2	11.3	12.3	13.3	16.8
Tennessee	11.3	12.6	12.9	14.0	17.6
United States	11.3	12.5	12.8	13.3	15.7

The elderly are very vulnerable and susceptible to the effects of climate change that cause extreme weather conditions such as floods, storm surges, high winds, heat waves and hurricanes.

In general, the elderly are very vulnerable due to various physiological, psychological, and socioeconomic factors that they cope during these extreme weather conditions.

Physiologically, they are already having higher prevalence of certain chronic diseases, medical conditions, and functional limitations that are exacerbated and impairments aggravated. An increase in ground-level ozone that occurs with climate change can lead to respiratory problems, such as asthma, heart disease, chronic obstructive pulmonary diseases (COPD), premature mortality. In addition, an increased number of emergency room visits and hospital admissions are experienced among the older adults. Extreme heat can induce heat-related mortality, heat exhaustion, heat strokes, dehydration, acute renal failure, and cardiopulmonary diseases.

Psychologically, the elderly are affected because of their functional limitations and mobility impairments that are present due to their decline in muscle strength, coordination, and cognitive functions that have occurred from illness, chronic diseases, or injuries in the older adults. The elderly are very sensitive to any extreme changes and environmental exposures resulting in decreased adaptive capacity to mentally adapt to these changes.

Socioeconomically, the older adults, especially, those living in poverty are deeply affected by not able to pay for air conditioning or well-constructed housing which would have helped them handle the extreme heat waves and hotter days. The elderly also have difficulties to access adequate transportation or other social services when needed during times of crises. Finally, they might not have sufficient financial support with lack of insurance and limited personal finances that lead to elderly not able to cope.

C. Environmental Justice

Empirical studies have shown that certain types of communities tend to suffer a disproportionate impact of environmental harms causing health-related concerns. Race and income distribution are the two most important determinants of an environmental justice community. EPA defines environmental justice as "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."[166]

Climate change poses special environmental justice challenges for communities that are already overburdened with pollution and environmentally-related illnesses. One challenge is a population's ability to prepare, respond, and recover when a disaster does occur. Hurricane Katrina helps illustrate the issue of environmental justice in the Southeast. When Hurricane Katrina struck Louisiana, Mississippi, and Alabama, it struck the three poorest states in the country; two of the states are located in Region 4.[167] The people most disproportionally impacted by the flooding and destruction of Hurricane Katrina were disadvantaged, mainly black communities.[168]

In general, environmental justice communities tend to be located next to or near potentially harmful areas. The charts below present the poverty status and racial demographics in Region 4 states.[169]

Subject	***Total***	***Below Poverty Level***	***Percent below Poverty Level***
REGION IV STATES			
Population (as of April 1, 2010)	61,082,315	-	-
Population for whom poverty status is determined	59,932,739	10,067,497	17.7%
Under 18 years	14,044,902	3,564,293	25.4%
Related children under 18 years	13,933,500	3,515,407	25.2%
65 years and over	8,424,993	860,595	10.2%
White alone, not Hispanic or Latino	38,137,978	4,809,917	12.6%
Hispanics	6,692,784	1,734,054	25.9%
Minority	21,794,761	5,797,580	26.6%

Considering all the individual states in Region 4, the poverty status for children, elderly people, and minority is highest in the state of Mississippi.[170] Poverty status for these same categories, on average across the Region, is high in the states of Alabama, Kentucky, South Carolina, and Tennessee.[171]

Total Population	61,082,315
% White	70.8
% Black	21.3
% Asian	2.1
% American Indian	0.5
% Other Race	3.2
% Multiracial	2.1
% Minority	36.2
% Hispanic or Latino (of any race)	11.1

Florida, Georgia, and Mississippi have the highest percent minority of all the individual states in Region 4.[172] Florida also has the highest percent Hispanic or Latino of any race.[173]

Environmental justice communities are concerned with the air pollutants contributing to the issue of climate change, in particular the coal-fired power plants that emit greenhouse gases and contribute to coal ash that must be stored and disposed. Mercury, arsenic and lead are also of major concerns. According to the American Lung Association, African-Americans are twice as likely to die from asthma attacks and Puerto Ricans have the highest asthma prevalence.[174]

Moreover, African-American, Hispanic, and Asian-Pacific Islander women who were pregnant were much likely than pregnant White women to live in areas with higher levels of air pollution.[175]

Climate change will have an adverse effect on human health, especially within environmental justice communities. Some of the human health consequences of climate change include asthma, respiratory allergies, and airway diseases, cancer, cardiovascular disease and stroke, food borne diseases and nutrition, heat and weather-related morbidity and mortality, and waterborne diseases.[176]

D. Tribal Governments

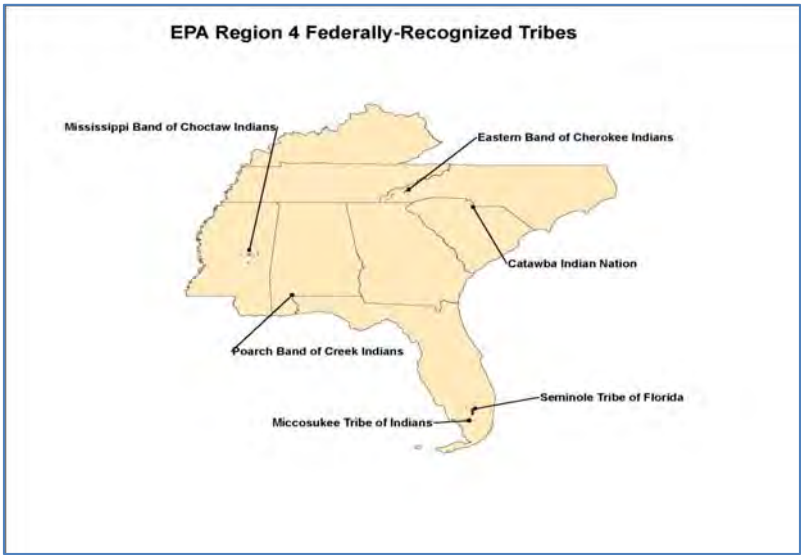
The United States has a unique legal relationship with Tribal governments based on the Constitution, treaties, statutes, Executive Orders, and court decisions. This relationship includes recognition of the right of Tribes as sovereign governments to self-determination, and an acknowledgment of the federal government's trust responsibility to Tribes. EPA works with federally-recognized Tribes on a government to government basis and, in keeping with the federal trust responsibility, consults with and carefully considers the interest of Tribes when making decisions and taking actions that may have Tribal impacts.[177]

Tribal communities are disproportionately vulnerable to climate change impacts, largely as a result of their close connection to the land, water, and natural resources. Tribes have limited relocation options due to reservation boundaries, and often depend upon their traditional homelands for natural resources to sustain economic, cultural, and spiritual practices. The accumulated knowledge and understanding of a Tribe's environmental connection with their homelands, or Traditional Ecological Knowledge (TEK), is intrinsically linked to Tribal cultural practices and threats to resources on which they depend.[178] A combination of qualitative data, gathered with TEK, and western science is needed to comprehensively understand and address Tribal climate change impacts. In Region 4, shifting habitats of to traditional food sources and medicinal plants have been observed based on TEK.

Economic impacts related to climate change are also anticipated. For example, the Eastern Band of Cherokee Indians manages a successful commercial trout fishery that attracts thousands of fishermen to the area year-round. North Carolina trout populations are predicted to experience significant reduction as a result of climate change; the estimated welfare loss is $5.63 to $53.18 per angler per single occasion.[179] A loss of this magnitude could drastically impact the viability of the Tribe's fishery program and overall economic well-being.

There are six federally-recognized Tribes in Region 4: Eastern Band of Cherokee Indians, Mississippi Band of Choctaw Indians, Catawba Indian Nation, Seminole Tribe of Florida, Miccosukee Tribe of Indians of Florida, and Poarch Band of Creek Indians (Figure below). Each Tribe is geographically diverse with unique government structures, priorities and challenges. EPA is committed to strengthening its partnership with Tribes on priorities related to climate change adaptation and to supporting the development of Tribal adaptive capacity.[180] The

vulnerabilities listed below identify potential areas in which Region 4's ability to be responsive to Tribal climate change adaptation priorities and adaptive capacity building needs may be impacted.



1. Resources

Tribal environmental programs are severely understaffed and underfunded. In some cases, Region 4 Tribal environmental departments are staffed by as few as two environmental professionals responsible for the development and implementation of environmental programs. Fiscal Year 2015 EPA funding needs for Region 4 Tribes are estimated at$ 9.7M; Tribes are currently funded at less than 25% of the projected need.[181] Anticipated Region 4 resource vulnerabilities include:

- Lack of funding to assist Tribes in climate change adaptation planning and related activities, such as increased air quality monitoring due to the potential of more frequent wildfires.
- Increased demand for technical resources, such as access to climate change information, tools and professionals, as well as innovative approaches to assist in developing climate change adaptation plans or address climate change priorities due to limited staff availability at Tribal level.
- Increased demand for training and information dissemination regarding climate change adaptation and potential adverse effects of climate change.

2. Education and Outreach

Tribes are subject to geographical impacts and, as sovereign nations, have unique government structures, planning processes, and capabilities for adaptation and response. Generally, there are few resources available to EPA for ascertaining regional and individual Tribal climate change impacts, priorities, and readiness capabilities. Anticipated Region 4 education and outreach vulnerabilities include:

- General lack of staff education and awareness of climate change priorities and impacts unique to Region 4 Tribes, including those related to Tribal boundaries and economic, cultural and spiritual practices.
- Lack of knowledge of existing Tribal climate change readiness and adaptive capacity.
- General lack of staff education, awareness and incorporation of TEK in Agency decision-making and planning, including traditional practices that may exclude climate change adaptation planning.

3. Communication and Collaboration

Climate change related priorities, responsibilities and activities vary by governmental agency. Tribes work with federal, state and local governments, and are often required to be responsive to complementary or duplicative requests for consultation and information sharing. Anticipated Region 4 communication and collaboration vulnerabilities include:

- Need for increased federal coordination and collaboration to share climate change adaptation efforts, as well as to inform, discuss and consult with Tribes on climate change actions, concerns, interests and priorities. Federal coordination, collaboration and consultation have been requested by Region 4 Tribes.
- Need for increased cross-program coordination and collaboration to inform, discuss and consult with Tribes on EPA and Region 4 specific climate change actions, decisions, and opportunities, such as adaptation planning process and anticipated climate change impacts to the Region.
- Jurisdictional challenges with adjacent local and state governments may impact collaboration opportunities and access to resources.

IX. Vulnerability Assessment Table

See Appendix A.

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PART 3

PRIORITY ACTIONS

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I. Introduction

The EPA's draft Climate Change Adaptation Plan identified nine agency-wide priorities for integrating climate change adaptation into its programs, polices, rules, and operations.[182] EPA's priorities are to:

- Fulfill the FY 2011-2015 EPA Strategic Plan measures.
- Protect EPA's facilities and operations.
- Factor legal considerations into adaptation efforts.
- Strengthen EPA's staff and partners' adaptive capacity through training.
- Develop decision-support tools to facilitate EPA staff and partners' integration of climate-change adaptation planning into their programs and operations.
- Identify cross-EPA climate adaptation science needs.
- Partner with tribes to increase their adaptive capacity.
- Focus on most vulnerable people and places.
- Measure and evaluate performance.

The Regions have been tasked with using the Agency's draft plan as guidance for their respective independent, stand alone plans.[183] The Regions have been requested to clearly articulate our criteria used to identify priority actions since limited and uncertain resources make it impossible to undertake all our proposed actions. According to the Agency's draft plan, Regional priority actions could range from addressing those vulnerabilities identified in the Region's vulnerability assessment to building Regional staff adaptive capacity through training. Some of the criteria Region 4 considered included, but were not limited to:

- Does the action support and align with other Region 4 priorities and actions, i.e. Strategic Plans?
- Is the action a priority for our partners?
- Does the action have an impact on reducing risk?
- Does the action protect a critical resource/investment?
- Is EPA uniquely situated to address the action?
- When is the climate risk likely to occur?
- Can the action be accomplished within current budget?
- Will the action be sustainable/durable?

Region 4 identified priority actions it could take to ensure that we can continue to accomplish our mission and operate at our multiple locations. The following priorities represent EPA Region 4's commitment to address the known programmatic vulnerabilities and to continue to identify other vulnerabilities that may occur over time due to climate change. By listing an action as a priority, the Region is not making a budgetary commitment to take or complete that action or to take or complete it by a particular point in time. The Region's ability will depend on resource

availability – which is uncertain. The Region has proposed actions it thinks are consistent with its role as a Regional office and can do as resources are available or when it can accomplish the priority concurrent with or as part of its ongoing activities.

As Regional Offices have been developing their priority actions, two categories of priority actions have emerged: region specific and "national-level" priority actions. The "national-level" priority actions are those that must be taken before the Regional Offices can appropriately implement climate change adaptation within their region. Appendix B is Region 4's Priority Action Matrix that identifies each priority action as a National and/or region specific action and notes whether Region 4 will need more coordination, policy, and/or guidance from EPA Headquarters.

II. EPA Region 4's Adaptation Strategy[184]

Region 4 is currently updating its Fiscal Year 2013-14 *Draft Energy and Climate Change Strategy* (Strategy) to describe the actions it would pursue to help the Southeastern United States address clean energy and climate change challenges. Two sections of this Strategy, Adaptation and Education, address the Region's concentration on climate change adaptation. In performing this work, the Region will use good science and state of the art analysis and will work to continually improve its ability to measure positive change. The Region will also continually evaluate and, as appropriate, adjust our base regulatory and assistance programs to account for climate change.

A. Adaptation: Actions to Understand and Respond to Unavoidable Changes

The Region 4 will assist its state, local, and tribal governments and Federal resource managers to prepare for and respond to climate-related changes such as sea-level rise, weather-related impacts on agriculture, changes in water quality and availability, and impacts on human health and ecosystems. Specifically, as budgets allow, the Region will work with its stakeholders to develop and implement strategies to respond to local concerns and to share these methods with other communities through such potential actions as:

- Promote EPA's Clean Energy-Environment State Partnership that encourages states to develop and implement cost-effective clean energy and environmental strategies.
- Promote EPA's Climate Ready Water Utilities and Climate Ready Estuaries programs that aid respective water sectors to understand climate science and adaptation options, as well as assess climate change vulnerabilities, implement adaptation strategies, educate stakeholders, and share lessons learned.
- Promote the SunWise Program to teach the public how to protect themselves from overexposure to the sun through the use of classroom-, school-, and community-based tools.

- Reduce the potential for wildfires and limit impacts on particulate matter air quality through prescribed fire and smoke management efforts with the Southeast Regional Partnership for Planning and Sustainability (SERPPAS).

- Work with local/state/federal emergency preparedness and response counterparts and businesses to develop and implement strategies to address adaptive measures needed for climate-related changes and work with state and industry to add enhanced emergency planning in operating permits.

- Promote the Southeastern Ecological Framework as a tool for evaluating and adapting to climate change impacts on important ecosystems and services across eight Southeastern states.

B. Education: Actions to Inform Internal and External Stakeholders

Region 4 will work to educate internal and external stakeholders on the science of climate change, energy efficiency and conservation, mitigation and adaptation activities, and revitalization through the following potential actions:

- Implementing activities that support national Climate for Action Education and Outreach Campaign.
- Working with the Region's National Estuary Programs and other coastal communities to assess vulnerabilities from and to adapt to climate change impacts.
- Promoting EPA's Smart Growth program to help communities grow in ways that expand economic opportunity, protect public health and the environment, and create and enhance the places that people want to live and work.
- Promoting the revitalization of contaminated land to productive environmental and economic reuse, with an emphasis on green technologies.
- Implementing additional activities that educate the public on climate change.

III. FY 2011-2015 EPA Strategic Plan measures

The following is Region 4's discussion on a goal by goal basis of possible priority actions the Region may take to integrate climate change adaptation into its programs and operations. In general, the Region does not engage in rule making activities with the exception of TMDL development, Offshore Dredged Material Disposal Site designations, and SIPs? For these limited rule making opportunities, the Region can incorporate as appropriate and consistent with Program Office guidance the best available climate change adaptation science to inform its decision making.

A. Goal 1- Taking Action on Climate Change and Improving Air Quality within Region 4

Region 4 will pursue the following Region-specific actions to address climate change vulnerabilities related to our goal *Improving Air Quality***.**

1. Ozone

Tropospheric (ground level) ozone pollution is likely to increase in Region 4 due to increased temperatures in the future. The Region will work with its partners at the state, local, and tribal levels to help them meet the ozone NAAQS.

- Work with other Regions and HQ air program managers to develop a strategy, in context to other programmatic priorities, on how to incorporate climate adaptation into air quality programs (e.g., SIP, permits).

- Criteria considerations impacts are medium for timing, medium for geographic/demographic scale, medium for programmatic scale, and low for physical.

2. Particulate matter

High local PM events are likely to increase due to changes in frequency or intensity of wildfires. The Region will work with its partners at the state, local, and tribal levels to help them reduce the potential for increased wildfires and limit the impacts on air quality.

- Mitigation actions can be implemented to reduce the potential for wildfires and resulting PM impacts. These actions include increased use of prescribed fires or alternative treatment options (e.g., mechanical clearing or herbicide treatments) to reduce the build-up of fuel loads in areas prone to wildfires.

- Smoke management is one of the important issues related to both wildfire and prescribed fire management. In the Southeast, Region 4 participates in a partnership of federal and state agencies called the Southeast Regional Partnership for Planning and Sustainability (SERPPAS). EPA has worked with the other partner agencies to develop a document containing Smoke Management Recommendations for prescribed fire. These recommendations could be applied more broadly to promote awareness of use of prescribed fire, which will reduce wildfire potential while also minimizing impacts on PM air quality. (Region-specific action)

- Criteria considerations impacts are medium for timing, medium for geographic/demographic scale, medium for programmatic scale, and low for physical.

B. Goal 2 – Protecting EPA Region 4's Waters

Region 4 has identified the following actions to begin to address climate change vulnerabilities related to our goal of Protecting America's Waters. Many of these actions will benefit from the development and implementation of appropriate national guidance to promote

consistency across the states. The Region will implement these actions in coordination with any related national guidance.

1. Watershed Planning

- Encourage green infrastructure and low-impact development to protect water quality, to make watersheds more resilient and to reduce the demand for additional water resources.
- Work with USGS to become knowledgeable in the best methods to model for current and projected low flow and high flow conditions in gauged and ungauged rivers and streams.

2. Water Quality Standards

- Use the Triennial Review of state water quality standards to work with states and tribes on changes in stream use classification or standards, where necessary, due to climate change induced increasing temperatures or changes in stream flow.
- Encourage states and tribes to develop appropriate coordination processes between water quality and water supply decisions to ensure proper implementation of state water quality standards.

3. Water Quality Monitoring, Assessing and Reporting

- Evaluate Region 4 states' and tribes' current monitoring and assessment practices to encourage the capturing of extreme low flow or other climate related conditions, including: 1) appropriate biological monitoring and assessment techniques, and 2) water monitoring system design.
- Work with states, tribes, and other water monitoring partners to help establish a long term monitoring program to track potential changes in temperature, flow, aquatic biological communities, habitat, and chemical constituents that are occurring over time at important sentinel reference sites in the SE Region.

4. Total Maximum Daily Loads (TMDL)

- Guidance from the Office of Water on methods and approaches is needed prior to the Region identifying specific regional actions.

5. National Pollutant Discharge Elimination System (NPDES)

- Encourage States to update fact sheets at permit reissuance to include the most up-to-date critical low flow as possible and to calculate reasonable potential based on those values.
- Continue to work with states on the incorporation of green infrastructure components in MS4 permitting.

6. Non-Point Source (NPS)

- Work with states and tribes to include climate change adaptation provisions in revised Nonpoint Source Management Plans to provide flexibility to fund programs and projects to assess, evaluate, plan and implement climate change adaptations.

7. Wetlands (CWA 404)

- Consider the effects of climate change as appropriate when evaluating Least Environmentally Damaging Practicable Alternatives (LEDPA) in the context of CWA Section 404 Wetlands Permitting.
- Ensure water conservation and efficiency measures are considered, where appropriate, as part of wetlands 404 permitting before new water resource projects are approved.

8. Dredging/Ocean Dumping

- Promote the beneficial use of suitable dredged material to support environmentally sound projects to protect from sea level rise and storm surge.
- Develop protocols to address the likely increase in emergency dredging from hurricanes of increased intensity and other extreme precipitation events that may cause unexpected sedimentation and shoaling.

9. National Estuary Program and South Florida

- Promote the Climate Ready Estuary program in Region 4 National Estuary Programs (NEPs).
- Promote the development of NEP coastal watershed management plans that consider climate change.
- Promote the development of vulnerability assessments by Region 4 NEPs.
- Work with the NEP's to revise and update the NEP Comprehensive Conservation and Management Plans (CCMPs) to address vulnerabilities to climate change.
- Work with the Gulf of Mexico Program Office, Region 6 and the Gulf of Mexico Alliance to address climate change in projects and programs under the BP Deepwater Horizon Natural Resource Damage Assessment and Restore Act procedures.
- Work with the Governor's South Atlantic Alliance to include climate change considerations into South Atlantic Alliance efforts.
- Continue to work with Monroe County, Florida (Florida Keys) to implement climate change in water quality management planning for protection of the Florida Keys National Marine Sanctuary.

10. Drinking Water, Wastewater and Stormwater Infrastructure

- Guidance from the Office of Water on methods and approaches is needed prior to the Region identifying specific regional actions.

11. Drinking Water Quality

- Include assistance to the utilities in developing vulnerability assessments to the anticipated effects of climate changes through the Region's Energy Management Initiative to reduce energy consumption at wastewater and drinking water utilities.

C. Goal 3 - Cleaning up Communities and Advancing Sustainable Development

1. Longer-term Cleanups (e.g., Superfund Remedial, Superfund Time-Critical Removal, RCRA Corrective Action, TSCA) and RCRA Hazardous Waste Management Facilities

- Identify and assess the potential vulnerability of NPL sites within delineated GIS-mapped zones (i.e., sea level rise, flooding due to storm surge, and flooding due to higher precipitation events) based on a consideration of site-specific factors (e.g., local topography, design and duration of cleanup remedies, potential risk to the cleanup).

- Based on the findings from the evaluation of potentially vulnerable NPL sites, develop an action plan to evaluate the vulnerability of other contaminated sites (e.g., brownfields, Superfund Time-Critical Removal, RCRA corrective action) and RCRA Hazardous Waste Management Facilities.

- In conjunction with tribes and state agencies, initiate an interagency dialog to plan and coordinate efforts to consider climate change impacts at contaminated site cleanups and RCRA hazardous waste management facilities.

- Incorporate energy efficiency and conservation into green site remediation practices funded by EPA, and encourage efficiency and conservation in actions conducted by responsible parties.

2. Emergency Response Program

- Utilize GIS-based mapping tools to locate potentially vulnerable critical public infrastructure (e.g., drinking water facilities, waste water treatment facilities) and sources of potential hazardous material releases (e.g., oil facilities) to aid in planning for and responding to emergency events.

- Conduct an assessment of the hazardous waste disposal infrastructure to determine whether it can manage potential disposal needs during a changing climate and whether facility operations will be impacted (e.g. accessibility, capacity, and disposal techniques).

3. RCRA and Brownfields

- Expand green remediation practices such as those which promote waste reduction, materials re-use and recycling, energy and water efficiency and conservation, use of alternate and renewable energies, and promotion of cleaner or reduced emissions.

- Integrate materials recovery principles, practices and programs into the Region's Brownfields and Revitalization program and projects.

4. Oil Program (e.g., Spill Prevention, Control, and Countermeasure (SPCC)/ Facility Response Plans (FRP) Facilities)

- Create layers in GIS to enhance existing mapping tools demonstrating potential impact areas, flood zones, storm surge areas etc.

- Identify SPCC and FRP facilities within EPA Region 4 and include in updated mapping tools.

- Include consideration of climate change impacts in EPA Region 4 management reviews of current and future SPCC and FRP facilities.

D. Goal 4 - Ensuring the Safety of Chemicals and Preventing Pollution

- Promote EPA's Green Building and Sustainable Materials Management challenge programs to encourage healthier and more resource-efficient models of construction, renovation, operation, maintenance and demolition of buildings.

E. Goal 5 - Enforcing Environmental Laws within Region 4

1. The Office of NEPA

Section 309 of the Clean Air Act (CAA) confers upon EPA broad review responsibilities for federal actions. It authorizes EPA to review certain proposed actions of other federal agencies in accordance with NEPA and to make these reviews public. If the proposing agency does not make sufficient revisions such that the project remains environmentally unsatisfactory, EPA may refer the matter to the Council of Environmental Quality.

The EPA Administrator has delegated to the Office of Federal Activities, the national program manager role, and the ten Regional Administrators for review of specific regional actions. Materials Which EPA Reviews Under Section 309 Authority include, proposed legislation and regulation, Environmental assessment (EA), Environmental impact statement(EIS), draft and final, any proposal that the lead agency maintains does not require an EIS but that EPA believes constitutes a major federal action significantly affecting the environment so as to require an EIS.

Region 4's Office of NEPA will

- Work to with NEPA to appropriately incorporate climate change into their environmental assessments and to promote consistency with respective Climate Change Adaptation plans.
- Region will work with other federal agencies to appropriately address vulnerable people and places as they are impacted by climate change.

The above actions were identified because they can be incorporated into the Region's NEPA staff routine activities. The Region NEPA Office often assists federal agencies implementing major federal actions having significant environmental impacts to identify appropriate alternatives and mitigation of impacts, including cumulative effects, to account for climate change. Moreover, the NEPA Office commonly serves an internal regional coordinating role to bring in all relevant and applicable regional program review on these projects. And as appropriate, the NEPA office facilitates discussions between affected communities and the federal agencies to resolve project conflicts. Additionally, EPA's unique CAA Section 309 authority gives it the opportunity to raise those projects of significance to the Council of Environmental Quality for appropriate resolution.

IV. Protect EPA's Facilities and Operations

A. Climate Events

The Region 4 office is located in downtown Atlanta, GA, sufficiently located distant from any major water body or coastal area. The relevant potential climate change impacts to this office are in the form of intense storm-related flooding, particularly the tunnel connecting office buildings and the subway system.

Additionally, tornado activity can be a problem as evidenced by the March 14–15, 2008, tornado outbreak within Region 4. A tornado caused widespread damage across downtown Atlanta, including to the CNN Center and to the Georgia Dome. EPA Region 4's office building is within a block of the Georgia Dome and near several other city buildings damaged by the storm.

The Region has Continuity of Operations (COOP) procedures in place. It is increasingly incorporating technology to allow work to effectively occur remotely should storm damage the Region's building making it inaccessible for routine business. In order to ensure effectiveness ad preparedness, several priority actions have been identified

- Investigate alternative lodging availability at the Alternate COOP Site.
- As a GSA building occupant, EPA Region 4 will promote facility efficiencies.
- Continue to use EMS to promote sustainable business practices including energy efficiency and renewable energy strategies that promote LEED certification.
- Maintain the staff's capacity to work remotely

B. Sustainability

In 2009, Executive Order 12514: "Federal Leadership in Environmental, Energy and Economic Performance" was signed to "establish an integrated strategy towards sustainability in

the Federal Government and to make reduction of greenhouse gas emissions (GHG) a priority for Federal agencies." To ensure that EPA Region 4's buildings meet the requirements and reflect our mission, the Agency implements a range of strategies to reduce the environmental impact of its facilities and operations supporting sustainability.

- Develop interagency federal sustainability team to promote greening federal facilities in Atlanta. Recruit Federal Green Challenge partners from federal departments to reduce their climate change impacts.

- Support the development of sustainable recycling infrastructure and commodities markets through partnerships with state and regional recycling coalitions, by developing and supporting product stewardship and extended producer responsibility models, and through efforts to encourage the recovery and recycling of organic waste streams.

- Recruit partners to implement the SMM Food Recovery Challenge to increase economically valuable and environmentally responsible use and diversion of organic waste away from land-filling to minimize the creation and release of methane.

V. Factor Legal Considerations into Adaptation Efforts

As policy and/or guidance from Program Offices become available, the Region will implement climate change adaptation planning and priority actions consistent with EPA's statutes and regulatory authorities.

No Priority Actions identified

VI. Strengthen EPA's Staff and Partners' Adaptive Capacity through Training

The Region sponsored a Climate Change Adaptation kick-off session, on March 18, 2013, as the first step in making its management and staff aware of the Agency's climate change adaptation planning efforts and the National Climate Assessment efforts at providing regional climate scenarios.

The Region recognizes climate change adaptation training is only as useful as it is relevant to staff's daily programmatic activities. The Region believes appropriate climate change adaptation-related training will inform staff how EPA intends to: 1) incorporate best available climate-change science into Agency's programs consistent with EPA's statutory and regulatory authority and the various Program Office guidance and 2) interpret existing statutory and regulatory authority to support climate change adaptation related activities to insure nation-wide consistency in implementing the Agency's mission.

- Encourage regional employees to take EPA Headquarters created training regarding climate change adaptation.
- Utilize Region 4's Energy and Climate Change Steering Committee and Workgroups to monitor opportunities to educate and outreach to employees and look for areas where climate change adaptation can be incorporated.
- Look for opportunities to bring in guest speakers to lecture employees about climate change and potentially how other agencies are tackling adaptation.
-

VII. Partner with Tribes to Increase their Adaptive Capacity

Region 4 has invited consultation with the six-federally recognized Tribes on climate change adaptation planning, and will continue to coordinate and support Tribal climate change adaptation efforts consistent with the Agency's statutory and regulatory authorities, program office guidance, and resources.

a) Resources

- Coordinate with the Regional Tribal Operations Committee (RTOC) and individual Tribes to identify climate change priorities, assess Tribes' climate change adaptation readiness and determine training, technical assistance and/or resource needs. Determination of needs will include identification of applicable audiences (i.e., Tribal Leaders, environmental staff, community, or other stakeholders). (Region specific action)
    - Criteria considerations impacts are high for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.
- Request clear guidelines from National Program Managers to Project Officers and Tribes about the management of available funds to grant awards addressing climate change adaptation activities. As an example, revise the OAR and EPA's Tribal Air Grants Framework: Menu of Options to include Climate Change Adaptation work as an option as appropriate and following the Clean Air Act. (National specific action)
    - Criteria considerations impacts are medium for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

b) Education and Outreach

- Facilitate a workshop or training for Tribal environmental staff on climate change impacts and priorities. Training may be provided through existing resources, such as the Institute for Tribal Environmental Professionals (ITEP) at Northern Arizona University.

ITEP is currently planning a training in the southeast in Fall, 2013. (Region specific action)

  - Criteria considerations impacts are high for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

- Collaborate with R4 Energy and Climate Change Coordinator and Divisions to incorporate Tribal component(s) in energy and climate change website. (Region specific activity)

  - Criteria considerations impacts are medium for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

- Incorporate Tribal climate change priorities, Traditional Ecological Knowledge, and related information into training opportunities for Region 4 staff. (Regional and National action)

  - Criteria considerations impacts are medium for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

c) Communication and Collaboration

- Coordinate with federal partners on a regular basis to share climate change related efforts, and to streamline education, outreach and consultation with Tribes, where appropriate. Region 4 is hosting the first southeast federal Tribal liaisons meeting on March 19. (Region specific action)

  - Criteria considerations impacts are high for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

- Enhance interagency cross-program coordination and collaboration opportunities to inform, discuss and consult with Tribes on EPA climate change actions and decisions. (Region specific action)

  - Criteria considerations impacts are high for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

VIII. Focus on Most Vulnerable People and Places

a) Children's Health Priority Actions

- Conduct an inventory of tools and materials available to address issues faced by children and pregnant women. Many of these existing tools may need to be updated or modified to more effectively target specific populations and risks. (National-level action)

- Promote and disseminate tools and materials to address issues targeting children and pregnant women. The use of partners and stakeholders can be utilized to assist in preparation and then equipped to support our information dissemination campaign. (National-level and Region-specific action)

- Educate and conduct outreach directed to pediatric health care professionals to enhance their understanding of the threats on children's health, and participate as children's advocates for strong mitigation and adaptation strategies. Pediatric health care professionals can be leaders in a move away from a traditional focus on disease prevention to a broad, integrated focus on sustainability as synonymous with health.[185] (National-level and Region-specific action)

- Conuslt with the Southeast Pediatric Health Specialty Unit (PEHSU) as a resource to address environmental health medical conditions that may be exacerbated by climate change. The expertise available through the National PEHSU Network should be expanded to include perinatology. The PESHU Network should also be equipped to provide expertise though consultations and training to public health officials and health care providers and to the general public through the media and direct intervention. (National-level and Region-specific action)

b) Environmental Justice

- Host climate change and adaptation educational workshops for environmental justice communities.

- Partner with other federal and state agencies and non-profit organizations to inform environmental justice communities of various activities and programs.

- Promote and distribute climate change and adaptation tools and materials via emails, listserv, and mailings.

- Create a train-the-trainer climate change and adaptation workshop where community partners are able to lead climate change and environmental justice workshops.

[182] Final draft *U.S. Environmental Protection Agency Climate Change Adaptation Plan* (June 29, 2012).

[183] Final draft *U.S. Environmental Protection Agency Climate Change Adaptation Plan* (June 29, 2012).

[184] U.S. Environmental Protection Agency Region 4 Energy and Climate Change Strategy Fiscal Year 2013-14 DRAFT 3-13-13.

[185] *Pediatrics, Global Climate Change and Children's Health, Committee on Environmental Health*, 2007;120; 1149, Available at http://pediatrics.aappublications.org/content/120/5/1149.full.pdf

PART 4

PERFORMANCE MEASURES

I. Introduction

This section describes how Region 4 plans to update the information and analysis in this implementation plan, evaluate the success of any activities, and continually improve the process of programmatic climate adaptation over time. The Region will implement measures and evaluate performance consistent with the Agency's statutory and regulatory authorities, Program Office guidance, and resources. Over the coming years, Region 4 will build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. We will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

II. Phased Approach

Region 4 plans to conduct a baseline assessment of all its priority actions to determine the status and the potential for completion of each action. Additionally, Region 4 will finalize its Fiscal Year 2014 Energy and Climate Change Strategic Plan and ensure alignment with this implementation plan.

The National Water Program 2012 Strategy: Response to Climate Change found the most amenable approach for evaluating progress is to assess institutional progress toward becoming a resilient and adaptive program. The Region 4 plan utilizes this approach. Region 4 is adopting a phased approach that uses indicators of progress and emphasizes peer-to-peer learning rather than a top-down mandate. A similar approach is in use in the United Kingdom (UK DEFRA, 2010).

Region 4's Phased Approach tracks the region's institutional *process* and *progress* in incorporating climate change considerations into EPA programs. *Outputs* will not be counted per se; rather, the collectivity of actions and their products will demonstrate *the weight of evidence* for determining the status of adaptation activities. The following Table presents a summary of the seven phases of the Region 4 approach. Recognizing that it may take years or decades to achieve adaptive preparedness and resilience, Region 4 designed phases for which progress could be demonstrated within a relatively short time frame (1 to 3 years).

Phases of Adaptive Management		
Phases	**Explanation**	**Examples of Evidence of Achievement**
1. Initiation	Conduct a screening assessment of potential implications of climate change to mission, programs, and operations.	• Preliminary information is developed to evaluate relevance of climate change to the mission or program; a decision is made as to whether to prepare a response to climate change; further exploration of climate change implications has been authorized. • Accountabilities and responsibilities are assigned at appropriate levels within the organization and resources are available to develop a more in-depth assessment.
2. Assessment	Conduct a broader review to understand how climate change affects the resources in question. Work with stakeholders to develop an understanding of the implications of climate change to the mission, programs, and operations.	• Review science literature and assessments to understand how climate change affects the resources being protected (threat to mission); Engage internal staff and external stakeholders in evaluation. • Identify climate change issues and concerns and communicate with internal and external stakeholders and partners. • Identify which specific programs are threatened and what specific information or tools need to be developed. • Communicate findings to partners and stakeholders and engage them in dialogue on building adaptive capacity.
3. Response Development	Identify changes necessary to continue to reach program mission and goals. Develop initial action plan. Identify and seek the research, information, and tools needed to support actions. Begin to build the body of tools, information, and partnerships needed to build capacity internally and externally.	• Develop initial program vision and goals for responding to climate change. • Identify needed response actions or changes that will allow the organization to begin to address climate impacts on its mission. • Initiate strategies and actions in a few key areas to begin to build organizational ability to use climate information in decision processes. • Identify program partners' needs for building adaptive capacity. • Begin working with an external "community of practice" to engage in tool and program development. • Rudimentary methods are put in place to track progress. • Develop a research strategy and partnerships to obtain additional needed research.

4. Initial Implementation	Initiate actions in selected priority programs or projects.	• Make it clear within the organization that incorporating climate change into programs is critical. • Initiate actions and plans identified in Step 3. • Initiate cooperative projects with partners. • Develop a range of needed information and tools. • Begin to institute changes to incorporate climate change into core programs. • Some program partners have begun to implement response actions.
5. Robust Implementation	Programs are underway and lessons learned are being applied to additional programs and projects.	• Lessons learned are evaluated and strategies are refined. • Efforts are initiated to consider climate change in additional, or more complex, program elements. • Continue to institute institutional changes to incorporate climate change into core programs. • External communities of practice are in place to support ongoing capacity development.
6. Mainstreaming	Climate is an embedded, component of the program.	• The organization's culture and policies are aligned with responding to climate change. • All staff have a basic understanding of climate change causes and impacts. • All relevant programs, activities, and decision processes intrinsically incorporate climate change. • Methods for evaluating outcomes are in place.
7. Monitoring and Adaptive Management	Continue to monitor and integrate performance, new information, and lessons learned into programs and plans.	• Progress is evaluated and needed changes are implemented. • As impacts of climate change unfold, climate change impacts and organizational responses are reassessed.

The intention is to use this approach to follow progress related to each program as the plan is implemented. The phase identified for each program is or will be a composite summary of the overall implementation. At this time, no attempt has been made to identify the phase of each individual action and Region 4 will begin its baseline assessment once there has been additional time to consider performance measures and consult with Headquarters and other Regions on the best practices.

Appendix A - Region 4 Summary of Region 4 Program Vulnerabilities to Climate Change Impacts by EPA Strategic Goal

5-28-2013 Draft

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]			Region 4 Programmatic Impacts	
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**	**Likelihood of Regional Program will be Affected by Impact**	**Example of Risks if Program were Impacted**
Goal 1 - Taking Action on Climate Change & Improving Region 4's Air Quality	• Increased tropospheric ozone pollution in certain regions	• Likely	• Protecting public health and the environment by approving state programs to meet National Ambient Air Quality Standards (NAAQS) and implementing programs in Indian Country.	• High	• Could become more difficult to attain NAAQS for ozone in many areas with existing ozone problems.	• High	• There could be more ozone exceedances in current nonattainment areas (Atlanta, Birmingham, Memphis,etc) and new non attainment areas that were previously attaining.
	• Increased frequency or intensity of wildfires	• Likely[2, 11]	Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	• Medium	• Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) and ozone pollution in areas affected by more frequent wildfires.	• Medium	• An increase in wildfire activity could cause more frequent elevated PM events, which would be hazardous to human health.
	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very Likely[3] • Likely[3]	• Protect public health by promoting healthy indoor environments through voluntary programs and guidance	• Medium	• Could increase public health risks, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations	• Medium	• Could see an increase in flooding which can contribute to mold and increased exposure to indoor chemicals as people stay indoors during heavy precipitation. • Could see more power outages which can lead to increases in $PM_{2.5}$ emissions from backup electricity and heat sources.
	• Effects on the stratospheric ozone layer	• Likely[4]	• Restoring the stratospheric ozone layer • Preventing UV-related disease • Providing a smooth transition to safer alternatives	• High	• Unable to restore ozone concentrations to benchmark levels as quickly at some latitudes	• Medium	• Continued decreases in ozone-depleting halocarbon emissions are expected to reduce their relative influence on climate change in the future; however potential for increased use of pesticides that contains ozone-depleting halocarbon emissions. • Climate Change may exacerbate health effects of ozone layer damage at some latitudes and mitigate them at others.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]			Region 4 Programmatic Impacts	
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**	**Likelihood of Regional Program will be Affected by Impact**	**Example of Risks if Program were Impacted**
	• Effects on response of ecosystems to atmospheric deposition of sulfur, nitrogen, and mercury	• Likely[5]	• Ecosystem protections from Agency emissions reduction programs	• Low	• Based on evolving research, could have consequences for the effectiveness of ecosystem protections under those programs	• Low	
Goal 2: Protecting Region 4's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely[9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	• High	**Watershed Management** • Higher air and water temperatures combined with nutrient pollution may result in increased growth of algae and microbes that threaten aquatic ecosystems. • Higher air and water temperatures may increase pollutant concentrations and lower dissolved oxygen levels, potentially resulting in additional water bodies not meeting water quality standards and being listed as impaired. • Areas experiencing periods of less precipitation, drought, lowe stream flow and limited ground water recharge may result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments. • Areas with increased intensity of drought or that may experience increases in events such as wildfires may see alterations in the structure and function of watersheds potentially affecting regional and state wetlands delineation and protection programs. • Increased intensity of rainfall events and storms may cause an increase in the number of sewer overflows and wastewater bypasses, fouling streams and requiring increased water qualit enforcement.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]			Region 4 Programmatic Impacts	
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Goal 2: Protecting Region 4's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely[9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	• High • High	**Water Quality Standards** • Warmer waters and other ecological shifts will threaten aquatic habitats and aquatic species, such as cold water fisheries and potentially requiring changes in State stream classificationsSalinity changes due to seal level rise may create a need to reclassify some water bodies from fresh to salt water. Sea-level rise may also result in a shifting from fresh water communities to salt water communities, such as is happening in the Chassohowitzka River System in Florida. Increased anthropogenic use of freshwater upstream may be a significant contributor in converting fresh to salt water. **Monitoring, Assessing and Reporting** • Stream ecosystems will be affected directly, indirectly, and through interactions with other stressors. Biological responses to these changes will vary regionally and could include altered community composition, interactions, and functions. . • Monitoring locations may need to be re-located in order to effectively monitor and assess changes in stream ecology or water quality. • Timing of monitoring may need to change in order to pick up seasonal shifts and the full range of climate vulnerability, especially for recreational and aquatic life uses.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]			Region 4 Programmatic Impacts	
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**	**Likelihood of Regional Program will be Affected by Impact**	**Example of Risks if Program were Impacted**
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely[9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	• High • High	**TMDLs** • Some areas may experience periods of less precipitation, drought, lower stream flow and limited ground water recharge resulting in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments; these considerations will need to be taken into account in the development of new TMDLs, and potentially result in the need for revision of existing TMDLs. • Some areas may experience episodes of increased intense precipitation resulting in increased runoff of pollutants; these considerations will need to be taken into account in the development of new TMDLs, and potentially result in the need for revision of existing TMDLs. **NPDES Program** • Areas experiencing periods of less precipitation, drought, lowe stream flow and limited ground water recharge will result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments. National Pollutant Discharge Elimination System (NPDES) permits wil need to take these factors into consideration during permit renewal or new permit issuance. These precipitation changes are compounded in certain areas by increased human uses of the water resources. • Increased intensity of rainfall events and storms may cause an increase in the number of sewer overflows and wastewater bypasses, fouling streams and requiring increased water quality enforcement. • Increased aquatic temperatures may result in the need to modify existing discharge limits.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]			Region 4 Programmatic Impacts	
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**	**Likelihood of Regional Program will be Affected by Impact**	**Example of Risks if Program were Impacted**
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely[9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	• High • High	**Wetlands** • Areas with increased intensity of drought or that may experience increases in events such as wildfires may see alterations in the structure and function of wetlands and watersheds potentially affecting regional and state wetlands delineation and protection programs. • Sea-level rise combined with coastal development will challenge the ability of coastal wetlands to migrate, potentially affecting coastal wetland protection programs. This migration will likely result in loss of coastal wetlands where developmen has encroached on natural migration pathways. • Drying out of seasonal wetlands with increased drought could affect wetland delineations and programs. • Physical damage or elimination of wetlands and dune structures that protect them due to hurricanes and other seasonal changes could affect wetland delineation and restoration efforts. **Dredging/Ocean Dumping** • Increased need and frequency of ocean dumping due to increased precipitation and rainfall intensity that cause erosion and sedimentation of rivers, channels and harbors. • Shifting sediments and forming of shoals due to higher intensity storms that impede safe navigation in harbors and channels may require increased use of emergency dredging. • Need for dredged materials to protect shorelines, beaches, dunes and marshes from sea level rise may stress existing regulatory programs.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]			Region 4 Programmatic Impacts	
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**	**Likelihood of Regional Program will be Affected by Impact**	**Example of Risks if Program were Impacted**
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely [9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	• High	**National Estuary Program/South Florida** • Successful implementation of NEP Comprehensive Conservation and Management Plans may be adversely affected. Efforts to restore or enhance water quality, habitat, living resources, hydrologic alterations, and human uses may be affected. • Increased ocean temperatures and acidification resulting from the absorption of CO2 will continue to stress coral reefs potentially affecting coral reef protection programs.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]			Region 4 Programmatic Impacts	
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**	**Likelihood of Regional Program will be Affected by Impact**	**Example of Risks if Program were Impacted**
Goal 2: Protecting Region 4's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Increasing intensity of hurricanes • Increasing flood risk	• Likely[3] • Likely[3] • Very likely[6] • Likely[3] • Likely[7] • Likely	• Drinking water, wastewater and stormwater infrastructure	• High	• Water infrastructure could be rendered inoperable or damaged, needing substantial repair/replacement • Drinking water intakes and wastewater outfalls could be affected • Integrity of coastal water infrastructure systems could be put at increased risk. • Drinking water and wastewater utilities may need an 'all hazards' approach to planning for emergencies and extreme weather events. • Problems of safety as well as access to clean and safe water may be exacerbated for all communities	• High	• Higher air and water temperatures combined with nutrient pollution will result in increased growth of algae and microbes that affect drinking water treatment needs. • Increased intensity of rainfall events and storms could contribute to additional infiltration/inflow in wastewater conveyance systems, which could cause an increase in the number of sewer overflows and wastewater treatment plant overloads, requiring expensive modifications and improvements to both wastewater conveyance and treatment systems. • Increased drought will place demands on both surface and ground water resources resulting in water supply problems. • Reduction in assimilative capacity of existing surface waters due to reduced stream flows and/or increased temperatures could lead to more stringent discharge limits on existing wastewater facilities, resulting in the need for expensive improvements or upgrades to maintain permit compliance. • Sea level rise could result in: 1) saltwater intrusion into the collection system of wastewater treatment systems; 2) wet wells in pumping systems leading to increased corrosion damage to pumping equipment, and treatment plant tankage and equipment; withdrawals and 3) malfunction of gravity conveyance systems and discharges. • Increases in flooding from extreme precipitation, storm surges, and loss of wetlands could cause damage to infrastructure resulting in increased needs for SRF funding. • Source water intake changes may be needed due to droughts and summertime extreme heat. Coastal aquifers may experience salt water intrusion where are outstripping recharge and increased pressure head from higher sea levels may worsen this problem resulting in the need for relocation of water and wastewater facilities. •

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	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**	**Likelihood of Regional Program will be Affected by Impact**	**Example of Risks if Program were Impacted**
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Increasing intensity of hurricanes • Increasing flood risk	• Likely[3] • Likely[3] • Very likely[6] • Likely[3] • Likely[7] • Likely	• Drinking water, wastewater and stormwater infrastructure	• High	• Water infrastructure could be rendered inoperable or damaged, needing substantial repair/replacement • Drinking water intakes and wastewater outfalls could be affected • Integrity of coastal water infrastructure systems could be put at increased risk. • Drinking water and wastewater utilities may need an 'all hazards' approach to planning for emergencies and extreme weather events. • Problems of safety as well as access to clean and safe water may be exacerbated for all communities	• High • High	• Drinking water and wastewater utilities emergency planning for extreme weather events may need to be reviewed and modified to account for climate change. Vulnerable and economically deprived communities may be particularly at risk, both for access to clean and safe water as well as for their ability to respond to emergencies during extreme events. Coastal and mountain communities will be particularly vulnerable. • Changes in rainfall patterns may lead to additional water supply infrastructure, with associated impacts on ecosystem fragmentation, aquatic life, physical stability, water quality, disruption of sediment and nutrient dynamics, downstream users, and system losses due to increased evaporation from impoundments. CWA Section 404 permit applications for reservoir creation in response to drought have increased in some states. **Nonpoint Source Management** • Increased intensity of rainfall events and storms will cause increased pollutant loads in runoff, and the velocity of runoff will scour and erode creek beds. • Accounting for greater quantities of runoff and pollutants, with more variability, from both urban and suburban stormwater and agricultural sources will stress existing nonpoint source best management programs. • Decreasing frequency of precipitation days and more concentration of runoff in intense storms, which is likely to be more damaging to aquatic habitats, and carry more erosion-related pollutants into water bodies will stress existing nonpoint source best management programs.

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Goal 2: Protecting Region 4's Waters	• Increased water temperatures • Increasing heavy precipitation events • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Loss of Snowpack	• Very Likely • Likely • Very Likely • Likely • Very likely	• The quality and availability of safe drinking water	• Medium	• High water temperatures and increased stormwater runoff will increase the need for drinking water treatment, raising costs. • May cause saltwater intrusion in surface water and ground water placing increased demands on drinking water treatment. • Water supplies may be affected, forcing communities to seek alternative sources. • Water demand may shift to underground aquifers or prompt development of reservoirs or underground storage of treated water, requiring EPA to ensure safety.	• High	• Higher air and water temperatures will promote increased growth of algae and microbes, which will increase the need for drinking water treatment and potentially affect the aesthetic quality of drinking water supplies. • Increased storm water runoff will wash sediment and other contaminants into drinking water sources, requiring additional treatment. • Sea-level rise could increase the salinity of both surface water and ground water through saltwater intrusion, encroaching upon coastal drinking water supplies. Additionally, extreme weather events such as hurricanes and extreme droughts could impact and potentially permanently affect both the availability and quality of drinking water sources. In southeastern areas with saltwater intrusion, Region 4 states may receive more permit applications and issue more permits for Class V aquifer recharge injection wells under the Underground Injection Control (UIC) program in an attempt to combat the effects of saltwater intrusion caused by sea-level rise. • Reduced annual precipitation or increased intensity and duration of drought in some regions will affect water supplies, causing drinking water providers to reassess supply plans and consider alternative pricing, allocation and water conservation options. • In areas with less precipitation, public water supply systems water demand may rely more heavily on underground aquifers or development of underground storage of treated water to supplement existing sources. Changes in the salt front of estuaries and tidal rivers due to sea level rise and over use of fresh surface and ground water resulting in flow changes may result in increased pressure to manage freshwater reservoirs to increase flows and attempt to maintain salinity regimes, in order to protect estuarine productivity and drinking water supplies.

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	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated EPA Program**	**Likelihood EPA Program will be Affected by Impact [f]**	**Example of Risks if Program were Impacted**	**Likelihood of Regional Program will be Affected by Impact**	**Example of Risks if Program were Impacted**
Goal 3: Cleaning Up America's Communities & Advancing Sustainable Development	• Sea Level Rise • Increasing heavy precipitation events • Increasing risk of floods • Changes in temperature • Increasing intensity of hurricanes • Decreasing seasonal precipitation days/drought conditions	• Very likely[6] • Likely[7] • Likely[7] • Very likely[3]	• Cleaning up Contaminated Sites and Waste Management	• Low	• Increased risk of contaminate release from EPA Sites • May need to alter selected remedies to ensure protection.	• Medium • High • High • Low • High • High	**Superfund** • Sea level rise may adversely impact contaminated sites in coastal areas in 6 of 8 Southeastern states through inundation, storm surge, and salt water intrusion • The Southeast is very likely to experience extreme storm events that could cause the release and affect the migration and management of contaminants through increased flooding, surface water runoff, infiltration into soils, and changes to water table levels). • Contaminated sites could experience increased wind damage and dispersal of contaminants through higher intensity hurricanes, particularly at coastal and near-coastal locations, or along major rivers. • Increased ambient temperatures could impact the design and operation of remediation systems due to extreme heat (e.g., increased pressurization of storage containers) and increased number of rain and ice storms during winter • Decreased precipitation days and increasing drought intensity could increase risk of wild fires and affect the design and operation remediation systems and restoration efforts at contaminated sites • Extreme storm events and other climate change impacts may create sudden, unexpected conditions at contaminated sites tha complicate cleanup actions, impose significant cleanup costs, and further endanger the health and safety of responders

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Goal 3: Cleaning Up America's Communities & Advancing Sustainable Development	• Sea Level Rise • Increasing heavy precipitation events • Increasing risk of floods • Changes in temperature • Increasing intensity of hurricanes • Decreasing seasonal precipitation days/drought conditions	• Very likely[6] • Likely[7] • Likely[7] • Very likely[3]	• Cleaning up Contaminated Sites and Waste Management	• Low	• Increased risk of contaminate release from EPA Sites • May need to alter selected remedies to ensure protection.	• Medium • High • High • Low • High • High	**RCRA** • The same climate change impacts that could affect contaminated site cleanups may also affect the management and operation of hazardous waste facilities. • Over-pressurization of tanks containing volatile wastes and the emergency venting of these wastes could occur with extreme ambient temperatures. • Buildings or other structures used for indoor storage of waste piles could be damaged or flooded in a hurricane causing the release of this material. • Region 4 has a universe of underground storage tanks which may be vulnerable to flooding events. Of particular concern is groundwater contamination from leaks from at risk tanks and damage to the supporting piping. • Failure of infrastructure (e.g. pipelines, and secondary containment) and damage or displacement of tanks due to increased intensity of hurricanes and resulting winds and storm surges. • Increased degradation and weathering of pipelines and infrastructure due to ocean acidification resulting in oil spills. • More sites may enter the brownfields inventory as natural disasters lead to release of hazardous substances and oil. EPA may begin experiencing even more competition for the already dwindling brownfields grant funding. • Flooding could disrupt or delay work at existing Brownfield sites.

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Goal 3: Cleaning Up America's Communities & Advancing Sustainable Development	• Increasing heavy precipitation events • Increasing risk of floods • Sea level Rise • Changes in temperature • Decreasing seasonal precipitation days/drought conditions	• Likely • Likely • Very Likely • Likely • Likely	Emergency Response	• High	• Increased need for emergency response. • Possible limitations to response capability due to staff and financial resource constraints.	• High	• Smaller entities with hazardous materials may lack resources for emergency planning, which may increase the risk of abandoned hazardous materials during a flooding o storm event. • Insufficient capacity to handle surges in treatment and disposals of hazardous and municipal waste as well as mixed waste from climatic events • Releases of hazardous materials or chemicals through high winds, flooding, and storm surge and a need for increased frequency and intensity of emergency response for both hazardous materials and oil. Current response resources, including laboratory requirements, may not be adequate for responses to extreme events. Specific impacts include o Increased number of brown/black outs will potentially lead to impacts with facility processes (i.e. runaway reactions, heat reactions, failure of chemical processes) o Coastal hazardous material and oil facilities may be impacted by extreme events and storm surge. The United States Coast Guard (USCG) has jurisdiction over hazardous material and oil spills along the coast, but the U. S. EPA has interagency agreements in plac to support the USCG during responses. • Storm surge caused by coastal storms, hurricanes and sea-level rise and flooding may cause the destruction of many homes in the impacted area. This will produce an increase in the amount of household hazardous waste and white goods (i.e., refrigerators, air conditioners, etc) that may need to be collected and placed in landfills. • Storm surge caused by coastal storms, hurricanes and sea-level rise may adversely impact industrial facilities located along the coast and cause releases of chemicals, discharge of oil and spread orphan containers (i.e., above ground storage tanks, drums, totes) in the affected area.

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Goal 3: Cleaning Up America's Communities & Advancing Sustainable Development	• Increasing heavy precipitation events • Increasing risk of floods • Sea level Rise • Changes in temperature • Decreasing seasonal precipitation days/drought conditions	• Likely • Likely • Very Likely • Likely • Likely	Emergency Response	• High	• Increased need for emergency response. • Possible limitations to response capability due to staff and financial resource constraints.	• High	• Twenty-seven percent of the major roads, 9 percent of the rail lines, and 72 percent of the ports in the Region 4 area are built on land at or below 4 feet in elevation, a level within the range of projections for relative sea-level rise in this region in this century. Increased storm intensity may lead to increased service disruption and infrastructure damage. More than half of the area's major highways (64 percent of interstates, 57 percent of arterials), almost half of the rail miles, 29 airports, and virtually all of the ports, are below 23 feet in elevation and subject to flooding and damage due to hurricane storm surge. • Additional planning for emergency response may be needed: o Brown and black-outs may cause releases and the frequency and intensity of storms may need to be incorporated into current national and area contingency plans. o Facility Response Plans (FRP) and Spill Prevention and Control Countermeasures (SPCC) plans may not consider climate change impacts. o Current regional debris management plans rely on historical climate assumptions and do not address the increasing uncertainty in climatic extreme events. o Additional planning may be needed as Stafford Act declaration (federal emergency declaration) may be more frequent with a changing climate. o Current energy infrastructure (oil, natural gas, nuclear) in Southeast may not include climate change assumptions for emergency planning.

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Goal 4: Ensuring Safety of Chemicals & Preventing Pollution	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very likely[3] • Likely[3]	• Protecting human health and ecosystems from chemical risks. • Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Section 18 emergency exemptions • FIFRA compliance monitoring • Integrated Pest Management (IPM) programs	• Low • Low	• Assure that chemical exposure models reflect changes in the environment • Changing in planting timing or location may affect the volume and timing of agricultural chemical use which could impact the appropriate risk management decisions.	• Low • High	• Region 4 may experience new pest problems, many of which will be from exotic invasive species. • Changes in pests and pest pressures due to increases in temperatures and variations in rainfall patterns. • There would be a potential increase in the need for emergency exemptions (FIFRA Section 18). These FIFRA exemptions ar granted when an emergency pest problem appears which cannot be controlled effectively by the current pesticides registered for that pest or commodity, allowing temporary use of chemicals which are not registered for that use • Increasing pesticides usage to control pests could also lead to increased resistance of the pest to the chemical being used. Resistance management will therefore become increasingly important. • The increase in amount and variability of precipitation projected for Region 4 can create an expanded mosquito habitat, which could increase exposure to more diseases like dengue fever and malaria. • Emergency exemptions for mosquito control may increase, especially after major weather events such as floods and hurricanes, which tend to spur populations of *A. aegypti* and *A. albopictus*. • Increase in fungal organisms in agricultural and non-agricultural settings due to extreme rainfall. • Increase in dry condition pests due to drought (e.g. mites that feed on a variety of field, vegetable and fruit crops). • These changes in pesticide choices and quantities will require changes to the pesticide applicator certification and training programs. Changes in chemical selection could result in new and increased chemical exposures especially for indoor applications.

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Facilities and Operations	• Increased Water Temperatures • Decreasing precipitation days and increasing drought intensity • Increased high wind event intensity, e.g., tornado	• Very likely[9] • Likely [7]	• Water usage at EPA facilities • Office building inaccessible due to tornado damage	• High	• Water temperatures impact research activities or cooling requirements. • Facilities could be located in areas with water shortages	• High	• Droughts could affect energy use – may experience periods of "brown outs" • Air temperatures impact cooling/energy demand, water temperature impact cooling equipment efficiency.
	• Increasing risk of floods • Increasing intensity of hurricanes • Sea level rise • Increasing extreme temperatures	• Likely [7] • Likely[3] • Very likely[6] • Very likely[3]	• Operations of Agency facilities, personnel safety, physical security, and emergency communications • Emergency management mission support (protective gear and acquisition)	• Medium	• Facilities in coastal or flood-prone areas • Personnel engaged in field work and vulnerable to extreme temperatures or events • Security, lighting and communication systems without backup power • Personnel and real property supporting emergency response and management	• High	• Region 4's Gulf Breeze Lab is located on Sabine Island on Florida Panhandle • The Region has the largest coastal population exposure.

Footnotes for Summary of Climate Change Vulnerabilities to Climate Change Impacts by EPA Goal Table

[a]This table summarizes vulnerabilities by goal for four of the five goals in EPA's Strategic Plan. Goal 5 "Enforcing Environmental Laws" is not included in this table. Please note that the table also summarizes vulnerabilities to EPA facilities and operations; this is not part of the EPA Strategic Plan goal structure but is an important element of EPA's vulnerability assessment. Please see Section 2 of this document for a fuller discussion of impacts.

[b]Climate Change Impacts are based upon peer-reviewed scientific literature

[c] Programmatic Impacts are based upon EPA best professional judgment at this time.

[d] Impacts can vary by season and location.

[e] In general, the sources cited in this section use Intergovernmental Panel on Climate Change (IPCC) likelihood of outcome terminology where the term 'very likely' means 90-100% probability and the term 'likely' means 66-100% probability. For some impacts in the table, additional discussion on the likelihood term is provided in the associated footnote.

[f] **High** assumes the program will be affected by the impact; **Medium** assumes the program could be affected under some conditions by the impact; **Low** assumes that there is a potential for the program to be impacted or uncertainty currently exists as to the potential nature and extent of the impact. This assessment is based on best professional judgment within EPA at this time. Please note, this column does not reflect several important considerations. For example it does not distinguish timeframes (current, near-term, long-term). It does not account for regional and local variations. And it does not reflect the priority of actions the agency may undertake now or in the future.

1) Denman, K.L., et al. (2007). Couplings Between Changes in the Climate System and Biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

2) C.B. Field et al., "North America," Chapter 14 in *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2007).

3) IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea,K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

4) World Meteorological Organization, *Scientific Assessment of Ozone Depletion: 2010*, Global Ozone Research and Monitoring Project—Report No. 52 (Geneva, Switzerland, 2011). Note: the word "expected" is used in the report to characterize projected climate change impacts on the stratospheric ozone layer. For purposes of this table the word "likely" has been used as a proxy for "expected."

5) Burns, D.A., Lynch, J.A., Cosby, B.J., Fenn, M.E., Baron, J.S., US EPA Clean Air Markets Div., 2011,National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment, National Science and Technology Council, Washington, DC, p. 114.

6) IPCC, 2012: "It is very likely that mean sea level rise will contribute to upward trends in extreme coastal high water levels in the future."

7) USGCRP, 2009: **Global Climate Change Impacts in the United States** . Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

8) NRC, 2010: National Research Council of the National Academies, America's Climate Choices: Panel on Advancing the Science of Climate Change, 2010. p 41. "One of the most certain outcomes from increasing CO_2 concentrations in the atmosphere is the acidification of the world's oceans." For purposes of this table, the term "certain" is used.

9) USGCRP, 2009: p. 46. [In the case of freshwater] "Increased air temperatures lead to higher water temperatures, which have already been detected in many streams, especially during low-flow periods." For the purposes of this table "very likely" is used.

10) Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 2008: Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, p. 130

11) Ingram, K.T., K. Dow, L. Carter (2012): Southeast Regional Technical Report to the National Climate Assessment.

Appendix B

Region 4 Priority Actions Matrix

	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
Regional Crosscutting Actions	The Region 4 will assist its state, local, and tribal governments and Federal resource managers to prepare for and respond to climate-related changes.	Region will work with its stakeholders to develop and implement strategies to respond to local concerns and to share these methods with other communities	As budgets allow: Promote EPA's Clean Energy-Environment State Partnership. Promote the Southeastern Ecological Framework as a tool for evaluating and adapting to climate change impacts on important ecosystems and services across eight Southeastern states. Implement activities that support national Climate for Action Education and Outreach Campaign. Promote EPA's Smart Growth program to help communities grow in ways that expand economic opportunity, protect public health and the environment, and create and enhance the places that people want to live and work.	B R B B	Y N N U
Goal 1: Taking Action on Climate Change & Improving Air Quality	Increased tropospheric ozone pollution	Protecting the public health and the environment by approving state programs to meet NAAQS and implementing programs in Indian Country	Work with other Regions and HQ air program managers to develop a strategy, in context to other programmatic priorities, on how to incorporate climate adaptation into air quality programs (e.g., SIP, permits).	B	Y
	Increased frequency or intensity of wildfires	Protecting the public health and the environment by approving state programs to meet NAAQS and implementing programs in Indian Country	Promote awareness of the use of prescribed fires or alternative treatment options to reduce build-up of fuel loads in areas prone to wildfires Broaden Smoke Management Recommendations for prescribed fires developed by SERPPAS	R R	Y N
	Increasing extreme temperatures	Protecting the public health	Promote SunWise Program to teach public how to protect themselves from overexposure to the sun.	B	N

	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
Goal 2: Protecting America's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Watershed Planning**	Encourage green infrastructure and low-impact development to protect water quality, to make watersheds more resilient and to reduce the demand for additional water resources.	B	Y
			Work with USGS to become knowledgeable in the best methods to model for current and projected low flow and high flow conditions in gauged and ungauged rivers and streams.	B	Y
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Water Quality Standards**	Use the Triennial Review of state water quality standards to work with states and tribes on changes in stream use classification or standards, where necessary due to climate change induced increasing temperatures or changes in stream flow..	R	Y
			Encourage states and tribes to develop appropriate coordination processes between water quality and water supply decisions to ensure proper implementation of state water quality standards.	R	N
Goal 2: Protecting America's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Monitoring, Assessing and Reporting**	Evaluate Region 4 states' and tribes' current monitoring and assessment practices to encourage the capturing of extreme low flow or other climate related conditions, including: 1) appropriate biological monitoring and assessment techniques, and 2) water monitoring system design.	R	Y
			Work with states, tribes, and other water monitoring partners to help establish a long term monitoring program to track potential changes in temperature, flow, aquatic biological communities, habitat, and chemical constituents that are occurring over time at important sentinel reference sites in the SE Region.	B	Y

	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **TMDLs**	Guidance from the Office of Water on methods and approaches is needed prior to the Region identifying specific regional actions.	N	Y
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **NPDES**	Encourage States to update fact sheets at permit reissuance to include the most up-to-date critical low flow as possible and to calculate reasonable potential based on those values. Continue to work with states on the incorporation of green infrastructure components in MS4 permitting.	R R	N N
Goal 2: Protecting America's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Non-Point Source (NPS)**	Work with states and tribes to include climate change adaptation provisions in revised Nonpoint Source Management Plans to provide flexibility to fund programs and projects to assess, evaluate, plan and implement climate change adaptations.	R	Y

	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Wetlands**	Consider the effects of climate change as appropriate when evaluating Least Environmentally Damaging Practicable Alternatives (LEDPA) in the context of CWA Section 404 Wetlands Permitting. Ensure water conservation and efficiency measures are considered, where appropriate, as part of wetlands 404 permitting before new water resource projects are approved.	B B	Y N
	• Increasing heavy precip. events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Dredging/Ocean Dumping**	Promote the beneficial use of suitable dredged material to protect from sea level rise and storm surge. Develop protocols to address the likely increase in emergency dredging from hurricanes of increased intensity and other extreme events that may cause unexpected sedimentation and shoaling.	B B	U Y

	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
Goal 2: Protecting America's Waters	• Increasing heavy precip. events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **National Estuary Program/South Florida**	Promote the Climate Ready Estuary program in Region 4 National Estuary Programs (NEPs). Promote the development of NEP coastal watershed management plans that consider climate change. Promote the development of vulnerability assessments by Region 4 NEPs. Work with the NEP's to revise and update the NEP Comprehensive Conservation and Management Plans (CCMPs) to address vulnerabilities to climate change. Work with the gulf of Mexico Alliance to include climate change considerations in projects and programs under the BP Deepwater Horizon Natural Resource Damage Assessment and Restore Act procedures. Work with the Governor's South Atlantic Alliance to include climate change into South Atlantic Alliance efforts. Continue to work with Monroe County Florida, (Florida Keys) to implement climate change in water quality management planning for protection of the Florida Keys National Marine Sanctuary.	R R R R B R R	Y Y Y Y Y Y U
	• Increasing heavy precip. events • Increasing intensity of hurricanes • Sea-level rise • Increase flood risk	**Drinking water, wastewater and stormwater infrastructure**	Guidance from the Office of Water on methods and approaches is needed prior to the Region identifying specific regional actions.	N	Y

	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
	• Increasing heavy precip. events • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	The quality and availability of safe drinking water **Drinking Water Quality**	Work with tribes on efforts towards sustainable infrastructure and participate on national workgroups aimed at directing tribal water systems towards sustainable operation/maintenance of tribal water systems.Include assistance to the utilities in developing vulnerability assessments to the anticipated effects of climate changes through the Region's Energy Management Initiative to reduce energy consumption at wastewater and drinking water utilities.	B	N
Goal 3: Cleaning Up America's	Increasing heavy precipitation events Changes in temperature	Cleaning up contaminated sites and waste **Longer-term Cleanups**	Identify and assess the potential vulnerability of NPL sites within delineated GIS-mapped zones based on a consideration of site-specific factors.	B	Y
			Develop an action plan to evaluate the vulnerability of other contaminated sites (e.g., brownfields, Superfund Time-Critical Removal, RCRA corrective action) and RCRA Hazardous Waste Management Facilities.	N	Y
			In conjunction with tribes and state agencies, initiate an interagency dialog to plan and coordinate efforts to consider climate change impacts.	R	U
			Incorporate energy efficiency and conservation into green site remediation practices funded by EPA, and encourage efficiency and conservation in actions conducted by responsible parties.	R	N

	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
	Increasing heavy precipitation events Changes in temperature	Cleaning up contaminated sites and waste **Emergency Response**	Utilize GIS-based tools to locate potentially vulnerable critical public infrastructure and sources of potential hazardous material releases to aid in planning for and responding to emergency events. Conduct an assessment of the hazardous waste disposal infrastructure to determine whether it can manage potential disposal needs during a changing climate and whether facility operations will be impacted. Work with local/state/federal emergency preparedness and response counterparts and businesses to develop and implement strategies to address adaptive measures needed for climate-related changes and work with state and industry to add enhanced emergency planning in operating permits.	B R B	Y N U
	Increasing heavy precipitation events Changes in temperature	Cleaning up contaminated sites and waste **RCRA/Brownfields**	Expand green remediation practices. Promote revitalization of contaminated land to productive environmental and economic reuse, with an emphasis on green technologies. Integrate materials recovery principles, practices and programs into the Region's Brownfields and Revitalization program and projects.	R R R	N N N
	Increasing heavy precipitation events Changes in temperature	Cleaning up contaminated sites and waste **Oil Program**	Create layers in GIS to enhance existing mapping tools demonstrating potential impact areas, flood zones, storm surge areas etc. Identify SPCC and FRP facilities within EPA Region 4 and include in updated mapping tools. Include consideration of climate change impacts in EPA Region 4 management reviews of current and future SPCC and FRP facilities.	B R R	U N N
Goal 4: Ensuring the Safety of Chemicals	Increasing extreme temperatures	Protecting human health and ecosystems from chemical risks	Promote EPA's Green Building and Sustainable Materials Management challenge programs to encourage healthier and more resource-efficient models of construction, renovation, operation, maintenance and demolition of buildings.	R	N

	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
Goal 5: Enforcing Environmental Laws	Earlier timing of spring events Increasing heavy precipitation events and risk of floods Increased frequency and intensity of wildfires		Work with NEPA to appropriately incorporate climate change into their environmental assessments and that NEPA analysis is consistent with respective Climate Change Adaptation plans. Region will work with other federal agencies to appropriately address vulnerable people and places as they are impacted by climate change.	R R	U N
Facilities & Operations	Decreasing precipitation days and increasing drought intensity	Water and energy usage at EPA facilities	Continue to use the Region's EMS to promote sustainable business practices, energy efficiency, renewable energy strategies, and maintain LEED certification As a GSA building occupant, EPA Region 4 will promote facility efficiencies. .	R R	N N
	Increasing extreme weather events	Operations of Agency facilities, personnel safety, physical security and emergency communications	Investigate alternative lodging availability at the Alternate COOP Site. Maintain the staff's capacity to work remotely	R R	N N
Facilities and Operations	Decreasing climate change impacts	Encouraging sustainability practices within the region 4 offices and surrounding area.	Develop interagency federal sustainability team to promote greening federal facilities in Atlanta. Recruit Federal Green Challenge partners from federal departments to reduce their climate change impacts Support the development of sustainable recycling infrastructure and commodities markets through partnerships with state and regional recycling coalitions, by developing and supporting product stewardship and extended producer responsibility models, and through efforts to encourage the recovery and recycling of organic waste streams. Recruit partners to implement the SMM Food Recovery Challenge to increase economically valuable and environmentally responsible use and diversion of organic waste away from land-filling to minimize the creation and release of methane	R R R	N N N

	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
EPA Staff Training	Cumulative	Increase employee knowledge regarding climate change adaptation and encourage consideration while performing job duties	Encourage regional employees to take EPA Headquarters created training regarding climate change adaptation.	B	Y
			Utilize Region 4's Energy and Climate Change Steering Committee and Workgroups to monitor opportunities to educate and outreach to employees and look for areas where climate change adaptation can be incorporated.	R	N
			Look for opportunities to bring in guest speakers to lecture employees about climate change and potentially how other agencies are tackling adaptation.	R	N
Vulnerable Populations	Climate Change Impacts to Tribes	Region 4's will coordinate with its six-federally recognized Tribes and support Tribal climate change adaptation efforts consistent with the Agency's statutory and regulatory authorities, program office guidance, and resources.	Coordinate with the Regional Tribal Operations Committee (RTOC) and individual Tribes to identify climate change priorities, assess Tribes' climate change adaptation readiness and determine training, technical assistance and/or resource needs.	R	N
			Request clear guidelines from National Program Managers to Project Officers and Tribes about the management of available funds to grant awards addressing climate change adaptation activities.	N	Y
			Facilitate a workshop or training for Tribal environmental staff on climate change impacts and priorities.	R	N
			Collaborate with R4 Tribal component(s) in energy and climate change website.	R	N
			Incorporate Tribal climate change priorities, Traditional Ecological Knowledge, and related information into training opportunities for Region 4 staff.	B	Y
			Coordinate with federal partners on a regular basis to share climate change related efforts, and to streamline education, outreach and consultation with Tribes, where appropriate.	R	N
			Enhance interagency cross-program coordination and collaboration opportunities to inform, discuss and consult with Tribes on EPA climate change actions and decisions.	B	N

	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
Vulnerable Populations	Climate Change Impacts to Children's Health		Conduct an inventory of tools and materials available to address issues faced by children and pregnant women.	N	Y
			Promote and disseminate of tools and materials to address issues targeting children and pregnant women.	B	Y
			Educate and conducnt outreach directed to pediatric health care professionals to enhance their understanding of the threats on children's health.	B	N
			Consult with the Southeast Pediatric Health Specialty Unit (PEHSU) as a resource to address environmental health medical conditions that may be exacerbated by climate change.	B	N
Vulnerable Populations	Climate Change Impacts to Environmental Justice Communities		Host climate change and adaptation educational workshops for environmental justice communities.	R	N
			Partner with other federal and state agencies and non-profit organizations to inform environmental justice communities of various activities and programs.	B	Y
			Promote and distribute climate change and adaptation tools and materials via emails, listserv, and mailings.	B	Y
			Create a train-the-trainer climate change and adaptation workshop where community partners are able to lead climate change and environmental justice workshops.	R	N

U.S. EPA Region 5

Climate Change Adaptation Implementation Plan

May 30, 2014

Disclaimer

To the extent this document mentions or discusses statutory or regulatory authority, it does so for informational purposes only. This document does not substitute for those statutes or regulations, and readers should consult the statutes or regulations to learn what they require. Neither this document, nor any part of it, is itself a rule or a regulation. Thus, it cannot change or impose legally binding requirements on EPA, States, the public, or the regulated community. Further, any expressed intention, suggestion or recommendation does not impose any legally binding requirements on EPA, States, tribes, the public, or the regulated community. Agency decision makers remain free to exercise their discretion in choosing to implement the actions described in this Plan. Such implementation is contingent upon availability of resources and is subject to change.

Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Change Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Bob Perciasepe
Deputy Administrator

September 2013

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EPA Region 5

Draft Climate Change Adaptation Implementation Plan

Background

Executive Order 13514 ("Federal Leadership in Environmental, Energy, and Economic Performance"), issued by the President on October 5, 2009, called on the Interagency Climate Change Adaptation Task Force to develop recommendations for adapting to climate change impacts both domestically and internationally. On October 5, 2010, the Task Force delivered its initial report and first set of recommendations to the President. A key recommendation in the report called for every federal agency to develop and implement a climate change adaptation plan addressing the challenges posed by climate change to its mission, operations, and programs.

On June 2, 2011, the EPA Administrator issued a Policy Statement on Climate Change Adaptation with a charge to develop a Climate Change Adaptation Plan for EPA by June 2012. This charge included the development of Program and Regional Office Implementation Plans. In response to these directives, EPA established a new cross-EPA work group on climate change adaptation planning. The work group developed the first ever Climate Change Adaptation Plan for EPA and delivered it to The White House Council on Environmental Quality (CEQ) on June 29, 2012. The draft Plan was released for public comment on February 7, 2013. EPA's Program and Regional Offices have developed their own Climate Change Adaptation Implementation Plans. The purpose of this Plan is to provide an overview of how EPA Region 5 will incorporate climate change considerations across the work of the region.

To promote consistency, the Agency-wide Climate Change Adaptation Plan identified eight "Common Areas of Focus" as required sections for all of the Implementation Plans:

1. Vulnerability assessments
2. Priority actions on climate adaptation
3. Agency-wide strategic measures on climate adaptation
4. Legal and enforcement issues
5. Training and outreach
6. Partnerships with tribes
7. Vulnerable populations and places
8. Evaluation and cross-office pilot projects

I. Vulnerability Assessment

Regional Climate Change Impacts

According to the U.S. Global Change Research Program (USGCRP, 2009), the following issues are among key areas of concern for the Midwest:

- During the summer, public health and quality of life, especially in cities, will be negatively affected by increasing heat waves, reduced air quality, and increasing insect and waterborne diseases. In the winter, warming will have mixed impacts.
- The likely increase in precipitation in winter and spring, more heavy downpours, and greater evaporation in summer would lead to more periods of both floods and water deficits.
- Increased storm intensity will lead to an increased risk of water pollution to the Great Lakes and Mississippi River basins from combined sewer overflows, sediments, and other threats to water quality.
- While the longer growing season provides the potential for increased crop yields, increases in heat waves, floods, droughts, insects, and weeds will present increasing challenges to managing crops, livestock, and forests.
- Native species and ecosystems are very likely to face increasing threats from rapidly changing climate conditions, including pests, diseases, and invasive species moving in from warmer regions.

Climate change impacts may impose significant costs on communities and people in the Midwest. For example, many communities are facing the need to update water infrastructure to control combined sewer overflows and protect water quality. Given the increased storm intensities anticipated in the Midwest, additional infrastructure investments may be necessary. While this plan prioritizes actions such as green infrastructure to help make communities more resilient to increased storm intensity, additional traditional infrastructure may still be required, and both approaches impose costs on communities. Given the complexity and potential magnitude of climate change and the lead time needed to adapt, preparing for these impacts now may reduce the need for far more costly steps in the decades to come.

Without proper adaptation, climate change impacts may also bring about additional costs through health impacts on both the general and vulnerable populations. The latter of may suffer greater consequences due to health disparities such as asthma and lack of access to quality housing, heating and cooling systems and drinking water.

Regional Vulnerabilities

Given the general climate change impacts in the Region, the following identifies vulnerabilities that we believe, at this time, are most significant to Region 5 divisions and offices. Many of the vulnerabilities identified in this Regional assessment have already been established in the *High-Level Vulnerability Assessment* in the Agency-wide Plan. Much of this assessment relies on the scientific findings of the Intergovernmental Panel on Climate Change (Field et al, 2007 and Denman et al, 2007) and USGCRP, 2009. In addition to the IPCC report, the vulnerabilities

outlined below under Goal 1: Taking Action on Climate Change and Improving Air Quality are attributed to the Institute of Medicine report "*Climate Change, the Indoor Environment, and Health"* and U.S. EPA's *"Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone*." Except where otherwise noted, the environmental conditions described derive from the findings in these reports. In some cases, the best professional judgment of Regional program staff was used in determining further vulnerabilities. A detailed explanation of Region 5's vulnerabilities to climate change is included in *Appendix A,* "*Region 5 Vulnerability Assessment Table*."

The assessment of Region 5's vulnerabilities is a dynamic process. The extent to which vulnerabilities have been identified and are understood varies across goals. The science of climate change will improve over time, providing greater weight of evidence to evaluate the consequences of existing and expected impacts. Region 5 will continue work with its federal, state, tribal and local partners to identify new vulnerabilities and improve our understanding of known vulnerabilities.

Goal 1: Taking Action on Climate Change and Improving Air Quality

a) Criteria Air Pollutants

Higher temperatures and weaker air circulation in the United States (U.S.) will lead to more ozone formation even with the same level of emissions of ozone forming chemicals. In addition to the six nonattainment metro areas in the Region, there are several attainment areas that are violating the ozone standard based on recent monitoring data.

- Increases in tropospheric ozone could lengthen the ozone season and make it more difficult to achieve or maintain attainment.

Wildfires are not a large contributor to particulate matter (PM) issues in the Great Lakes states. However, hotter temperatures and increased drought could increase the incidence of wildfires and increase dust in the air from dry soil. Droughts can also cause restrictions on water use and an increase in the price of water. This would make it more expensive or difficult for industries to control storage piles, which could also create more PM.

- Increased PM from wildfires and drought could increase PM concentrations and associated respiratory and cardiovascular health impacts in affected areas.
- Additional PM could also increase deposition of some contaminants to the Great Lakes.

Higher temperatures would likely cause an increase in use of air conditioners and therefore an increase in the demand for electricity.

Increased demand for electricity could increase the emissions of PM, as well as carbon monoxide (CO), sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) from electric generating units. However, energy efficiency efforts and measures to promote cleaner electricity generation may counteract the impacts of this increased demand.

b) Indoor Air Environments

Increased temperatures and extreme weather may cause residents to spend more time indoors with windows closed, increasing exposure to indoor air pollutants. Extreme weather conditions may bring about other indoor air issues, including:

- Power outages or damage to heating, ventilation and air conditioning (HVAC) systems due to extreme weather increases the potential for the misuse of generators and combustion sources such as gas stoves. If improperly operated, these combustion sources can cause elevated levels of CO and nitrogen oxides (NOx) if their exhaust builds up indoors.

- Residents may weatherize buildings to increase comfort and indoor environmental quality in addition to saving energy. Although in general these actions should be encouraged, this may lead to a reduction in ventilation and an increase in indoor environmental pollutants unless measures are taken to preserve or improve indoor air quality. EPA has developed practical guidance for improving or maintaining indoor environmental quality during home energy upgrades or remodeling in single-family homes and schools. EPA's guidance and protocols may need to be revised to include state and local considerations for projected climatic changes. In addition, these programs may need to increase partnerships with other agencies to address training needs and workforce development for building owners, managers, and others, as well as develop new tracking mechanisms to assess the effectiveness of weatherization and remodeling techniques as they relate to indoor environmental quality.

Flooding may increase damage to buildings, leading to poor environmental conditions such as mold and pest infiltration. Increased temperatures, including warmer winters with fewer days of temperatures below freezing, may also increase the type and number of pests.

- Outdoor and indoor air impacts will increase health risks, particularly for vulnerable populations including individuals with respiratory conditions, children and the elderly, as well as those confined to alternate/emergency shelters during extreme weather situations. Exposure to environmental asthma triggers in homes and schools may also increase.

Goal 2: Protecting America's Waters

a) Water Quality

Climate change is expected to increase air temperatures, which in turn is likely to increase water temperatures in surface water bodies. Climate change is also expected to change weather patterns, resulting in more frequent intense storms and polluted runoff, separated by periods of drought. Various water quality impacts are possible, including increased pollutant concentrations and lower dissolved oxygen (DO) levels, as well as an increased threat of invasive species in the Great Lakes. These changes are likely to have impacts on EPA water programs and will affect our ability to achieve Clean Water Act (CWA) goals in the following ways:

- Increasing numbers of water bodies may be impaired;
- Revisions to monitoring programs may be needed to assess new conditions.
- New water quality models and data may be needed.
- Requests by states to revise water quality standards (WQS), including designated uses and water quality criteria that protect those uses may be more frequent, as water quality impacts become increasingly serious and lasting.
- Permitting and pollution control programs may see a new workload of permit limit revisions to reflect new environmental conditions and revised uses.
- Water quality degradation may impact the availability of water of sufficient quality needed for uses, most notably public water supplies.

b) Pollution Control – Point Source

Climate change is expected to change weather patterns, resulting in more frequent intense storms and polluted runoff, separated by periods of drought.

- Current wastewater collection and treatment systems may not be adequately designed for future conditions.
- Combined sewer systems may not meet performance expectations and water quality objectives in long term control plans EPA and the states have negotiated with communities.
- Storm water collection systems may be inadequate to remove pollutants or prevent flooding.
- In communities with both combined and separate sewer systems, wastewater infrastructure may be stressed by extreme, variable flows.
- EPA and state wastewater regulatory programs will see workloads increase or evolve as we respond to these challenges and to increased expectations from communities regarding assistance on new resilient practices such as green infrastructure, integrated municipal wet weather planning, and energy efficient practices.

c) Pollution Control – Nonpoint Source (NPS)

Climate change is expected to change weather patterns, resulting in more frequent intense storms and polluted runoff, separated by periods of drought.

- Management practices funded or promoted in the CWA section 319 program may not perform as expected, or may be washed out in extreme events.
- As resource managers adapt to changing precipitation patterns, practices may change in ways that increase NPS pollution (e.g., increased tile drainage to more efficiently drain heavy precipitation).
- Climate change may create new demands on EPA and states for outreach to promote environmentally protective, climate resilient practices.

d) Drinking Water/Other Uses

More frequent heavy downpours and floods could increase the amount of sediment and contaminants mobilized and transported to surface waters used for drinking water. Warmer water temperatures can create conditions suitable for pathogens and harmful algal blooms, and the lowering of water tables can expose formations and oxidize arsenic, which makes the contaminant more soluble in water.

- The drinking water program will need to address impacts to drinking water supplies associated with changes in drinking water quality, quantity, and infrastructure.
- Changes in water quality may result in more Safe Drinking Water Act (SDWA) violations, which would increase the workload of the regional and state compliance officers.

Climate change may adversely affect availability of surface and ground water supplies for drinking water, irrigation, etc.

- Increased evaporation associated with warmer temperatures and increased drought conditions could reduce the amount of water available in surface drinking water supplies, as well as reduce the amount of ground water recharge.
- Increased demand for water, whether for drinking or other uses, may coincide with decreasing water availability and quality. Education about water conservation and source water protection will be increasingly important within all sectors and levels of government.
- Where drought conditions affect the presence of surface waters, it may be difficult to establish jurisdiction to implement federal CWA programs to protect vulnerable resources like wetlands.

Water infrastructure decisions made under prior climate scenarios may not be resilient in future climate conditions.

- Increased temperature fluctuations could result in increased frequency of main breaks; flooding can damage water infrastructure; and reduced water levels could require intake structure modifications. Infrastructure costs would increase the demand for funding through the Drinking Water State Revolving Funds.

e) Great Lakes

Changes in average temperature and precipitation patterns have begun to have noticeable impacts on the Great Lakes ecosystem. For example, extreme storm events have resulted in unprecedented sediment inputs to the lakes, and Lake Superior had rare algal blooms in 2012. These trends are projected to continue with higher water and air temperatures and increased evaporation rates.

- Ice cover on the Great Lakes is expected to decline, leading to increased evaporation in winter. Climate change will also affect some lake levels, with some models showing a significant decrease.
- Heightened storm intensities are projected to increase flooding, combined sewer overflows, beach closures, waterborne diseases, wildfires and other stressors on the Great Lakes ecosystem.
- EPA's ability to achieve the objectives of the Great Lakes Restoration Initiative (GLRI) and fulfill the commitments of the Great Lakes Water Quality Agreement of 2012 may be compromised by climate change impacts.

Goal 3: Cleaning Up Communities and Advancing Sustainable Development

a) Risk of Contaminant Release

Region 5 has a significant universe of contaminated sites due to our industrial legacy. Increased flood and drought conditions may impact the mobilization of contaminants at these sites and alter the time, cost and effectiveness of cleanups.

- Drier conditions might cause severe erosion issues on terrain and constructed landfills.
- Corrective actions may need to be altered to ensure they are protective given the potential for increased flooding.
- Flood events could wash away constructed remedies and increase contamination to the environment. Standing water could bring contaminants to the surface and increase exposure potential.
- Potential contaminant releases may pose an increased risk of adverse health impacts, with environmental justice and other vulnerable populations most at risk as they may reside close to these sites.

b) Emergency Response

Increased precipitation may lead to increased riverine flooding, resulting in additional hazardous waste and domestic white goods removal and cleanup.

- Availability of emergency response teams to react quickly may be stressed as extreme weather related events become more frequent.
- The need for emergency response and debris/waste management due to storms resulting in large-scale releases of chemicals and generation of debris from flooded/damaged and/or demolished buildings may also increase. Existing waste management capacity may not be adequate to meet the demands of an increased debris stream resulting from more frequent storms.
- Increased extreme temperatures will impact the health and safety of response workers.

If climate change leads to more intense weather events and increases EPA's involvement in disaster response and remediation, then core program work in all media could be affected due to a scarcity of available staff and resources.

- The need to activate the Response Support Corps and other staff to respond to emergency/disaster situations within the Region and in support to other Regions may have an adverse impact on the Region's ability to consistently and effectively implement core activities and address identified national and regional priorities.

c) Clean up and Corrective Action

The increase in heavy precipitation events that are likely to occur in the Midwest as a result of climate change may cause an increase in flooding risk; droughts are also expected to become more common.

- Flooding often produces significant debris that must be quickly managed by local communities in the region**.**
- Landfill design and controls may become inadequate to protect the environment and human health. The impact of flooding on non-hazardous disposal facilities and their engineered systems is significant as municipal solid waste landfills are only required to design for handling run-on or run-off from a 25-year storm.
- Drought conditions may affect the performance of vegetative caps on closed landfills which may result in increased leachate generation and/or emissions from landfills.
- Contaminated sites where groundwater is involved may have to consider different remedies that reflect the possibility of long term drought, as well as the purging effect of flooding. Groundwater, gas, and leachate monitoring systems may all be affected. States and local governments may need assistance in evaluating the impacts on these facilities.

Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution

a) Exposure to Toxic Chemicals

- Damage to homes, buildings and other community infrastructure as a result of extreme weather events may increase risk of exposure to lead, polychlorinated biphenyls (PCBs), halogenated flame retardants, asbestos and other chemical applicants. Incidents of flooding may increase Persistent Bioaccumulative and Toxic (PBT) chemical impacts to surface water.
- Increased release of toxics resulting from flooding and severe weather may exacerbate exposure and children are particularly vulnerable to this risk. Existing risk assessment methodologies may need adjustment to assure that chemical exposure models reflect changing climate conditions.

b) Exposure to Pesticides

Climate change may drive changes in crops and agricultural practices, including introduction of new genetically modified organisms (GMOs) with new pesticidal traits or immunities and change how, where, and the quantity of pesticides used due to increased pest pressure.

- Increased application amounts, as well as extreme precipitation events and flooding, may result in increased exposure risks and surface water impacts from pesticide application.

- Increased levels of carbon dioxide in the atmosphere may make weeds more difficult to control leading to increases in herbicide use and increased risks of surface and ground water contamination. Existing risk assessment methodologies may need adjustment to assure that pesticide use and exposure models reflect changing climate conditions.
- Weather changes may also result in pesticide use, application or active ingredient changes that may merit increased or more frequent EPA review or study of specific pesticide uses, applications, or effects.

c) Pollution Prevention

Increased precipitation and extreme weather events may play a more prominent role in the Pollution Prevention (P2) Program.

- The P2 Program could respond to these changes in a variety of ways, such as building the adaptive capacity of industries to address the impacts of climate change, including supply chain disruption, changing energy uses, and market demands.

Goal 5: Enforcing Environmental Laws

The enforcement of environmental laws is considered within each program area.

a) National Environmental Policy Act (NEPA)

The uncertainties associated with climate change present challenges to EPA's ability to:

- Effectively comment to other federal agencies on potential environmental impacts of proposed projects; and
- Help to ensure that proposed projects are able to adapt to a changing climate.

Region 5 Facilities and Operations

Climate change will not only impact Region 5's program work, but may also have impacts on its facilities and operations. Region 5's main office and regional laboratory are located in downtown Chicago. Region 5 also has facilities in Westlake, Ohio, and Grosse Ile, Michigan. In addition, the Great Lakes National Program Office (GLNPO) has two research vessels.

- Extreme heat, increased heavy precipitation events and poor air quality may increase the health risks of EPA Region 5 employees engaged in field work or force delays in such work.
- Increased demands on electrical grids during heat waves could impact Region 5's facilities, causing greater need for back-up power sources and contingency planning.
- Severe storms and heat waves could impact public transportation systems, thus preventing Region 5 employees from commuting in to work. Increased risk of floods and extreme events in Region 5 may increase staff demands to provide Emergency Response support. Staff away from the office for periods of time may pose a challenge to the completion of core programmatic work.

Region 5 has the Homeland Security Work Plan (HSWP) which is a series of tasks and focus areas for each division to help with regional preparedness and readiness. Tasks and focus areas range from databases and mapping tools to external partnerships and regulatory activities. To prepare for a disruption in the Region's ability to work in our facilities, the Region 5 Continuity Plan is also covered in the HSWP and includes tasks such as increasing the ability to work from alternate locations and preparing for the closing of our offices. The HSWP is revised annually to reflect any changes or new areas that need to be addressed.

II. Regional Priority Actions

The vulnerabilities described in the previous section require that Region 5 adapt to the impacts of climate change and adjust the work of its programs accordingly. The following criteria were used to identify Priority Actions to adapt to climate change:

1. The action addresses Regional and/or national objectives; it is part of EPA's core activities and programs.
2. Legal authority exists for the action.
3. The action is achievable in a reasonable timeframe using existing resources or a moderate shift of resources.
4. The action has benefits: it reduces the impact on the environment, avoids maladaptation, and increases the effectiveness of EPA's programs in light of climate change impacts. Note: Some of these actions will also provide mitigation co-benefits in that they will also result in reduction of greenhouse gas emissions. These actions are highlighted in green in the Program-Specific Priority Actions discussion that follows.
5. The action addresses vulnerable populations, areas, and/or ecosystems.

Regional Priority Action Themes

Although the specific needs and actions vary by program area, there are several Priority Action themes that cut across the Region. As practical, actions in these areas will be implemented at the Regional level to avoid duplication of work. In addition, actions identified by specific program areas, as described below, may also address these themes.

Training

Train staff on climate change adaptation (see also *Section V, Training and Outreach*):

a. Core training—Increase basic level of climate change understanding of all technical staff; such training is currently being developed by Headquarters (HQ).
b. Targeted training—Increase staff understanding of potential climate change impacts on specific program areas.
c. Incorporate climate change considerations into health and safety training.

Internal Collaboration

Inform EPA national program offices on regional climate change impacts to identify needs and inform rulemaking and guidance development/revision; revise regulations and guidance, in

coordination with other Regions and HQ, to reflect climate change impacts.

Outreach
Provide outreach and technical assistance to States, tribes, federal agencies, and other partners regarding impacts, vulnerabilities, and incorporating climate change considerations into environmental program activities and coordinating actions, as appropriate:

a. Provide access to up-to-date data (e.g., precipitation and stream flow statistics) and tools to factor climate change into programmatic and regulatory decisions;
b. Identify data and tool needs and seek ways to fill them (e.g., inform HQ, Office of Research and Development (ORD);
c. Develop processes jointly with States and tribes to incorporate new data into regulatory decisions (e.g., State Implementation Plan (SIP) development);
d. Anticipate and streamline regulatory decision-making processes affected by climate change (e.g., water quality variance requests) to promote timely, protective decisions.
e. Incorporate climate change considerations into planning work and grant-related processes (e.g., NEPA documentation; state program negotiations, tribal environmental agreements).

Resources
Allocate resources to address climate change vulnerabilities to programs:

a. Reassess workload and staffing priorities, as necessary, to accommodate climate change adaptation work, including potentially increasing emergency/disaster response work demands.
b. Revise inspection and field work priorities as appropriate to reflect climate change considerations (e.g., target sites that appear to be vulnerable to climate change, such as hazardous waste landfills located in areas with increased flooding).

Program-Specific Priority Actions

The actions below are priority actions to address important climate change vulnerabilities on Region 5 programs.

Air & Radiation Division

1. **Address adverse impacts to air quality from climate change, particularly ground-level ozone concentrations**.

Link to Vulnerability Assessment: Higher temperatures and weaker air circulation due to climate change will increase ozone formation. In addition, other impacts of climate change, including wildfires and increased demand for electricity due to greater need for air conditioning, could increase emissions of PM and other criteria pollutants.

Goal: Meet air quality standards in the Region despite the additional challenges that climate change will present.

Actions:

a. To the extent that it becomes apparent that a changing climate is preventing attainment of national air quality standards, Clean Air Act provisions may require identification of additional control measures to reduce criteria pollutant emissions. Region 5 will work with EPA HQ to determine appropriate actions if and when such control measures are needed. Such actions may include:
   - Consideration of Supplemental Environmental Project (SEPs) that would reduce emissions of ozone precursors;
   - Targeting of enforcement and permit review; and
   - Promoting options for reducing criteria pollutant emissions in anticipation of expected adverse climate change impacts, including Ozone Advance, PM Advance, and output-based standards.

2. Address increased adverse impacts to indoor air quality (IAQ) from climate change.

Link to Vulnerability Assessment: Increased temperatures and extreme weather conditions may worsen existing indoor air quality problems and exposure to indoor air pollutants may increase if weather extremes cause residents to spend more time indoors.

Goal: Continue to improve indoor air quality in the Region and balance energy-saving measures with ventilation and indoor air quality.

Actions:

a. Continue to promote Indoor airPLUS and Healthy Indoor Environment Protocols for Home Energy Upgrades. Indoor airPLUS builds on ENERGY STAR requirements for new homes and provides additional construction specifications to provide indoor air quality protections in new homes. The Protocols provide a set of best practices for improving indoor air quality in conjunction with energy upgrade work in homes and are intended for voluntary adoption by weatherization assistance programs, federally funded housing programs, private sector home performance contractors, and others working on residential energy upgrade or remodeling efforts.

b. Add information on climate change impacts as they relate to IAQ to stock outreach presentations for schools, health care professionals, etc. Incorporate these messages into collaborative IAQ work with state and local health departments, Habitat for Humanity, HUD, etc., so that our partners are aware of these impacts and the need to weatherize and make other building improvements with IAQ in mind.

Water Division

1. Target highly vulnerable public water systems for source water protection.

Link to Vulnerability Assessment: Both the quantity and quality of drinking water sources are

likely to be adversely affected by climate change. Source water quality degradation, increased demands for water in the face of extreme temperatures, drought and other stresses exacerbated by climate change will impact some public water systems, and the people served by them.

Goal: Source water protection is increasingly used at highly vulnerable systems to minimize risk and make our drinking water sources and water systems more resilient to climate change impacts.

Actions:

a. Develop a process to identify highly vulnerable systems. Water Division and its partners will develop a prioritization scheme to identify the highly vulnerable public water systems to highlight those water sources and systems most at risk to climate change effects. This might involve analyzing compliance information or raw water quality data trends to identify those most susceptible to particular impacts of climate change.

b. Provide targeted outreach and compliance assistance. Apply targeted outreach and compliance assistance on measures to reduce negative effects of climate change to those most in need of additional support. Depending on the mechanism for prioritizing highly vulnerable public water systems, the applicable programmatic tools from across the water program to aid groups of systems receptive to assistance will be utilized.

c. Coordinate adaptation activities with federal, state, and tribal partners. Leverage assistance from external partners such as the Indian Health Service and technical assistance providers, as well as the states, to provide a coordinated set of adaptation practices. Use source water protection tools to improve resilience of highly vulnerable water systems. Where necessary, use enforcement actions to compel adoption of approaches other than, or in addition to, treatment (i.e., Source Water Protection (SWP) and other Sustainable Water Infrastructure (SWI) practices) to increase resiliency and return water systems back to compliance.

2. Increase climate–readiness at water utilities

Link to Vulnerability Assessment: Wastewater, drinking water and storm water utilities will be under increasing strain to maintain compliance and achieve performance and water quality objectives in the face of climate change, as precipitation events are expected to become more extreme throughout the region and may overwhelm infrastructure.

Goal: Resilience of drinking water and wastewater utilities to climate change is increased through application of SWI practices.

Actions: Continue promoting SWI practices to make water utilities more resilient to climate change impacts, emphasizing the following:

a. Incorporate SWI conditions into NPDES permits, where appropriate. Water Division and state partners will identify SWI approaches that are amenable to NPDES permit conditions, for example, green infrastructure and asset management, and develop model

language for incorporation into NPDES permits. EPA will track and report to states, providing case examples and best practices to promote replication.

b. Incorporate SWI considerations into compliance assistance and enforcement settlements, where appropriate. Provide information to facility operators on SWI tools and resources as a regular part of our municipal inspection program including the Climate Ready Water Utilities (CRWU) initiative and the Climate Resilience Evaluation and Awareness Tool (CREAT). Water Division and state partners will identify SWI approaches that are amenable to NPDES enforcement settlements, for example, green infrastructure and asset management, and develop model language for consideration in settlement negotiations, orders, etc.

c. Begin tracking EPA enforcement actions for the incorporation of sustainable practices. Incorporate new fields in the Water Enforcement Tracking database for tracking sustainable practices and populate the fields to provide a full accounting of existing efforts. As it becomes available, performance information will be incorporated. The results will be used to identify best practices and lessons learned to inform future efforts and promote replication by states.

d. Promote energy management at utilities as resources allow. Conduct energy management outreach, as resources allow, to replicate the success of initial efforts in the Indiana energy management pilot. Using the information acquired from these demonstrations, promote the benefits of energy management and its potential role in utility climate-readiness, in collaboration with states, professional organizations and others.

3. Improve information on climate change impacts on surface water quality and quantity available and used for regulatory and assistance actions.

Link to Vulnerability Assessment: Climate change is expected to cause changes in surface water characteristics such as water quality (chemical, physical, and biological), stream flow characteristics, and lake levels. The regulatory and assistance programs EPA, states and tribes use to protect water quality will require up-to-date information about surface water characteristics to ensure that they remain effective. Monitoring programs may not presently be designed and managed to acquire appropriate data.

Goal: High quality, up-to-date information on water resources is collected through state monitoring programs; such information is factored into regulatory and standards programs (e.g., NPDES, WQS and TMDL) and assistance efforts (e.g., NPS management).

Actions:

a. Identify, with state and tribal partners, critical water resources information necessary to inform program work as climate changes. Such information is likely to include chemical and biological metrics needed to determine the health of water bodies or to demonstrate changes/trends in water quality.

b. Identify, with partners, potential information sources. Critical water resources information identified will potentially be available through sources such as other federal agencies, while other information is appropriate for state monitoring programs. The most cost-effective approach for meeting our data needs will collectively be identified.

c. Incorporate climate change into state and tribal monitoring strategies. Where appropriate, incorporate appropriate metrics and other climate-related adjustments into state and tribal monitoring strategies. To the extent that the revisions necessitate trade-offs or require additional resources, approaches to meet those needs will be jointly developed.

d. Ensure that up-to-date climate-related information is factored into regulatory, standards and assistance programs. Ensure existing state operating procedures and practices are adjusted, as necessary, to access and use up-to date monitoring data, stream flow metrics, etc. for development of water quality standards, TMDLs, permit conditions and other regulatory decisions. Promote transparency by ensuring that documentation of regulatory decisions clearly identifies where climate change-related information factors into a decision, e.g., standard revision submissions, permit fact sheets.

4. Streamline and standardize water quality standards decision-making processes to ensure timely, protective decisions.

Link to Vulnerability Assessment: As the effects of climate change place more stress on our waters, more submissions from states and tribes for WQS revisions are likely. These may come in two forms: variances from existing criteria, and revised standards (criteria and/or use designations).

Goal: State processes for considering WQS changes are efficient and decisions are well-supported; EPA is able to timely act on changes submitted by States.

Actions:

a. Determine, in consultation with headquarters (Office of Waste/Office of Science and Technology), the flexibility allowed to change designated uses in surface waters that are adversely impacted by climate change and communicate clear guidance to states and tribes.

b. Identify and replicate "best practices" among the states and tribes.
   i. Identify and implement efficient procedures to process large numbers of similar variance requests.
   ii. Identify and implement efficient procedures to process large numbers of use designation revisions. For example, Ohio routinely submits multiple use designation change packages including anywhere from 30 to 150 use change proposals, which EPA can review as a package. If other states could be encouraged to submit these types of multiple use change rule packages, this would further enhance the efficiency

of our reviews.

c. Ensure that any approach to streamline a WQS process is exercised transparently and that decisions are well-supported by data.

Great Lakes National Program Office

1. Continue to restore and maintain the chemical, physical, and biological integrity of the Great Lakes ecosystem in the face of climate change

Link to Vulnerability Assessment: Climate trends are changing the Great Lakes in a variety of ways (e.g., the Lakes themselves are getting warmer, storm frequency and intensity are increasing, lake levels are changing, etc.). The Great Lakes are expected to be increasingly vulnerable to toxic and nutrient loadings, invasive species and habitat loss.

Goal: Impacts of climate change to the Great Lakes ecosystem are decreased by applying the latest climate change information to GLRI projects and other GLNPO efforts.

Actions:

a. Adjust long-term ecosystem monitoring programs to fulfill the U.S. commitments under Annex 10 (Science) of the Great Lakes Water Quality Agreement. Current climate change information will be taken into account when assessing the timing, frequency, scheduling, and geographic scope of water quality and fish monitoring programs. Adjustments may occur annually or as needed during monitoring activities. Climate change-related indicators (ice cover, water and air temperature, lake levels, critical ecosystem indicators, etc.) will be assessed and reported on an ongoing basis through the State of the Lakes Ecosystem Conference (SOLEC) and other channels to advise management actions at a regional and local scale.

b. Integrate climate change knowledge into GLRI-funded projects, as well as other GLNPO funding mechanisms (e.g., Legacy Act, Sustain Our Great Lakes), to ensure the latest science informs project design. Climate change impacts will be required to be considered in all appropriate GLRI Request for Application (RFA) categories annually. For remaining categories, credit for attention to climate change in applications will be provided. When feasible, guidance and examples as to how to consider climate change in applications will be provided to applicants in RFAs. A GLRI RFA category for capacity-building of local governments and resource decision-makers in the Great Lakes to implement climate change adaptation actions will be offered.

c. Direct necessary revisions to Great Lakes strategic implementation documents, while working with federal, state, tribal and binational partners, using the latest climate change information. Guide development, revision and implementation of both Remedial Action Plans for Areas of Concern and Lakewide Management and Action Plans, in collaboration with the appropriate partners, with the latest climate change information as

required under the Great Lakes Water Quality Agreement. In addition, the next update of the GLRI Action Plan will factor the latest scientific information on climate change.

Superfund Division

1. Revise current Superfund processes to reflect new protocols.

Link to Vulnerability Assessment: Increased temperatures and flood and drought conditions will impact mobilization of contaminants at sites and may alter the time, cost, and effectiveness of cleanups. As a result, recommended processes and remediation techniques may need to be changed.

Goal: Ensure that standard processes and procedures in the Region consider climate change impacts and reflect any changes from Program Offices.

Actions:

a. Review existing Superfund processes to identify where climate change will require process and template changes. Superfund processes include: Remedial Investigation/Feasibility Study (RI/FS), Record of Decision (ROD), Remedial Design/Remedial Action (RD/RA), Five Year Reviews, and language in Brownfield grants terms and conditions (T&C) that considers climate change in evaluating cleanup alternatives.

b. Adjust requirements and language in Superfund processes to reflect the new protocols. This includes reviewing and revising how to:
   i. Evaluate alternative remedies for sites that may be impacted by floods and changing water tables, such as landfills on floodplains;
   ii. Choose remediation techniques that incorporate vegetation that might be more tolerant of heat, excessive rain, or drought;
   iii. Manage severe erosion issues on terrain and constructed landfills, with larger rain events contributing to additional erosion concerns;
   iv. Account for water table fluctuations that might impact changing plume direction and increase smear zones;
   v. Redesign corrective actions to manage frequent flooding that may bring contaminants to the surface and increase exposure potential;
   vi. Manage changes in construction season due to warmer or erratic weather; and
   vii. Manage increases in sedimentation and scouring due to larger rain events at sites.

c. Train staff on these new protocols. Once new procedures have been accepted and guidelines are changed, ensure that staff are trained and will follow the new protocols.

2. Enhance flexibility of Emergency Response to climate change conditions.

Link to Vulnerability Assessment: There will be an increased need for emergency response due

to frequency of events and duration of response activities. Changing climatic conditions can also pose additional hazards for staff.

Goal: Improve the flexibility of the Emergency Response team to an anticipated increase in events.

Actions:

a. Assess how changing climatic conditions in the Midwest will impact Emergency Response. Evaluate how changing climatic conditions will impact the ability of staff to respond to emergency situations, including staff readiness, equipment needs, availability of staff, and duration of response action.

b. Evaluation of resource needs. Determine how Superfund will adjust staff flexibility and availability, training, and equipment to ensure timely responses to events. This will also include improvements in communication channels with state and local authorities. Additionally, an increase in training and cross program coordination for Regional Science Council (RSC) and Incident Management Team (IMT) members will be necessary to prepare for more frequent response.

c. Implementation. Create an implementation plan to acquire or train staff, and to acquire equipment.

3. Disseminate climate change information related to risk, safety, requirements, and alternative remedies to states and tribes.

Link to Vulnerability Assessment: Increased temperatures and flood and drought conditions will impact mobilization of contaminants at sites and may alter the time, cost, and effectiveness of cleanups. As a result, recommended processes and remediation techniques may need to be changed.

Goal: Inform state and tribal partners of any new or revised recommendations on emergency response, remedial cleanup, and Brownfields grants terms and conditions.

Actions:

a. Review list of state contacts and tribes that should receive new information related to emergency response, new or modified investigation strategies, remediation techniques, risk based cleanup factors and ranking, disposal of hazardous waste and domestic white goods, and Brownfield cleanup alternatives.

b. Disseminate new fact sheets and information to state and tribal partners. HQ will be developing new guidelines on risks, safety, new requirements, and alternative remedies.

c. Ensure content on Region 5 website reflects current information related to revised processes and requirements under climate change conditions by working with IT/web content/GIS departments.

d. Pursue additional opportunities to share information with states and tribes, through meetings, conferences, webinars, etc.

Land & Chemicals Division

1. Maintain and improve available information on managing disaster debris to support planning and emergency response.

Link to Vulnerability Assessment: An increase in heavy precipitation events may cause an increase in flooding risk which often produces significant debris that must be quickly managed in the region**.** State, local, and federal emergency response personnel will need up-to-date information to help them plan for debris management and find facilities that can safely manage, and when possible, recover or recycle various types of debris.

Goal: High quality and up-to-date information is maintained and readily available for use by federal, state, and local emergency response personnel to support planning for and managing large volumes of debris that may be generated by storm or heavy precipitation events.

Actions:

a. Verify, maintain, and annually update at least 1/3 of the records currently maintained in the Disaster Debris Recovery Database in consultation with state and local officials as well as private sector information sources.

b. Continue to provide technical assistance and support to state disaster debris planning efforts and maintain and update the planning resources and mapping tools available on Region 5's website: (http://www.epa.gov/region5/waste/solidwaste/debris/disaster_debris_resources.html)**.**

c. Ensure awareness of the Disaster Debris Recovery Database and mapping tool and planning resources by conducting at least one presentation annually to local and state emergency planners and response personnel.

2. Maintain and improve pesticide producer information and target pesticide (FIFRA) and chemical (EPCRA-TRI/TSCA) inspections to identify and address sites that appear to be vulnerable to climate change.

Link to Vulnerability Assessment: Increased precipitation events and flooding may result in increased exposure risks and impacts from industrial chemicals and pesticides. For example, chemical manufacturers, processors and formulators might be located in areas of measurably increased flooding. Improved data about these facilities will help EPA and other stakeholders to identify and prioritize potential impacts.

Goal: Improved information within managed databases and targeted inspections under FIFRA and EPCRA-TRI/TSCA which will be used to identify chemical facilities and pesticide establishments that may require re-assessments or additional attention.

Actions:

a. Add geographical information on flood-prone areas to the selectivity criteria to target pesticide producing establishments for inspection under FIFRA and chemical manufacturing/processing facilities for inspection under EPCRA 313 / TSCA.

b. Target establishments and facilities located in flood-prone areas for inspection, with our State partners under FIFRA, to address bulk chemical containment requirements.

c. Maintain and update location and other available information on pesticide producer establishments on an annual basis. The Region, in collaboration with the regulated community, will ensure that applications for new establishment registrations under FIFRA and the cancellation of establishment registrations for those facilities no longer engaged in pesticide production.

d. Develop a database and map of TSCA and TRI regulated chemical manufacturers, processors and formulators for the Region using new TSCA CDR and TRI information. This map can be used to better target sites that may be more vulnerable to climate change.

e. Create a list of chemicals, in consultation with the Chemicals of Emerging Concern (CEC) Network, other Divisions/Offices, OCSPP, and ORD, whose risk may need to be re-assessed or which may have a higher potential for the need for a chemical-specific mitigation and/or elimination strategy in different climate change scenarios.

NEPA Program

1. Address climate change impacts as a required component of a NEPA analysis.

Link to Vulnerability Assessment: New construction or upgrades that require a NEPA analysis, (infrastructure, energy, land use, transportation, etc.) will likely be impacted by climate change. Impacts resulting from NEPA projects may exacerbate existing environmental and health issues both directly and indirectly. Projects may need to weigh both positive and negative impacts.

Goal: All NEPA projects (Environmental Impact Statements and Environmental Assessments) will identify and analyze the effects of climate change on the proposed project as well as the impact of the project on climate change.

Actions:

a. Develop a framework of expected analysis that will be conducted by the lead agency and included in NEPA documents. EPA will determine what information is relevant for

inclusion for the proper analysis of the association between the proposed project and climate change. Specific factors, data, and information that EPA will look for in a NEPA review will be clearly listed, defined and disseminated to other federal agencies in a programmatic manner.

b. Coordinate early with lead agencies (federal, state, local, and tribal) that submit NEPA documents for review. Common language across federal agencies and implementation of permitting standards will be captured in NEPA documents. The NEPA documents will reflect both EPA guidelines (expected from CEQ) as well as adhere to the individual agency's guidelines to analyze climate change, and climate change priorities and adaptations. It is imperative to coordinate this analysis early in the scoping process. By identifying concerns and working with lead agencies from the onset of a project, many of the adverse impacts (both direct and indirect) can be adapted and/or mitigated.

III. Agency–wide Strategic Measures on Climate Change Adaptation

The *FY 2011-2015 EPA Strategic Plan* contains the Agency's first strategic performance measures for integrating climate change adaptation into its activities. These strategic performance measures commit the Agency to integrate adaptation planning into five major rulemaking processes and five major financial assistance mechanisms by 2015. They also call for the integration of adaptation planning into five major scientific models or decision-support tools used in implementing Agency environmental management programs. Region 5 will support these measures through the following:

1. Integrate Adaptation Planning into Rulemaking Processes

- Provide information on regional climate change impacts to EPA national program offices to inform rulemaking and guidance development/revision; revise regulations and guidance, in collaboration with other Regions and EPA HQ, to reflect climate change impacts.
- Explore, with the states, how state rules may need to be changed as a result of climate change.

2. Integrate Adaptation Planning into Financial Assistance Mechanisms

- Explore opportunities to incorporate climate change adaptation considerations into competitive funding announcements in accordance with the October 18, 2011, EPA guidance memo jointly issued by the Office of Policy and the Office of Grants and Debarment. This may include a climate change adaptation criterion wherever it is relevant to the program's mission and outcomes.
    - GLNPO will include consideration of climate change as a grants scoring criterion and ensure that scientific information on climate change impacts and adaptation is incorporated into projects funded by GLRI and other mechanisms (e.g., Sustain Our Great Lakes, Great Lakes Legacy Act). Include consideration of climate change as a criterion in reviewing/scoring competitive grants.
    - Region 5 Indian Environmental Office (IEO) and EPA Headquarters American Indian Environmental Office will jointly determine how to appropriately and

effectively use Indian General Assistance Program (GAP) funds to plan or respond to climate change impacts, and share information on lessons learned with other Regions.

3. Integrate Adaptation Planning into Models or Decision-Support Tools

- Identify opportunities to incorporate climate change adaptation considerations into models or decision-support tools. Provide information to EPA national program offices to identify needs and inform the development of such tools.

IV. Legal and Enforcement Issues

The EPA derives its authority to act from the laws passed by Congress. The Agency is committed to ensuring that its actions are constitutional, authorized by statute, consistent with Congress's vision and intent, and otherwise legally supported. Congress has given the Agency the broad mandates to protect human health and the environment. This mandate affords the Agency with the broad legal authority to support climate change adaptation work. However, specific questions may arise in the course of adaptation planning and implementation that cannot be answered without a legal review of Agency policies and/or guidance as well as court precedents.

Region 5 Divisions and Offices and Office of Regional Counsel will continue to work closely on matters related to climate change adaptation. To date, the work on climate change adaptation has not faced significant legal issues.

- The Region will address any legal and enforcement issues that may arise through the Office of Regional Counsel, in consultation with the Office of General Counsel and the Office of Enforcement and Compliance Assurance (OECA), as necessary.
- In addition, Region 5 will confer with OECA on the inclusion of climate change considerations in compliance and enforcement activities.

V. Training and Outreach

A central element of the Region's efforts to adapt to a changing climate will be to increase staff awareness of how climate change may affect their work by providing them with the necessary data, information, and tools. Strengthening adaptive capacity of staff within the Region is necessary to anticipate and plan for future changes in climate and incorporate considerations into our programs, policies, and operations.

Through the development of a regional climate change adaptation training module, consistent training will be provided to all Regional staff. A workgroup formed out of the Region's Mid-Level Leadership Development Program is currently developing the structure and content for training on Regional impacts of climate change, as well as program-specific training and discussions to further outline changes that need to be made to core work processes. In addition,

the Regional Climate Change Adaptation Team will continue in its efforts to educate, foster buy-in, and plan for program resiliency.

Adaptation requires coordination across sectors and should build on the existing efforts and knowledge of stakeholders. States, tribes, and local communities share responsibility for protecting human health and the environment with EPA. Working with these partners will be critical for efficient, effective and equitable implementation of climate change adaptation strategies, which will evolve over time.

Region 5 will:

- Provide general and program-specific training opportunities to our staff and management to increase their understanding of climate change vulnerabilities in our Region, and how to best incorporate climate change adaptation into our work.
- Encourage our partners to integrate climate change adaptation effectively into their work. Share existing decision-support tools and training opportunities on climate change adaptation, especially where training is local or available on-line.
- Develop a regional climate adaptation communication strategy to engage and inform partners.
- Build adaptive capacity and encourage climate adaptation planning depending upon state, local, and tribal needs and conditions.
- Engage the Midwest Natural Resources Group of federal agency senior managers to promote cooperation on climate change adaptation.

VI. Partnerships with Tribes

EPA values its unique government-to-government relationship with Indian 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* and the *2011 Policy on Consultation and Coordination with Indian Tribes*. These policies recognize and support the sovereign decision-making authority of tribal governments. Supporting the development of adaptive capacity among tribes is a priority for the EPA. 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 to develop adaptation strategies that promote sustainability and reduce the impact of climate change on Indian tribes.

EPA engaged tribes through a formal consultation process in the development of the Agency's *Climate Change Adaptation Plan*. Tribes identified some of the most pressing issues as erosion, temperature change, drought and various changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. At the same time, tribes challenged EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative

burdens are reduced.

This Implementation Plan identifies specific steps that will be taken to partner with tribal governments on an ongoing basis to increase their adaptive capacity and address their adaptation-related priorities. These collaborative efforts will benefit from the expertise provided by our tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change and has been used by tribes for millennia as a valuable tool to adapt to changing surroundings. Consistent with the principles in the 1984 Indian Policy, TEK is viewed as a complementary resource that can inform planning and decision-making.

Networks and partnerships already in place will be used to assist tribes with climate change issues, including Regional Tribal Operations Committees, the Institute for Tribal Environmental Professionals and GAP. Additionally, efforts will be made to coordinate with other Regional and Program Offices in EPA, since climate change has many impacts that transcend media and regional boundaries. Transparency and information sharing will be a focus, in order to leverage activities already taking place within EPA Offices and tribal governments.

Tribes in Region 5 are increasingly concerned about the effects of a changing climate on their communities, resources and traditional cultural practices. Many tribal populations are already experiencing climate change impacts; for example, moose populations and wild rice cultivation have already been adversely impacted on tribal lands.

Region 5 is committed to an ongoing partnership with the tribes to strengthen their capacity to address climate change impacts and address their adaptation-related priorities. The Region will:

- Integrate climate change adaptation into existing funding mechanisms to help tribes incorporate and consider climate change in their environmental programs. Region 5's IEO will ensure that the GAP funds it manages are used appropriately and effectively to plan for and respond to climate change impacts.
- Provide outreach and technical assistance on climate change impacts and adaptation that is specific to tribal needs and assists in meeting their environmental regulatory responsibilities. Region 5 will use existing regional forums/resources, including the annual Tribal Environmental Program Management conference, Region 5 Tribal Operations Committee meetings, and Tribal Caucus calls or meetings, as appropriate, for outreach and/or training. Region 5 will leverage limited resources and avoid duplication of efforts through coordination of training and outreach efforts with other federal agencies (through the Region 5 Memorandum of Understanding Workgroup), Headquarters, and other partners.
- Provide opportunities for meaningful tribal participation in regional climate change efforts and facilitate communication with the tribes to gather updated information on climate change impacts they are experiencing to inform programmatic work as appropriate.

VII. Vulnerable Populations and Places

The effects of climate change have the potential to have an adverse impact to specific vulnerable populations, contingent upon their geographic location and demographic information. Impacts may vary depending upon a population's susceptibility to the health effects of environmental pollution, economic status, education level, income source and access to relevant information. For example, children, the elderly, and individuals with respiratory problems are more vulnerable to poor indoor and outdoor air quality, both of which may worsen in a changed climate. In general, environmental justice issues may be amplified by the impacts of climate change. One of the principles guiding EPA's efforts to integrate climate change adaptation into its programs, policies and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society.

This Implementation 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 Plan is conducted, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events (e.g., Hurricane Katrina and Superstorm Sandy) and the subsequent recovery efforts.

Region 5 will integrate consideration of vulnerable populations and environmental justice into our actions as this plan is implemented. Region 5 intends to build on existing partnerships with tribal and environmental justice programs to ensure such populations are represented in climate change impact analysis. Finally, we will explore opportunities to share information, case studies, and experiences related to climate change adaptation among tribes and other vulnerable populations with HQ and other regional offices, federal agencies, and non-governmental organizations.

VIII. Measuring & Evaluation

Region 5 will evaluate its climate change adaptation activities, particularly our Priority Actions, to assess progress toward mainstreaming climate change adaptation into programs, policies, rulemaking processes, and operations. Region 5 will develop a work plan based on the Priority Actions, including additional details on actions and assignment of roles and responsibilities. Using this work plan, the Region will conduct an annual evaluation of our progress and performance under this Implementation Plan. Based on the lessons learned through these evaluations, Region 5 will make any necessary adjustments to its approach.

Region 5 recognizes that the integration of climate change adaptation planning will occur over time. This will happen in stages, and measures should reflect this evolution.

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Appendix A: Region 5 Vulnerability Assessment Table

Office	Climate Change Impact[a]	Likelihood of Impact[b]	Focus of Associated EPA Program	Example of Risks if Program were Impacted	Likelihood EPA Program will be affected by Impact[c]	Regional Importance of Vulnerabilities	Variation in importance across the Region
ARD	Increased tropospheric ozone pollution in certain regions	Likely[1]	Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	Could become more difficult to attain NAAQS for ozone in many areas, including areas with existing ozone problems as well as those currently in attainment.	High	Five of the six Region 5 states already struggle with attaining the ozone standard in large urban areas. Increases in tropospheric ozone could result in more nonattainment areas and lengthen the ozone season.	Important across Region, but new non-attainment areas could be in smaller metro areas and in the northern part of the Region.
ARD	Increased frequency or intensity of wildfires	Likely[2]	Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) pollution in areas affected by more frequent wildfires.	Medium	Currently wildfires are not a large contributor to PM issues in the Great Lakes States; however, a significant increase in wildfires could change this profile. Could also increase deposition of certain contaminants to the Great Lakes.	Forest areas are mostly in the northern part of the Region.
ARD	Increasing extreme temperatures	Very Likely[3]	Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	Could complicate efforts to attain NAAQS for various criteria pollutants and increase public health risks, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations.	Medium	Increased temperatures and extreme weather events could increase demand for electricity (for example, through increased use of air conditioning units), which would require more electricity creating greater pollution from EGUs, back-up generators, and peaker plants. This could increase difficulty of meeting NAAQS for O3, PM2.5, SO2, NO2, and CO.	Important across Region, but risks higher in urban areas and areas with more sources.
ARD	Increasing extreme temperatures Increasing heavy precipitation events	Very Likely[3] Likely[3]	Protect public health by promoting healthy indoor environments through voluntary programs and guidance	Could increase public health risks from indoor air pollution, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations	Medium	Susceptible individuals across Region 5 will be impacted by potentially greater exposure to air pollution, both indoors and outdoors. More time spent inside during extreme weather, mold issues as a result of flooding and storms, and inappropriate energy efficiency measures (i.e., making buildings too "tight") could all increase IAQ problems.	Important across the Region, but particularly in EJ areas and areas with high density of more susceptible populations.

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ARD	Increasing extreme temperatures Increasing heavy precipitation events	Very Likely[3] Likely[3]	Atmospheric deposition initiatives Ecosystem protection from Agency emissions reduction programs	Effects on ecosystems, including the Great Lakes, to increased atmospheric deposition of sulfur, nitrogen, and mercury (and potentially increased methylation of mercury). Also impacts compliance with water quality standards and TMDLs.	High	Mercury is a high priority in Region 5 in both the Great Lakes and inland lakes. All of our states have water bodies impaired by mercury. Increases in mercury deposition, as well as sulfur and nitrogen, would further stress our ecosystems.	Very important across the Region.
EJ	Increasing heavy precipitation events Increasing flood risk	Likely[3] Likely[5]	Drinking water, wastewater and stormwater infrastructure	Inadequate water supply for human consumption (Contaminated wells, water systems) Damage to water infrastructure from intense storms	High	EJ communities will need added assistance and attention if these events compound already existing concerns.	Regionwide
GLNPO	Changes in temperature Increased water temperatures Increasing heavy precipitation events	Very Likely[3] Very Likely[6] Likely[3]	GLRI, GLQWA	Overall climate change impacts to Great Lakes water quality and ecosystem characteristics	High	As a result of its working relationship with Canada under the new GLWQA commitments, GLNPO will be put under increased pressure to develop and coordinate with Canada monitoring, modeling, downscaling and other climate efforts, including capacity building and sharing information needed by GL resource managers. States, tribes and other GLRI partners will face increasing pressure to address various local impacts to Great Lakes resources and begin adaptation efforts. This will increase	Lake Superior, a "cold water" lake, will be extremely affected by climate change in general. The nature of the fish species, aquatic species, wildlife habitat will all be tremendously affected (more so than the other lakes) by climate change.

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						pressure on GLRI programs and funding sources. GLNPO will face an increased workload to understand the science of climate change in the Great Lakes and monitor climate change variables in assessments of the overall health of the Lakes. GLNPO will face an increased workload in outreach/communication in helping partners, local communities, cities, etc, adapt to a changing climate.	
GLNPO	Increased frequency or intensity of wildfires	Likely[2]	Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) pollution in areas affected by more frequent wildfires	Medium	More forest fires will increase emissions of mercury and other contaminants, thereby hindering progress in reducing mercury in the Great Lakes ecosystem under our binational commitments in the new Great Lakes Water Quality Agreement 2012 (GLWQA), and may complicate mercury reduction efforts under GLRI Toxics Focus Area. May also prevent the achievement of the mercury reduction goals of the Lake Superior Zero Discharge Demonstration Program.	Lakes Superior, Huron, Michigan
GLNPO	Effects on response of ecosystems to atmospheric deposition of sulfur, nitrogen, and mercury	Likely[4]	Ecosystem protection from Agency emissions reduction programs	Based on evolving research, could have consequences for the effectiveness of ecosystem protections under those programs.	Medium	Changes in atmospheric deposition patterns of these and other toxic chemicals could adversely affect EPA's ability to fulfill its commitments to reduce toxic chemicals in the Great Lakes ecosystem under the GLWQA and the GLRI Toxics Focus Area.	Lakes Superior, Huron, Michigan

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				Watershed, aquatic ecosystems and wetlands will be at risk from runoff contamination from sulfide mining in the Upper Great Lakes, during heavy precipitation events.		Could potentially affect the ecosystem response with respect to sulfide levels in wild rice habitat.	
GLNPO	Increasing heavy precipitation events Increasing intensity of hurricanes Decreasing precipitation days and increasing drought intensity Increased water temperatures	Likely[3] Likely[3] Likely[5] Very Likely[6]	Restoring and protecting watersheds, aquatic ecosystems and wetlands GLRI, GLQWA	Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. Challenges to coastal wetlands' ability to migrate. Reduced streamflow, altering the aquatic environments and increasing impairments. Higher nutrient loadings will likely lead to an increase in toxic algae blooms. Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	High	GLWQA nutrient loading and concentration targets will be harder to achieve if the Great Lakes experience increased runoff from more frequent and intense precipitation events. GLWQA and GLRI commitments to address risks to water quality from chemicals will be harder to address if increased runoff increases the amount of nonpoint source pollution such as chemicals, pesticides, oil and pharmaceuticals to the Great Lakes. GLRI-funded habitat restoration projects will be at risk from destruction or decreased performance due to increased erosion, scouring, wave action, etc. as a result of increased storm intensity. Additional costs and design considerations will result. Climate change effects on CSOs, NPS and other water pollution loadings will put current cleanup, remediation and restoration activities in Great Lakes Areas of Concern (AOCs) at risk from destruction or decreased performance.	Especially Lake Erie, Green Bay, Saginaw Bay 31 US Areas of Concern spread throughout the GL Basin

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GLNPO	Changes in temperature Increased water temperatures	Very Likely[3]	GLRI, GLQWA	Shifting habitat ranges and migration patterns of Great Lakes species.	High	May force changes in goals for GLRI-funded restoration projects. Protection efforts for GLRI-critical species will require additional analysis and tools to address the increasingly out of sync migrations of some species with the appearance of their food sources.	Regionwide
GLNPO	Increasing heavy precipitation events	Likely[3]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Increased pathogens on Great Lakes beaches	High	Fulfilling EPA's commitments to remove "beach closings" as a beneficial use impairment from Great Lakes AOCs will be hindered if E. coli increasingly over-winters and faces ideal air and water conditions for growth.	Regionwide
GLNPO	Increasing heavy precipitation events Increasing intensity of hurricanes Increasing flood risk	Likely[3] Likely[3] Likely[5]	Drinking water, wastewater and stormwater infrastructure GLQWA	Water infrastructure could be overwhelmed or damaged. Integrity of coastal water infrastructure systems could be put at increased risk. Drinking water and wastewater utilities will need an 'all hazards' approach to planning for emergencies and extreme weather events. Problems of safety as well as access to clean and safe water will be exacerbated for vulnerable and economically deprived communities.	High	A significant number of CSOs still exist in the Great Lakes Basin, so increased precipitation will continue to have a negative impact on EPA's ability to meet its commitments under the GLWQA. The Upper Great Lakes basin has a significant and increasing number of mining operations, which will face new weather conditions that do not match engineering design assumptions, thereby increasing the vulnerability of Great Lakes waters to contamination. CWA Programs, NEPA, and GLRI programs may have an increased burden in dealing with these changes.	Lakes Superior, Huron and Michigan

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GLNPO	Changes in temperature Increased water temperatures Increasing heavy precipitation events	Very Likely[3] Very Likely[6] Likely[3]	GLRI, GLQWA	Changing Seasonality of Great Lakes precipitation, evaporation, tributary flows Seasonal ice cover over the Great Lakes has been decreasing measurably, and will affect evapotranspiration, local weather, etc.	High	Depending upon changes in evaporation, lake levels, and seasonality of tributary flows, the concentration of some toxic chemicals may increase in some places. This will create negative conditions for management of toxic chemicals of concern to Great Lakes waters under the GLWQA and GLRI. These changes will complicate goal-setting, design and implementation phases of habitat/species restoration under GLRI and to fulfill GLWQA commitments, including projects associated with the AOCs.	Regionwide
GLNPO	Changes in temperature Increased water temperatures Increasing heavy precipitation events Decreasing precipitation days and increasing drought	Very likely[3] Very likely[6] Likely[3] Likely[5]	GLRI, Other non- EPA programs including Great lakes Compact & IJC Water Regulation Authorities	If GL water levels decrease significantly, costs to pollution abatement, habitat restoration and the economy could be significant. If GL levels increase, current GLRI remediation projects and activities (including those at AOCs) may be in jeopardy.	High	Further modeling and monitoring of lake levels is needed, which will require the investment of GLNPO's federal, state and academic partners.	Throughout Great Lakes Basin
GLNPO	Increased water temperatures	Very likely[6]	GLWQA	Increased potential for aquatic invasives to enter the Great Lakes. Some invasives already present in Great Lakes can be	High	The new GLWQA commits US and Canada to undertake an assessment of climate change impacts on AIS. EPA's contributions to AIS monitoring, prevention, control, and eradication programs may be affected, requiring shifts in priorities or added costs.	Regionwide

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				triggered to become more invasive or increase their range. Some species may become less invasive in some places with new conditions. Longer shipping season increases the risk that a greater amount of ballast delivered might include a greater number of species not yet established in the Great Lakes. More flooding, due to greater numbers of severe precipitation events, means that species established (from pathways such as pet, water garden, bait, recreation, etc.) in isolated inland lakes and rivers near the Great Lakes will be more likely to be transported within watersheds and into the Great Lakes.			
GLNPO	Increasing heavy precipitation events	Likely[3]	Cleaning up Contaminated Sites and Waste Management	Increased risk of contaminate release from EPA Sites. May need to alter selected remedies to ensure protection.	Medium	Increased volatility of weather and loss of predictability will complicate planning and implementation of AOC remediation projects.	Regionwide

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				Erosion and flooding could increase the potential for chemical and hazardous substances contamination from Superfund and other sites within Great Lakes AOCs.		The GL Basin is vulnerable to resuspension and volatilization of toxic chemicals from sediments due to the increased storm intensity. May render some remedies less effective in AOCs, may require changes in design.	
GLNPO	Increasing heavy precipitation events	Likely[3]	Emergency Response	Increased need for emergency response. Possible limitations to response capability due to staff and financial resource constraints.	High	Increased storm intensity will increase the risk of toxic spills to the Great Lakes from shipping. ER must be coordinated with Coast Guard and the Canadians.	Regionwide
GLNPO	Increasing risk of floods Increasing intensity of hurricanes Increasing extreme temperatures	Likely[5] Likely[3] Very likely[3]	Operations of Agency facilities, personnel safety, physical security, and emergency communications Emergency management mission support (protective gear and acquisition)	Facilities in coastal or flood-prone areas Personnel engaged in field work and vulnerable to extreme temperatures or events Security, lighting and communication systems without backup power Personnel and real property supporting emergency response and management	Medium	Increased storm intensity will increase the risk to EPA vessels and crews on the Great Lakes.	Regionwide
Homeland Security	Increasing risk of floods	Likely[5] Likely[5]	COOP Occupant Emergency Plan Activation of Homeland Security Frameworks	Increased occurrence and intensity of natural disasters increase the risks to Region 5 personnel and facilities	Medium	Impact to EPA Personnel and facilities; response to Natural Disasters; Emergency Communications; Activation of FEMA	Regionwide

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	Decreasing precipitation days and increasing drought intensity Increasing intensity of hurricanes	Likely[3]				Support Functions	
IEO	Increasing heavy precipitation events Increasing risk of floods Changes in temperature	Likely[3] Likely[5] Very likely[3]	General Assistance Program (GAP) capacity building program	Flooding, heat waves, droughts, etc. can interrupt essential services such as drinking water systems and wastewater treatment facilities. Subsistence resources may also be affected.	Medium	Increased requests for assistance from tribes that are experiencing climate-related hazards and impacts. Tribes will likely contact IEO to request assistance from EPA. IEO and the media Divisions will need to identify the types of assistance (technical, financial, personnel, etc.) that may be available from the Agency and if there are other federal agencies that should coordinate activities. May need to adjust how the Indian Environmental General Assistance Program (GAP) can be used by the tribes to plan for or respond to climate change impacts.	Tribal impacts would mostly be limited to MI, WI and MN
LCD	Increasing heavy precipitation events Increasing risk of floods Changes in temperature	Likely[3] Likely[5] Very likely[3]	Cleaning up Contaminated Sites and Waste Management	Increased risk of contaminant release from EPA Sites. GW and subsurface contamination could be impacted by drought and flood conditions. Contaminants increase risk of migration from floods.	Low	May need to consider altering selected remedies to ensure protection; altering (hazardous/nonhazardous) landfill criteria and BMPs to ensure protection; conduct more frequent targeted inspections at hazardous waste disposal facilities; increase oversight of authorized states and/or provide increased technical assistance. Climate changes may trigger the following impacts at Corrective Action sites and the	Little variation in impact across Midwest; potentially increased risk in Great Lakes Basin and Ohio River Valley

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						selected remedies will reflect these considerations: Increased flood and drought conditions will impact mobilization of contaminants at sites and may alter the time, cost, and effectiveness of cleanups. Vegetation considerations: Whatever plants are used may not be tolerant to heat or excessive water. May need to change plant species or do additional maintenance. Drier conditions might cause severe erosion issues on terrain and constructed landfills. Might have 500 year flood events. Drier conditions combined with larger rain events might contribute to additional erosion concerns. Could have water table fluctuations - wells might need to be screened in different zones. Contaminant plumes might change direction. Remedies might become ineffective due to fluctuating water tables which could increase smear zones and additional remedy options may need to be considered. Frequent Flooding – may need to design corrective action to ensure it is protective given possible increased flooding. High flood event might wash away constructed remedies and increase contamination to the environment. Standing water could bring	

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						contaminants to the surface and increase exposure potential. Colder weather and erratic weather - could change construction season. Investigations and remedies may take longer to construct. Increased sedimentation and scouring due to larger rain events could impact sediment sites.	
LCD	Increasing intensity of hurricanes Increasing heavy precipitation events Increasing risk of floods Increasing extreme temperatures	Likely[3] Likely[3] Likely[5] Very likely[3]	Emergency Response Emergency Response Support Remedial Response Clean-Up & Corrective Action	Increased PBT chemical impacts to surface water	Low	Programs will need to consider updates to operating facility SPCC, contingency and other risk management and P2 plans for listed wastes, solid wastes and PBTs/Chemicals of Concern. Consideration/evaluation of appropriate work times for remedial/removal activities, and impacts to clean-up timelines. Consideration of facility and siting issues, as permitting occurs.	Regionwide, particularly for permitting and planning activities, where facilities may not have previously required an awareness for water releases, or risk management for water/flooding.
LCD	Increasing intensity of hurricanes Increasing heavy precipitation events Increasing risk of floods	Likely[3] Likely[3] Likely[5] Very likely[3]	Emergency Response (debris management and recovery related to disaster response to storm events, flooding, etc.) Emergency Response Support	Increased need for emergency response and debris/waste management due to storms resulting in large-scale releases of chemicals and/or air emissions (e.g., asbestos, PCBs, Hg, PBTs, SO2) from flooded/damaged and/or demolished buildings.	High	Possible limitations to response capability due to staff and financial resource constraints. Possible increased need for emergency disposal permits.	Regionwide

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	Increasing extreme temperatures						
LCD	Increasing extreme temperatures Increasing heavy precipitation events Increasing flood risk	Very likely[3] Likely[3] Likely[5]	Protecting human health and ecosystems from chemical risks. EPCRA (TRI): o Maintaining inventory of chemical releases o Maintaining lists of facilities releasing chemicals TSCA: o Maintaining chemical database (inventories, dossiers and information) on chemicals within U.S. commerce (currently and previously, including allowances and prohibitions) o Maintaining lists of major chemical manufacturers, processors and formulators (MPFs) FIFRA: o Maintain Registration Review schedules/information o Maintaining establishment (facility) information	Increased need for emergency response and debris/waste management due to storms resulting in large-scale releases of chemicals from flooded/damaged and/or demolished buildings. Any regional risk assessments could be affected as weather and climate events could affect RCRA/TSCA and Superfund interpretations of risk at the facility level.	High	Risk Assessment Framework may need adjustments in order to: Assure that chemical exposure models reflect changes in the environment; Perform climate change assessments on chemicals/substances with a climate change impact; Address risk-shifting and new risk considerations where chemicals impact---or are impacted by---climate change (e.g., changes in chemical applications or uses). Will need to keep other media offices aware of chemical use trends that affect their programs. Facility awareness of these emerging chemical and risk issues and addressing them within their Operation and Emergency Management plans, as needed, but particularly where risk shifting or new risk considerations occur.	More relevant near sites with large densities of chemical Manufacturers, Processors and Formulators (MPFs), and RCRA and Superfund sites. Extremely relevant, particularly for permitting and planning activities, where facilities may not have previously required an awareness for water releases, or risk management for water/flooding.

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RMD	Increased water temperatures Decreasing precipitation days and increasing drought intensity	Very likely[6] Likely[5]	Water usage at EPA facilities	Water temperatures impact research activities or cooling requirements. Facilities could be located in areas with water shortages	Low	Use of water in facilities is of medium importance since GSA owns the majority of EPA buildings in the region. R5 has COOP and extensive flexiplace availability.	All field offices except the Lake Guardian
RMD	Increasing risk of floods Increasing intensity of hurricanes Increasing extreme temperatures	Likely[5] Likely[3] Very likely[3]	Operations of Agency facilities, personnel safety, physical security, and emergency communications Emergency management mission support (protective gear and acquisition)	Facilities in flood-prone areas Personnel engaged in field work and vulnerable to extreme temperatures or events Security, lighting and communication systems without backup power Personnel and real property supporting emergency response and management	Medium	R5 office is located in an area with low probability for flooding, tornadoes, and earthquakes. There is a greater probability for blizzards. Severe Lake Weather is of high regional importance (affects GLNPO operations on Lake Guardian) R5 has COOP and extensive flexiplace availability. In addition, the Region has MOAs with R3 and R4 to assist in emergencies.	Lake Guardian is a vessel that is affected by changes in the Great Lakes weather
SFD	Increasing heavy precipitation events Increasing risk of floods Changes in temperature	Likely[3] Likely[5] Very likely[3]	Cleaning up Contaminated Sites and Waste Management	Increased risk of contaminant release from EPA Sites May need to alter selected remedies to ensure protection.	Medium	Increased flood and drought conditions will impact mobilization of contaminants at sites and may alter the time, cost, and effectiveness of cleanups. Vegetation considerations: Whatever plants are used may not be tolerant to heat or excessive water. May need to change plant species or do additional maintenance.	Regionwide

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						Drier conditions might cause severe erosion issues on terrain and constructed landfills. Might have 500 year flood events. Drier conditions combined with larger rain events might contribute to additional erosion concerns. Could have water table fluctuations - wells might need to be screened in different zones. Contaminant plumes might change direction. Remedies might become ineffective due to fluctuating water tables which could increase smear zones and additional remedy options may need to be considered. Frequent Flooding – may need to design corrective action to ensure it is protective given possible increased flooding. High flood event might wash away constructed remedies and increase contamination to the environment. Standing water could bring contaminants to the surface and increase exposure potential. Colder weather and erratic weather - could change construction season. Investigations and remedies may take longer to construct. Increased sedimentation and scouring due to larger rain events could impact sediment sites.	

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SFD	Increasing heavy precipitation events Increasing flood risk	Likely[3] Likely[5]	Emergency Response	Increased need for emergency response. Possible limitations to response capability due to staff and financial resource constraints.	High	Due to population densities along rivers in the Midwest, increased precipitation will lead to increased riverine flooding and to additional hazardous waste and domestic white goods (refrigerators, stoves) removal and cleanup as a result. Additionally, the frequency of events may stress availability of emergency response teams to react quickly. Hotter during days, and longer "summers" – health and safety considerations for the workers; Might need to take mid-day breaks and need more breaks - could change construction season; could take longer to conduct investigations and construct remedy; need to consider health and safety of workers. More severe weather- could take longer to conduct investigations and construct remedy; need to consider health and safety of workers May have a great proliferation of pests if we have no freeze and thaw to control them. This could then require additional safety concerns for workers.	Hurricanes are not much of a risk in R5, but there may be an increased risk of extreme weather especially in the southern part of the Region (Illinois, Indiana, Ohio).
SFD	Increasing extreme temperatures Increasing heavy precipitation events	Very likely[3] Likely[3]	Protecting human health and ecosystems from chemical risks	Changing in planting timing or location may affect the volume and timing of agricultural chemical use which could impact the	Low	Assure that chemical exposure models reflect changes in the environment	Unknown (Chemical Preparedness & Prevention)

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				appropriate risk management decisions.			
WD	Increasing heavy precipitation events	Likely[3]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health.	High	Increased demand for re-evaluation of controls and effluent limitations in NPDES permits; re-evaluation of development of WQBELs and TBELs to account for the pollutant loads. There could be increased requests for variances from water quality standards. Pretreatment programs may need to be assessed for local limit revisions and other controls on industries to ensure protection of a wastewater treatment plant and the receiving water body.	Regionwide
WD	Increasing heavy precipitation events	Likely[3]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health.	High	Increased need for wet weather inspections (CSO/SSO communities, stormwater discharges), to assess compliance and confirm appropriate level of control; may lead to increased enforcement action, requests for revisions to consent decrees.	Majority of CSO communities are in IL, IN, OH, however SSO communities are spread across region.
WD	Decreasing precipitation days and increasing drought intensity	Likely[5]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Reduced streamflow during summer months, altering the aquatic environments and increasing impairments.	Medium	Changes in watershed hydrology due to climate change will need to be reflected in changes to watershed assessment methodologies and models as well as TMDL development processes in order to predict the effects of pollutant loadings on water quality. These methodologies and models, which are critical in state and EPA development of TMDLs, will need to be revised to ensure TMDLs continue to be effective in attaining water quality standards.	Regionwide

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WD	Increasing heavy precipitation events	Likely[3]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Challenges to coastal wetlands' ability to migrate.	High	Watershed planning and permitting would be impacted should waterbody boundaries move or are displaced.	Regionwide
WD	Increasing heavy precipitation events Decreasing precipitation days and increasing drought intensity Increased water temperatures	Likely[3] Likely[5] Very likely[6]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Changes in hydrology may alter aquatic habitat, ability of water bodies to support historic aquatic life communities may be compromised, prompting requests for use designation changes, revised water quality standards. CWA programs, such as assessments, 303(d) lists, TMDLs may not provide adequate protections without revisions. Current practices to control nonpoint sources and nutrient pollution may be less effective. Economic and cultural practices of tribal communities may be adversely affected.	Medium	Watershed planning efforts will need to be modified to include projections related to climate change. The 319 program may not have adequate funds and the needed technical expertise to support states/tribes/local units of government in their efforts to continue to meet/maintain water quality standards. The research and models used to inform nonpoint source controls measures may need to be updated to reflect new runoff situations and effectiveness of practices at reducing pollution, particularly nutrient pollution from agricultural sources. Biennial listing process for TMDLs likely to be more challenging as hydrology changes. Hydrology strongly affects pollutant loadings, so changes in hydrology will affect the model and TMDL assumptions used to determine pollutant loading capacities. Impact on staff - more time on evaluating listings, more sophisticated training on models used in the program , more frequent reviews of TMDLs to determine if loadings are still sufficient to attain water quality standards. Impact to states/tribes: more time to evaluate the specific hydrodynamics of assessed waterbodies, possible changes in use designations, more frequent reviews of TMDLs to determine if loadings are still	Regionwide; tribal impacts limited to MI, WI and MN

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						sufficient to attain water quality standards For tribes, wild rice, occurring in both lakes and streams, conditions may be impacted by climate change, new methods of protecting that crop will be necessary.	
WD	Increasing heavy precipitation events Increasing risk of floods	Likely[3] Likely[5]	Drinking water, wastewater and stormwater infrastructure	Water and wastewater infrastructure could be overwhelmed or damaged, potentially resulting in noncompliance and causing human health and aquatic life risks. Existing emergency contingency plans may be insufficient for affected water and wastewater utilities. Problems of safety as well as access to clean and safe water may be exacerbated for vulnerable and economically deprived communities.	High	Particularly likely to affect direct implementation (DI) tribal program (provides oversight of and technical assistance to tribal public water systems), for example: tribes may need more assistance related to infrastructure impacts associated with climate change, putting demands on the region to be aware of changes occurring at the system level and educate systems about how best to adapt, (e.g., implement an "all hazards" approach to emergency planning); the DI program could be called on to prioritize an increasing number of projects for contractors and Indian Health Service (IHS) public health officials; we may see demands to assist in emergency response efforts. State and tribal technical assistance (promote awareness and information exchange)—the region may face increased demands to assist states and tribes with information sharing on available downscaled models and tools (climate ready water utilities (CRWU) and climate resilience evaluation and awareness tool (CREAT)), as well as lessons learned associated with climate change adaptation at	DI—significant (as of 10/4/12, there are 101 tribal water systems in Region 5)

Office	Climate Change Impact[a]	Likelihood of Impact[b]	Focus of Associated EPA Program	Example of Risks if Program were Impacted	Likelihood EPA Program will be affected by Impact[c]	Regional Importance of Vulnerabilities	Variation in importance across the Region
						states, tribes, and systems. State and tribal grant management and oversight may become more complicated.	
WD	Increased water temperatures Increasing heavy precipitation events Decreasing precipitation days and increasing drought intensity	Very likely[6] Likely [3] Likely[5]	The quality and availability of safe drinking water	High water temperatures and increased stormwater runoff may increase the need for drinking water treatment, raising costs, or compromise quality of drinking water. Water supplies may be affected, forcing communities to seek alternative sources. Water demand may shift to underground aquifers or prompt development of reservoirs or underground storage of treated water, requiring EPA to ensure safety.	Medium	DI tribal program—water quality changes may result in more Safe Drinking Water Act (SDWA) violations, which would increase the work of the regional compliance officers; State and tribal voluntary programs—the region could see demands to increase technical assistance, outreach, and education to further implementation of state and tribal: (1) source water protection programs, including encouraging systems to track water quality/quantity trends (particularly static water levels) and (2) WaterSense/water conservation/green infrastructure/water recycling and reuse programs.	Regionwide; tribal impacts limited to MI, WI and MN
WD	Increased water temperatures	Very likely[6]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Pollutant limitations in NPDES wastewater permits may no longer be protective of water quality standards.	Medium	Water quality standards and/or effluent limitations may be revised to continue to be protective of the water body. As water temperatures increase thermal loads in permits would need to be evaluated possibly restricting thermal limitations to lower levels in permits to continue to be protective of the aquatic life in the water body. Inability of permittees to meet revised limits may prompt	Regionwide

Office	Climate Change Impact[a]	Likelihood of Impact[b]	Focus of Associated EPA Program	Example of Risks if Program were Impacted	Likelihood EPA Program will be affected by Impact[c]	Regional Importance of Vulnerabilities	Variation in importance across the Region
						permit challenges or lead to noncompliance, increasing administrative or enforcement workloads, respectively.	
WD	Increased water temperatures	Very likely[6]	Restoring and protecting watersheds, aquatic ecosystems and wetlands	Ability of water bodies to support historic aquatic life communities may be compromised, prompting requests for use designation changes, revised water quality standards.	Medium	Requests for more WQS revisions/reviews, including revised uses, criteria, variances; more pressure from states, industry for flexibility, less stringent WQS; more stresses on listed species will mean more ESA BE work in conjunction with WQS changes; staff will spend more time working with states to develop climate change monitoring strategies.	Variable for two reasons: 1) climate maps appear to show some inter-regional variability in degree of change; and 2) cold water systems will be substantially affected, warm water systems less so.
WD	Increasing intensity of hurricanes Increasing heavy precipitation events	Likely[3] Likely[3]	Drinking water, wastewater and stormwater infrastructure	Damage from intense storms may increase the demand for public infrastructure funding and may require re-prioritizing of infrastructure projects.	High	Increased demands on the clean water and drinking water State Revolving Fund. Investments in water infrastructure may be needed to manage both decreases in rainfall (e.g. reservoirs) and increased in rainfall (e.g. increases in pipe and storm water management facilities), straining water financing generally including the State Revolving Funds.	Regionwide
WD	Decreasing precipitation days and increasing drought intensity Increasing heavy precipitation events	Likely[5] Likely[3]	The quality and availability of safe drinking water Restoring and protecting watersheds, aquatic ecosystems and wetlands	Increased number of applications, increased evaluation of more complex applications, and more assistance to primacy states	Medium	Increased use of lower quality aquifers could mean more drinking water treatment residuals that are sometimes disposed of down injection wells. Increased use of aquifer recharge wells. Some of these may be injecting water from waste water treatment plants.	Regionwide

Office	Climate Change Impact[a]	Likelihood of Impact[b]	Focus of Associated EPA Program	Example of Risks if Program were Impacted	Likelihood EPA Program will be affected by Impact[c]	Regional Importance of Vulnerabilities	Variation in importance across the Region
	Increased water temperatures	Very likely[6]				Increased use of aquifer storage and recovery wells to extend drinking water infrastructure. Competition for water use between agricultural, municipal/residential and energy uses. This may result in how the Agency evaluates aquifer exemptions. In some cases, aquifers could be so polluted that cleaning them up may be too expensive and they might then be granted exemption from protection under SDWA. However, if the cost of water sources rises due to droughts and dwindling resources, then the comparative cost of cleaning them up might be cheaper than exempting them. Increased number of storm water drainage and agricultural drainage wells Increased use of non-hazardous and hazardous injection wells to dispose of increased fluids that exceed the capacity of their systems (e.g., landfill leachate). Increased use of warm water for cooling (e.g., power plants) may result in more brackish water that will need to be disposed of instead of discharged via NPDES	

[a] Climate Change impacts are based upon peer-reviewed scientific literature.
[b] In general, the sources cited in this section use Intergovernmental Panel on Climate Change (IPCC) likelihood of outcome terminology where the term 'very likely' means 90-100% probability and the term 'likely' means 66-100% probability. For some impacts in the table, additional discussion on the likelihood term is provided in the associated footnote.
[c] High assumes the program will be affected by the impact; Medium assumes the program could be affected under some conditions by the impact; Low assumes that there is a potential for the program to be impacted or uncertainty currently exists as to the potential nature and extent of the impact. This assessment is based on best professional judgment within EPA at this time. Please note, this column does not reflect several important considerations. For example it does not distinguish timeframes (current, near-term, long-term). It does not account for regional and local variations. And it does not reflect the priority of actions the agency may undertake now or in the future.

[1] Denman, K.L., et al. (2007). Couplings Between Changes in the Climate System and Biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
[2] C.B. Field et al., "North America," Chapter 14 in Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2007).
[3] IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea,K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.
[4] Burns, D.A., Lynch, J.A., Cosby, B.J., Fenn, M.E., Baron, J.S., US EPA Clean Air Markets Div., 2011,National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment, National Science and Technology Council, Washington, DC, p. 114
[5] USGCRP, 2009: Global Climate Change Impacts in the United States . Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.
[6] USGCRP, 2009: p. 46. [In the case of freshwater] "Increased air temperatures lead to higher water temperatures, which have already been detected in many streams, especially during low-flow periods." For the purposes of this table "very likely" is used.

U.S. Environmental Protection Agency • Region 6 • Dallas, Texas

Climate Change Adaptation Implementation Plan

Prepared by:

The Region 6 Clean Energy & Climate Change Work Group

May 30, 2014

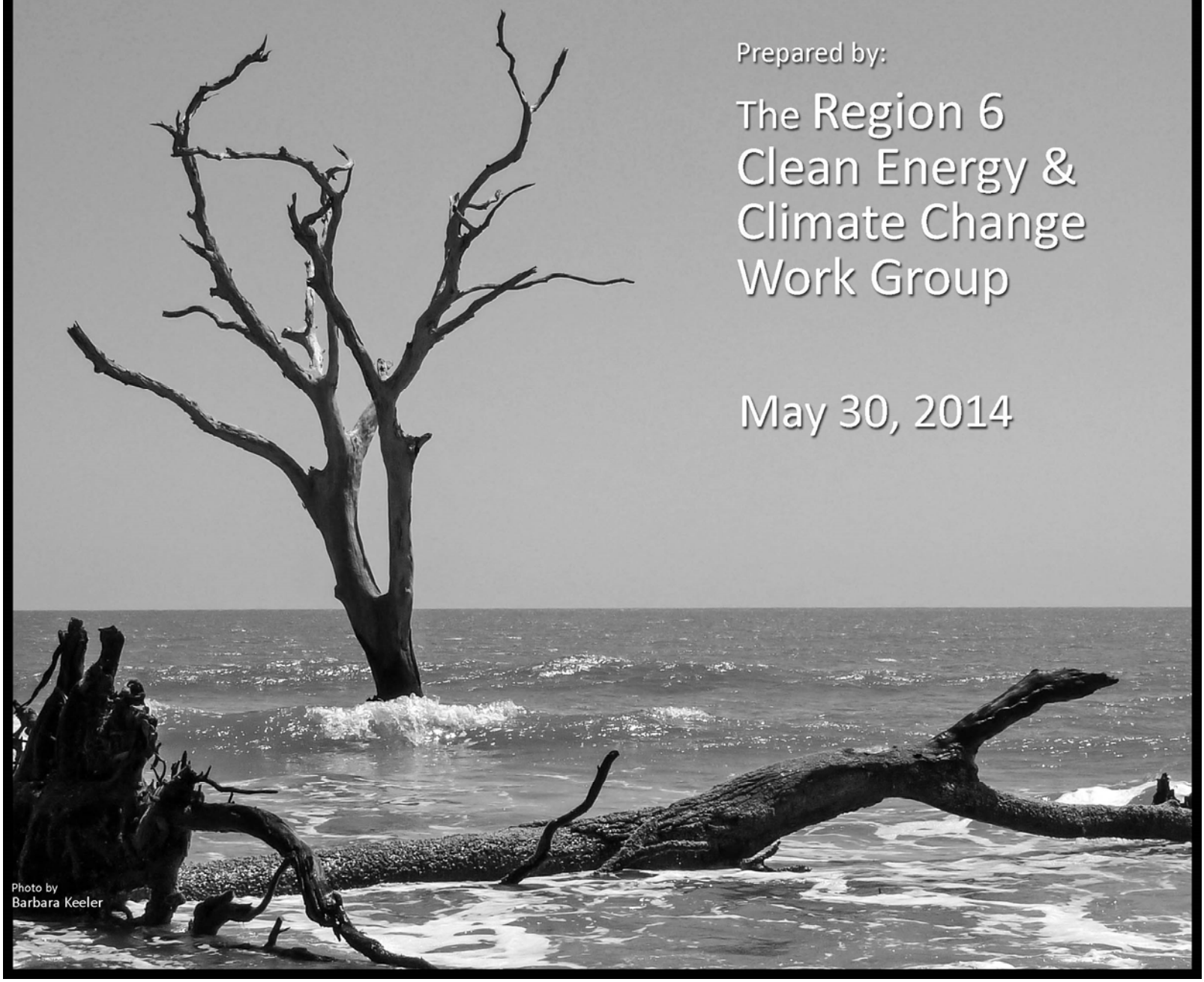

Photo by Barbara Keeler

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Disclaimer

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Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

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September 2013

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Introduction

The EPA Region 6 Climate Change Adaptation Implementation Plan stems from the National Climate Adaptation Plan which was prepared by EPA to fulfill the requirements of Executive Order 13514, calling for all Federal Agencies to develop a plan on how they will address climate change adaptation. EPA's draft Adaptation Plan was submitted to the White House Council on Environmental Quality in June of 2012, and has undergone a tribal consultation as well as a public review and comment period that ended April 9, 2012. EPA expects to publish the final Climate Adaptation Plan in 2014. While the Adaptation Plan was under development, EPA Administrator Jackson issued a *Policy Statement on Climate Change* in June 2011. The *Policy Statement* recognizes that climate change can pose significant challenges to EPA's ability to fulfill its mission, and calls for the Agency to anticipate and plan for future changes in climate and incorporate considerations of climate change into its activities. The *Policy Statement* also directs all EPA Program and Regional Offices to develop Implementation Plans that provide more detail on how they will meet the priorities and carry out the work called for in the Agency's Adaptation Plan.

In response to the Policy Statement, the Region 6 Clean Energy and Climate Change Workgroup produced a draft Regional Implementation Plan and submitted it to EPA's Office of Policy on September 18, 2013. The Plan, along with the draft Implementation Plans developed by all EPA Program Offices and Regional Offices were the subject of a Federal Register notice of availability and request for public review and comment in late 2013. The comments were reviewed by EPA Region 6 and, where appropriate, changes were made to this revision of the Implementation Plan.

The Regional Implementation Plans explain how climate change considerations will be integrated and mainstreamed into programs, policies and operations to ensure they are effective under future climate conditions. Through the Implementation Plans, EPA will continue to protect human health and the environment while accounting for the effects of climate change. The EPA Region 6 Climate Change Adaptation Implementation Plan discusses climate change vulnerabilities the Region will face in coming years, identifies priority actions the Region will take in response to these vulnerabilities, outlines an approach for measuring and evaluating performance, and stresses the importance of working in partnership with stakeholders, states, tribes, and vulnerable communities and places. The Implementation Plan is an evolving document, and will certainly change as new information about the climate and ways to mitigate and adapt to it become available. As a result, periodic updates and changes to this Plan are expected.

This Regional Implementation Plan is voluntary in nature. It does not impose any legally binding requirements or funding commitments on EPA, states, tribes, the public, or the regulated community. Its goal is to address the challenges that a changing climate present to the Region's internal operations, focusing on critical programs, policies and procedures, and to develop and implement appropriate adaptive measures. State and local decision makers remain free to exercise their discretion in choosing to implement the actions described in this Plan. Flexibility is a key aspect of adaptation because it is highly localized and dependent on a variety of site specific factors. EPA further recognizes that the implementation of adaptation measures is contingent upon the availability of resources which could be subject to change.

Relationship to Sustainability

Many of the adaptations described in this Implementation Plan relate to sustainability. EPA's efforts to address sustainability are described at:

http://www.epa.gov/sustainability/basicinfo.htm#sustainability.

Sustainability is based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. Sustainability has emerged as a serious concern as a result of the unintended social, environmental, and economic consequences of rapid population growth, economic growth and consumption of our natural resources. Climate change impacts can affect the natural environment and even our survival and well-being. We will need to adapt in order to support the delicate balance among a healthy environment, societal well-being, and a strong economy.

In the context of this Implementation Plan, sustainability also refers to the momentum and persistence of Region 6 efforts to champion certain approaches or changes in behavior that promote adaptation to a changing climate. Should EPA's involvement at some point become more limited or need to be redirected, Region 6 wants to ensure that the initiative will continue to grow without our presence.

In some cases, market forces will continue to push desired outcomes even without the Agency's involvement. For example, in the drought stricken State of Texas, water conservation and efficiency campaigns through the WaterSense program have been launched by EPA to encourage changes in the way Texans use water in the industrial, agricultural, municipal and domestic sectors. As the demand for water continues to grow and supplies diminish, water will inevitably become more expensive and the free market economy will respond with a variety of water saving devices and products that were previously not widely available. This economic response would likely occur with or without government sponsored water conservation campaigns. Moreover, local watering restrictions and state permitting procedures would enforce water use restrictions beyond involvement by the federal government. Thus, sustainability in water conservation and efficiency would be achieved by market forces, even though an early catalyst to use water more efficiently was created by government. In other cases where market forces provide less motivation to change, EPA's partnerships with organizations aligned with our environmental and public health protection goals will be needed to continue promoting climate adaptation initiatives.

The federal government has an important and unique role in climate change adaptation, but is only one part of a broader effort that must include public and private partners throughout the country and internationally. Partnerships with local communities, tribes, states, other governments, businesses, and international organizations, many of which have already begun to implement adaptation measures, are essential. EPA's leadership and commitment to help build the nation's adaptive capacity are vital to the goal of protecting human health and the environment. Working with our partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Part 1: Vulnerability Assessment

1.1 Geographic Setting

Region 6 straddles three different climate regions identified by the U.S. Global Change Research Program: the Great Plains, the Southeast and the Southwest. The majority of Region 6 (by land mass) lies in the Great Plains Climate Region.

Climate Regions

The Third National Climate Assessment (NCA3) was released in May 2014, to fulfill the requirements of the Global Change Research Act. To complete the assessment more than 70 workshops were held, comprised of a wide range of stakeholders who identified issues and information for inclusion in the report. Also, over 300 experts compiled and wrote the NCA3, which draws from an extensive number of peer-reviewed scientific research efforts on climate change and related topics. The NCA3 identifies eight different climate regions throughout the United States. While the NCA3 delineates the climate regions by state boundaries, adjacent areas in two climate regions may bear more similar climate characteristics than that described in the climate region. For example, in EPA Region 6 part of coastal Texas has climate characteristics related more to the Southeast climate region as opposed to the Great Plains.

For all U.S. regions, the NCA3 reports that warming in the future is projected to be very large compared to historical variations. Higher temperatures also contribute to the formation of harmful air pollutants and allergens (Portier, et al., 2010). Ground-level ozone is projected to increase in the 19 largest urban areas of the Southeast, leading to an increase in deaths (Chang, et al., 2010). Precipitation patterns will be altered as well, with some regions becoming drier and some wetter. The heaviest precipitation events are projected to increase everywhere, and by large amounts. Extended dry spells are also projected to increase in length. Some areas could capitalize on longer growing seasons which could benefit the agricultural sector in parts of the U.S.

Key climate change projections and related issues and impacts for the climate regions and Region 6 states are presented in the following discussion.

Great Plains

The Great Plains Climate Region extends from the Dakotas and Montana in the north to Texas in the south. On the west, it is bounded by the Rocky Mountains and the Basin and Range geographic provinces, and the central lowlands and coastal plain provinces to the east and to the south. Parts of eight states in two EPA Regions (6 and 8) are located in this vast grassland prairie and mountainous region, which nevertheless includes several very large and rapidly growing urban areas.

Oklahoma and Texas, in EPA Region 6, make up the southernmost extent of the Great Plains climate region. Climate projections summarized in the NCA3 suggest more frequent and more intense droughts, severe rainfall events, and heat waves. The NCA3 identifies key climate change projections, issues and impacts for this region to include:

1. Rising temperatures are leading to increased demand for water and energy. In parts of the region, this will constrain development, stress natural resources, and increase competition for water among communities, agriculture, energy production, and ecological needs.

2. Changes to crop growth cycles due to warming winters and alterations in the timing and magnitude of rainfall events have already been observed; as these trends continue, they will require new agriculture and livestock management practices.

3. Landscape fragmentation is increasing, for example, in the context of energy development activities in the northern Great Plains. A highly fragmented landscape will hinder adaptation of species when climate change alters habitat composition and timing of plant development cycles.

4. Communities that are already the most vulnerable to weather and climate extremes will be stressed even further by more frequent extreme events occurring within an already highly variable climate system.

5. The magnitude of expected changes will exceed those experienced in the last century. Existing adaptation and planning efforts are inadequate to respond to these projected impacts.

Southeast

The Southeast climate region includes Atlantic and Gulf coastal states of Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, and Louisiana. Inland states comprising the region include Kentucky, Tennessee, and Arkansas. In EPA Region 6, Arkansas and Louisiana belong to the Southeast climate region. The NCA3 reports that temperatures across this region are expected to increase during the next century, with a significant increase in the number of hot days exceeding 95°F, and decreases in freezing events. Projections of future precipitation patterns are less certain than projections for temperature increases, with many models projecting drier conditions in the far southwest of the region and wetter conditions in the far northeast of the region. The coastal area of this region is also vulnerable to sea level rise and coastal land loss, with related threats to infrastructure through inundation, and salt water intrusion threatening agricultural practices and drinking water sources (Parris, et al., 2012). All of these projected changes and impacts are expected to be compounded by population growth projections for the region. Though part of the Great Plains climate region, areas along the Texas coast may experience climate change issues and impacts more similar to those projected for the coastal areas in Louisiana. Key climate change projections, issues and impacts reported in the NCA3 for this area include:

1. For coastal Louisiana (and possibly parts of coastal Texas), sea level rise (and associated coastal land loss) poses widespread and continuing threats to both natural and built environments and to the regional economy.

2. Decreased water availability, exacerbated by population growth and land-use change, will continue to increase competition for water and affect the region's economy and unique ecosystems.

3. Increasing temperatures and the associated increase in frequency, intensity, and duration of extreme heat events will affect public health, natural and built environments, energy, agriculture, and forestry.

Southwest

The Southwest climate region extends westward from New Mexico and Colorado all the way to the West coast and includes the states of Arizona, Utah, Nevada and California as well. This vast mountainous and arid region is the driest and hottest part of the United States. Although New Mexico is the lone state in EPA Region 6 that belongs to the Southwest Climate Region,

areas in West Texas and the panhandle of Oklahoma may experience similar climate change effects. The NCA3 reports that climate changes will pose challenges for the already parched region that is expected to get hotter and, in its southern half, significantly drier. Increased heat and changes to rain and snowpack will impact the region's agriculture sector, and population growth will compound the effects of climate change. Severe and sustained drought will stress water sources, already over-utilized in many areas, forcing increasing competition among farmers, energy producers, urban dwellers, and plant and animal life. Tourism and recreational industries could experience economic losses due to these projected changes. The following climate change projections, impacts and issues which apply to parts of New Mexico, are noted in the NCA3:

1. Snowpack and streamflow amounts are projected to decline in parts of the Southwest, decreasing surface water supply reliability for cities, agriculture, and ecosystems.
2. Increased warming, drought, and insect outbreaks, all caused by or linked to climate change, have increased wildfires and impacts to people and ecosystems in the Southwest. Fire models project more wildfire and increased risks to communities across extensive areas.
3. Projected regional temperature increases, combined with the way cities amplify heat, will pose increased threats and costs to public health in southwestern cities, which is where more than 90% of the region's population live. Disruptions to urban electricity and water supplies will exacerbate these health problems.

As a result of this geographic and climate diversity, Region 6 could face many different types of climate change impacts, including increases in air and water temperatures, drought, increased flooding, increased frequency and intensity of extreme precipitation events, loss of habitat and reduced ecosystem functions, and a general deterioration of water quality. The southeastern part of Region 6 will face continuing problems of sea level rise and coastal land loss, while the western section of Region 6 will likely experience reduced snowpack and associated impacts to natural water storage and discharge in the mountains of New Mexico. These impacts are expected to be compounded by continued drought, population growth and competing demands for fresh water among the industrial, agricultural, energy and municipal sectors throughout Region 6.

1.2 Adaptation Planning

The term "adaptation" relates, in this context, to changes in natural ecosystems that are induced by climate change or to adjustments we make to expected changes in climate. Such adjustments can be defensive in nature (e.g., infrastructure changes to anticipate climate change impacts) or opportunistic (e.g., expanding agriculture in areas that have become more climatically amenable). Historically, humans have adapted to environmental and climate changes by growing different crops, modifying shelter types, and moving to new areas (Adger et al., 2007). However, with the current pressures of climate change on expanding populations, it will be increasingly difficult for societies to adapt. With increasing interdependence, impacts on one population or economy can have world-wide repercussions (USGCRP, 2009; U.S. EPA, 2012a).

In response to this challenge, an Interagency Climate Change Adaptation Task Force has been created and is co-chaired by the White House Council on Environmental Quality (CEQ),

the White House Office of Science and Technology Policy, and the National Oceanic and Atmospheric Administration. There are also representatives from over 20 federal agencies on this Task Force. The objective is to develop recommendations to the President about what federal government can do to better prepare for climate change impacts. One of the first steps is for each agency to integrate climate change adaptation into their planning, operations, and policies and to develop a climate change adaptation plan (U.S. EPA, 2012b).

EPA issued a climate change adaptation policy statement in June 2011 (U.S. EPA, 2011) and a year later completed an agency-wide Climate Adaptation Plan. The policy statement requires every program and each regional office to develop an Implementation Plan outlining the projected impacts of climate change on its operations and programs, as we well as carrying out the work called for in the Agency-wide Plan.

In response, Region 6 coordinated among all its Divisions and with its standing Clean Energy-Climate Change (CECC) Workgroup. In 2008, the CECC Workgroup produced a strategic plan for Regional climate change priorities, which served as a starting point for the Implementation Plan. The EPA Office of Water's "National Water Program 2012 Strategy: Response to Climate Change," the NCA3, and reports from the Intergovernmental Panel on Climate Change proved to be additional valuable resources to inform the development of the Implementation Plan. The Region also gleaned insights by coordinating in 2011 and 2012 with state, tribal, and local governments in the south-central U.S. The challenges expressed by these governments assisted our efforts to clarify potential vulnerabilities.

Region 6 concluded that our main vulnerabilities internal to our operations involve increasing air temperatures and worsening air quality, water quantity and quality issues, emergency response challenges, contaminated site cleanups (CERCLA, RCRA, Brownfields, LUST), the consequences of enhanced use of pesticides and herbicides, coastal resource protection, increased requests for assistance from vulnerable populations and tribes, and supporting the continuity of Region 6 internal operations by providing consistent electrical power and water to Regional facilities.

Although this document speaks specifically to climate change adaptation, the Region has a host of additional climate change efforts that fall under the separate category of climate change mitigation. As a review, climate change adaptation relates to adjusting to a changing environment while climate change mitigation refers to reducing the human influences on the climate system. Examples of climate change mitigation would include strategies to reduce greenhouse gas (GHG) emissions and increasing the capacity of carbon sinks. By contrast, an adaptation measure might be to move coastal infrastructure further inland in response to the effects of relative sea level rise.

Region 6 has a strong and ongoing climate change mitigation program including a greenhouse gas reduction initiative, technical programs to enhance geosequestration capacity, and efforts to promote energy efficiency used for irrigation and water utilities. However, this implementation plan speaks specifically to adaptation actions. Future revisions to this Implementation Plan may include mitigation activities.

1.3 Vulnerabilities to Climate Change Impacts

Generally, climate scientists predict that mean temperatures in the five states of Region 6 will rise significantly in the 21st century. This will result in higher mean low temperatures in the winter. In summer months, greater frequencies of heat waves are expected, with elevated high and low temperatures.

Projections of precipitation changes are less certain than those for temperature. In the Great Plains, the NCA3 notes that the number of days with heavy precipitation is expected to increase by mid-century, especially in the north. Large parts of Texas and Oklahoma are projected to see longer dry spells (Garfin, et al., 2014).) Under a continuation of current rising emissions trends, reduced winter and spring precipitation is consistently projected for the southern part of the Southwest by 2100 (Garfin, et al., 2014). Much of the southern plains and New Mexico currently experience modest to little precipitation, but it comes with a high degree of inter-annual variability. The NCA3 notes that “extreme precipitation events” will constitute a larger percentage of the total, which could prompt greater flooding. Seasonal shifts are likely to affect snow packs in the mountains of New Mexico, where runoff is expected earlier in the spring and summer, with attendant decreases in runoff in the warmer months. Droughts are expected to become more frequent and larger in spatial extent and thus more damaging. The NCA3 reports that warmer air temperatures, drought conditions and related impacts such as decreased soil moisture could lead to an increased frequency and spatial extent of wildfires.

Climate change may also play a role in the effects of hurricanes along the Gulf coast, with some studies showing a lower frequency but slightly higher intensity of hurricanes (Knutson, et al., 2010). Hurricanes and tropical storms will continue to impact populations, industry, land, and wildlife in Louisiana and Texas. Coastal land loss and relative sea-level rise are ongoing challenges in Louisiana and Texas, where some of the highest existing rates of wetland loss occur. Climate change projections indicate that Gulf coastal ecosystems and communities will face increasing risks. Though vulnerable populations and critical infrastructure occur throughout the Gulf coastal zone, two of the largest population centers in the Region, the Houston-Galveston and the Baton Rouge-New Orleans corridors, have been subject to major hurricane and tropical storm damage in the past and are of particular concern.

Expected changes in temperature, drought and seasonality are anticipated to significantly impact municipal water availability, agricultural practices, ecosystem functions, types and extent of habitat coverage, occurrence of pest problems, human health, population displacement, coastal infrastructure security, coastal land loss, and air quality in the Region. Complicating this overall picture is a continuing, underlying variability in weather systems which may temporarily modify these overall trends and subject the Region to greater weather variability (Christensen et al., 2007; U.S. EPA, 2012c; Nielsen-Gammon, 2009; Deser et al., 2012; Longergan, 1998; Hanes et al., 2000; Martens et al., 1997).

In order to evaluate fully the vulnerabilities these changing conditions pose to the Region, a full assessment was made of the Regional responsibilities by programmatic Divisions. A Regional organizational chart is included for reference as Figure 1, and a summary of the results is provided in Table 1. Overall, many of the projections for climate change impacts and environmental consequences were found to be consistent with findings from the Intergovernmental Panel on Climate Change Fourth Assessment Report (Field et al., 2007).

1.4 Region 6 Program Impacts

1.4.1 Multimedia Planning and Permitting Division

1.4.1.1 Air Quality

Currently there are three metropolitan areas that fail to meet the National Ambient Air Quality Standard (NAAQS) for ozone in Region 6. However, up to 18 other areas in Region 6 have recently monitored concentrations exceeding the new NAAQS standard of 75 parts per billion and may ultimately become “nonattainment” areas. Exacerbating the health impacts from ozone pollution on urban populations will likely be higher nighttime temperatures expected in urban areas, both as a consequence of climate change but also because of enhanced effects from urban heat islands. This is apparently particularly evident in sprawling urban centers, which are common in Region 6 (Stone et al., 2010).

A related complication for ozone pollution is an anticipated increase in electricity demand due to higher temperatures in the summer. A further, related complication is the availability of water for power plant cooling purposes. Without sufficient quantities of water that is cool enough, interruptions in service or even shutdowns could occur at these power plants, as happened during the summer of 2011 in Texas (ERCOT, 2011).

Further, other air pollutants, such as particulate matter and sulfur dioxide, may become problematic in Region 6, particularly if many additional fossil-fueled power plants are built to meet an accelerating electricity demand. These may also negatively impact progress in attaining the goals of the Regional Haze Program in Class I National Park and Wilderness Areas. Increased frequency and spatial extent of wildfires due to enhanced droughts may significantly increase particulate matter loadings in the atmosphere (U.S. EPA, 2009).

Greenhouse gas (GHG) emissions from power plants and industrial sources in Region 6 contribute to elevated atmospheric concentrations of GHG pollutants, which endanger both public health and welfare. New major stationary sources and major modifications at existing stationary sources are required by the Clean Air Act to obtain a GHG air quality permit before commencing operations.

EPA Region 6 is currently the GHG Permitting authority for GHG Prevention of Significant Deterioration (PSD) in Texas and is implementing this permitting program in Texas under a Federal Implementation Plan. The other Region 6 states are implementing their own GHG PSD permitting programs through their EPA approved regulations. With an expectation of increased industrial activity in Region 6 states, EPA-Region 6 will continue to perform direct permit development or permit development oversight in those states.

Best Available Control Technology (BACT) determinations for GHGs currently consider options that improve the overall energy efficiency of new stationary sources or existing sources undergoing a major modification. As the climate changes, these BACT determinations may become more detailed and comprehensive, requiring an increased level of Region 6 involvement in order to ensure that sources are constructed and operated in a manner consistent with achieving the energy efficiency goals established as BACT.

1.4.1.2 Pesticides

Local, regional, and global climate changes that result in an increase and duration of mean and extreme temperature, and a reduced average rain fall in combination with extreme precipitation events and floods, are predicted to result in the increased use of pesticides by volume, target site, and type.

The region is likely to experience increased incidence of existing pests, exotic invasive species, and the rise of new endemic pests. The reduced availability of land for agricultural use, decrease in quality and quantity of water for irrigation, decrease in favorable growing seasons, and increased demand on commodities will have a significant impact on crops. The risk of vector-borne diseases that affect public health and agriculture will likely increase dramatically. This is not only due a predicted increase in abundance of endemic and invasive pest species, but also due to predicted changes to migration patterns of vertebrate hosts, human introduction, and temperature conditions that promote decreased development time for pests and increased pathogen amplification.

As a consequence of the impacts that pests and pest-borne diseases will have on crops and humans, it is expected that the quantity, formulation, or classification of pesticides will change in order to combat these pests. It is reasonable to expect that this increase in pesticide use will generate additional risk to workers, specifically those in agriculture. The use of new and/or unfamiliar pesticides for new or invasive species will pose challenges in communicating risks and implications to workers. Issues will include exposure, reentry requirements, health and personal protective equipment requirements. With an increase in extreme rainfall events and floods, increased pesticide run-off and contamination of both surface and ground water may occur. Such events could reasonably be expected to have significant implications for surface and groundwater quality throughout the Region. Any increased use of pesticides in quantity, formulation or classification may also increase exposure risks to pollinators. New endemic and exotic pests may require the use of pesticides on new target sites and time periods that increase the risk of pesticide exposure to honey bees, native bees, and other beneficial pollinators (i.e., spraying of pesticides for daytime biting mosquitoes that transmit human disease). Introduction of novel pesticides and application techniques must consider their impact on pollinators in a changing climate.

1.4.1.3 Waste Site Management

Flooding from more intense and/or frequent storms may lead to contaminant releases from Corrective Action waste management sites. Inundation and flooding may lead to transport of contaminants through surface soils, ground water, surface waters and/or coastal waters. Saltwater intrusion and increased ground water salinity in coastal aquifers may also increase the permeability of clay liners installed at waste sites, such as landfills, allowing contaminants to spread to nearby properties. These contaminant releases may pose an increased risk of adverse health and environmental impacts.

Additionally, increased incidents of flooding may disrupt existing hazardous waste management networks. Inundation from relative sea level rise or severe storms may disrupt the transportation system in place to handle hazardous waste or may damage treatment, storage or disposal facility infrastructure. A major storm event may increase the amount of hazardous waste generated, and may lead to the release of hazardous materials. Smaller entities that use and store hazardous materials may lack resources for emergency planning, which may increase the risk of abandoned hazardous materials during a flooding or storm event.

Changes in precipitation patterns and temperature may adversely affect the performance and efficacy of remedies, and cleanup timing and duration. To the extent that climate change leads to more prolonged droughts, water intensive remedies may become limited and the risk of wildfires spreading to contaminated sites and chemical storage areas may increase (e.g., Los Alamos National Lab). Changes in precipitation may affect the rate at which vegetation grows, impacting landfill covers, phytoremediation, ecological revitalization efforts, and remedies relying on biological processes (e.g., land farming and enhanced monitored natural attenuation). The impacts may be positive or negative, depending on conditions at each site. Groundwater characteristics (i.e., depth, flow, chemistry) may also be altered, resulting in potential adverse impacts on the performance and cost of remediation. To the extent that temperatures increase with climate change, contaminants at cleanup sites may become more volatile, increasing risks for local populations.

1.4.2 Water Quality Protection Division

Numerous environmental complications from expected climate change in Region 6 center around the complex and interrelated issues of drought and inundation. General population growth and shifts in population from the Region's rural areas to urban centers will continue to create demands for water storage to maintain sustainable water supplies and increase competition among water users (e.g., energy, industrial, agricultural and municipal uses). Decreased water availability due to increased temperature, increased evaporation, and longer periods of time between rainfall events, coupled with an increase in societal demand, is very likely to affect many sectors of the Region's economy. More frequent and more intense droughts could adversely impact agriculture, silvaculture, energy production and a myriad of other industries and economic sectors.

Decreases in water supply for fire protection could also hamper the capacity of local, state and federal fire-fighting efforts, which could lead to fire loss increases including human life, property, infrastructure, and ecosystem flora, fauna, habitat, and function. Declines in soil moisture are expected to increase the magnitude and frequency of wildfires, which have increased over the last 30 years, and to impact water quality in streams, creeks, rivers, lakes.

Reduced groundwater supply due to a lack of recharge will also be a concern. Declining surface and groundwater quantity and quality, coupled with more frequent and severe droughts, will continue to exacerbate water shortages in the Region.

Loss of snowpack in the western portion of the Region will further impact water use, storage, and irrigation practices. Warmer temperatures will reduce mountain snow packs and peak spring runoff from snow melt will shift to earlier in the season, increasing the shortage of water during the summer. A longer and hotter warm season will likely result in longer periods of extremely low flow and lower minimum flows in late summer. Water supply systems that have no storage or limited storage (e.g., small municipal reservoirs) may suffer seasonal shortages in summer and ecosystems and wildlife may be stressed. The resulting temporal changes in water distribution, storage and availability could have significant consequences for water reservoir and storage system design, operation and management to ensure municipal (e.g., drinking water and fire protection), agricultural and irrigation, industrial, energy production, and other critical needs are met. Moreover, the temporal changes in water distribution, storage and availability could impact downstream water quality and aquatic life. These changes must be

taken into consideration as the adequacy of current water infrastructure is evaluated and as new infrastructure is designed and brought into service.

Possible increases in the frequency and altered timing of flooding could increase risks to people, ecosystems, and infrastructure. Increased flooding could occur as a result of an increased percentage of winter precipitation falling as rain. Water quality impacts will be amplified both by increases in precipitation intensity and by longer periods of low flow in streams. Increased nonpoint source pollution (e.g., sediments, phosphorus, and nitrogen) is to be expected as a result of increased periods of intense rainfall. This could result in changes to natural stream morphology and could negatively impact the functioning of aquatic ecosystems.

As relative sea levels rise and rainfall patterns change, the physical and chemical structure of estuaries, coastal wetlands, and tidal rivers are likely to become more variable and potentially less sustainable. Some of the fastest rates of relative sea level rise in the U.S. are occurring in areas where the land is subsiding, including parts of the Gulf coast. For example, in coastal Louisiana, relative sea level rise was about eight inches or more during the last 50 years, which is slightly faster than twice the global rate. Much of New Orleans sits below the mean local sea level and the State's only inhabited barrier island, Grand Isle, is reporting one of the highest sea level rise rates in the world. Projections are that an additional 1,750 square miles of Louisiana's coastal zone will be inundated in the next 50 years (CPRA, 2012). As the ecological risks grow so do the financial costs of maintaining and restoring coastal ecosystems. The challenge will be to leverage financial and technical resources with those from outside the agency in order to focus more on landscape scale coastal restoration projects, rather than on small projects yielding more limited results.

Relative sea levels will vary along the Gulf coast and will contribute to changing barrier island configurations and coastal shorelines. Wetlands will be drowned or eroded and low-lying areas, including some populated areas, will be inundated more frequently or permanently. Salinities will increase in the estuaries and aquifers. Hurricanes often have their greatest impact at the coastal margin where they make landfall, intensifying beach erosion, inland flooding, and wind-related damage to both cultural and natural resources. Increasing relative sea level rise, combined with the damaging effects of more intense storm surges and hurricanes, are expected to pose severe and growing risks to people, personal property, and public infrastructure along the coast. Infrastructure at risk includes energy, transportation and communications facilities, as well as wastewater treatment facilities and drinking water systems.

The Water Quality Protection Division will continue to heighten its focus on sustainable infrastructure and climate adaptation planning and implementation issues to ensure the water programs, policies and procedures remain effective even as the climate changes. Attention will include emergency response planning and recovery functions as well as maintaining the long-term viability of the Clean Water Act and Safe Drinking Water Act programs in a changing climate.

1.4.3 Management Division

Region 6 has its main facilities in three different Texas cities. The main Regional office is in downtown Dallas, the Regional laboratory is in Houston, and the U.S.- Mexico Border Office is

in El Paso. Additionally, a Training and Conference Center is located in Addison, a suburb of Dallas.

In addition to fulfilling Executive Order commitments to reduce energy use, conserve water, reduce waste, and expand recycling, the Region will likely face acute power and water challenges in these locations. This is a consequence of being in an area of rapid population growth that is expected to experience significant warming and less reliable precipitation. Therefore, all these facilities could suffer from decreasing reliability of electrical power and water availability. For example, load-shedding occurred in the Texas electrical grid, ERCOT, in February 2011, with Electricity Emergency Alerts in summer 2011. In addition to employee discomfort from such a situation, without reliable power and water, information technology equipment may be compromised. Whether enhancing employee telework would be an effective response to these challenges is unclear.

1.4.4 Superfund Division

1.4.4.1 Emergency Response

Region 6 Emergency Response personnel are very familiar with the challenges of responding to emergencies and natural disasters, having worked for months in several different hurricane response activities, including that for Katrina in 2005. With hurricanes affecting the Gulf of Mexico coast perhaps being more powerful, coupled with an expected increase in extreme precipitation events, Emergency Response in Region 6 will be further challenged. Although the Region maintains a volunteer, basically trained “Regional Support Corps” to assist emergency response activities in an extreme short-term need, it is likely there will be shortages of specialized Emergency Response personnel to respond to these kinds of events in the future. This is particularly true of major events that may require many weeks or months of follow-up cleanup activities. Further, if the strength of future hurricanes and extreme precipitation events is as predicted, Emergency Response personnel may be confronted with a whole new set of challenges such as massive storm surges, larger and more widespread flash floods, and long-lived breakdowns in electricity grids and water and sewer systems.

1.4.4.2 Superfund Sites

A number of Superfund sites are located in vulnerable areas of Region 6, particularly the Gulf Coast regions of Texas and Louisiana. Rising coastal waters and massive storm surges could potentially flood sites where waste has been capped and left in place. Although most caps and barriers at Superfund sites are engineered to contain waste for many years, the possibility of long term and extensive flooding, even permanent submersion, could affect the integrity of engineered remedies at some sites where waste has been consolidated and remains in place.

Additionally, there are active Superfund cleanups expected to be ongoing for many years to come in the vulnerable Gulf Coast areas that will likely be impacted by energy shortages, flooding, storm surges, water shortages and other expected climate change impacts. For example, domestic or public water supplies could be affected in areas where Gulf Coast Superfund sites are utilizing energy intensive pump and treat methods to remedy groundwater contamination in aquifers used to supply drinking water. Or, as discussed above, EPA’s common practice of consolidating waste and leaving it in place in landfills or under engineered caps may no longer be protective of human health and the environment if climate changes result in frequent, massive flooding in the Gulf Coast areas.

In December 2013, the Office of Solid Waste and Emergency Response Administrator issued a memorandum to "Encourage Greener Cleanups." The memorandum encouraged all Office of Solid Waste cleanup programs, including the Superfund program, to consider utilizing ASTM's Standard Guide for Green Cleanups (E 2893-13), for reducing the environmental footprints of cleanups. The Region 6 Superfund Division fully supports its project manager utilizing this ASTM Standard Guide to "green cleanups", including efforts to consider climate change and potential adaption when evaluating remedy selections.

1.4.4.3 Brownfields Sites

Brownfield sites in Region 6 exist in many different forms. Brownfield sites can vary from an old abandoned gas station or movie theater to an illegal dump site or old airport. Some of these sites are relatively small while others may cover many acres. It is the goal of the Brownfields program in Region 6 to encourage state, tribal, or local entities that are redeveloping old Brownfield sites to consider green technologies and sustainable practices that reduce energy use. In urban areas, the Region encourages development that reduces GHG effects and minimizes the urban footprint. Some of the Region 6 Brownfield sites have been returned to parks and to new construction that utilizes practices resulting in Leadership in Energy and Environmental Design (LEED) certification. These sustainable practices will continue to be important in the Region 6 Brownfield program and as a means of contributing to climate change adaptation.

1.4.5 Office of Environmental Justice and Tribal Affairs

The Region 6 Office of Environmental Justice and Tribal Affairs (OEJTA) oversees affirmative federal environmental protection programs for vulnerable communities and 66 tribal lands in Region 6. These represent populations that may be at greatest risk as climate change occurs in the future. Many lower-income minority areas are ones characterized by substandard infrastructure which may be the first to fail during times of high temperatures, drought or extreme precipitation events, for example. Older residents of urban areas may be particularly vulnerable to synergistic health impacts due to elevated night time temperatures which are expected as the climate changes. Tribes may be particularly affected by heat waves and drought conditions, as many are dependent upon natural resources on their tribal lands. OEJTA will be challenged to understand fully the differential impacts on these various communities, to educate themselves about how EPA may be able to assist these populations to protect human and environmental health, and to conduct effective outreach to these vulnerable populations.

As more of the Region's tribal partners begin to develop their own climate change adaptation plans, OEJTA will need assistance from Regional staff to help with these efforts. OEJTA should see an increase in this effort and the current draft Indian General Assistance Program guidance mentions this work as an eligible activity. This increase may occur as soon as 2013. Demands for funding to address climate change can be expected to increase and, therefore, there will be a greater need for grant funding from the Region 6 Management Division and OEJTA's EJ Small Grant program.

1.4.6 Compliance Assurance and Enforcement Division

Regional compliance and enforcement activities may be complicated by shifting priorities influenced by climate change. These could include a surge in violations of water-related regulations that may occur as a result of excessive precipitation events and floods. Air-related

regulations could be more frequently violated because of stress on regional electricity grids. With electricity demand increasing, problematic financing for new electricity generating units, and long-term fuel trends complicating decision-making, construction of new power plants may not keep pace. Ensuring grid integrity may portend increasing difficulty meeting air emissions limits. These same factors can also influence success in meeting water quality effluent limits. Regular assessment of such trends will be necessary to ensure Regional compliance and enforcement resources are appropriately tailored to meet future challenges.

1.4.7 Office of Regional Counsel

The Region's broad mandates to protect human health and the environment afford a reservoir of legal authority to support adaptation work. However, specific legal questions that may arise in the course of adaptation programming cannot be answered in the abstract. As part of a federal agency, EPA Region 6 derives its authority to act from the U.S. Constitution and the laws passed by Congress. Because the legality of its actions is such a high priority for EPA, program managers and staff will consult with the appropriate attorneys in the Office of General Counsel (OGC), Offices of Regional Counsel (ORC), and the Office of Enforcement and Compliance Assurance (OECA) as they conduct their adaptation work.

The variation among the statutes our Region administers, as well as the regulatory programs EPA designs, implements, and enforces under those laws will require special attention and legal analysis on a case by case basis. The evolving scientific understanding of climate change impacts and the sensitivity of EPA programs to those impacts will also necessitate case specific analysis. The relative weight climate change considerations should be given in evaluating options for EPA action will depend on many factors including, but not limited to, the time and geographic scale of the relevant climate impacts compared to the temporal and spatial scale of the proposed EPA action; the scientific understanding of the climate impacts; and the environmental and economic consequences estimated to result from the proposed climate change adaptation measures. Considerations such as these are by definition case-specific. As such, Regional program managers and staff will consult with this Region's ORC branch for special analysis and legal application as discrete issues develop.

1.4.8 Cross Program Impacts

Cross-Divisional and interoffice communications and partnerships are essential methods for Region 6 to understand better its climate change adaptation vulnerabilities and to make plans to address these. The following is an illustrative, but certainly not exhaustive, list of these:

1.4.8.1 Communications — In light of a changing climate, Region will need to maintain strong EPA headquarters and Regional communications, as well as with states and tribes. We will also need to continue Regional training related to climate change (Regional Science Council and Clean Energy-Climate Change Workgroup), as well as outreach initiatives (WaterSense, meetings with elected officials, presentations to citizen groups) and conferences (Municipal Separate Storm Sewer Systems (MS4), Low Impact Development (LID), Green Infrastructure (GI), Clean Air Through Energy Efficiency Conference, and the Texas Combined Heat and Power Conference). Much of the internal communications and integration of climate change adaptation planning and implementation in Region 6 will continue to be coordinated through the cross-program Clean Energy and Climate Change Workgroup.

1.4.8.2 Partnerships — To leverage resources, involvement and cultivate a synergistic response from vested stakeholders, Region 6 will continue and expand partnerships with public, non-governmental organizations, and private sector organizations, such as Councils of

Governments and Metropolitan Planning Organizations (e.g., NCTCOG), North Texas Sustainable Materials Forum, Texas Association of Builders, Texas AgriLife, DFW International Airport, Region 6 Tribes and vulnerable communities, sporting organizations (Greening Sports Initiative), the Electricity Reliability Council of Texas, Texas Public Utilities Commission, Arkansas Public Service Commission, and the Southwest Power Pool. Efforts will be made to expand informal partnerships throughout affected public and private sectors including but not limited to the municipal, industrial, energy, agricultural, and transportation sectors. Climate change adaptation will not be inclusive, integrated or effective unless these key relationships are developed, fostered, and mobilized into action through active EPA leadership.

1.5 Summary of Vulnerabilities

Region 6 faces many serious vulnerabilities in successfully fulfilling its mission as the climate changes. As an area of rapid population growth but one subject to major future temperature and precipitation changes, increasing numbers of people will be impacted by increased environmental pressures due to climate change. It is our goal to anticipate fully and understand the nature of such pressures in order to achieve our mission to protect human health and the environment in the Region. This vulnerability assessment reveals the current state of knowledge but will necessarily change as additional information is received and new scientific and technical knowledge is gained. Thus, the vulnerabilities outlined herein are expected to take on new characteristics and to continue to pose challenges over time.

Part 2: Responding to Vulnerabilities—Priority Actions

2.1 Overview

The NCA3 states that climate change is happening now and that adaptation efforts need to accelerate to address the impacts. From an Agency-wide perspective, ten separate priorities have been identified to respond to the climate change adaptation challenge:

(1) Fulfill strategic measures in FY 2014-2018 EPA Strategic Plan by such actions as integrating climate change trends and scenarios into five rule-making processes, five major financial mechanisms, and five major scientific models and/or decision support tools;

(2) Protect Agency facilities and operations;

(3) Factor legal considerations into adaptation efforts;

(4) Strengthen adaptive capacity of EPA staff and partners through training;

(5) Develop decision-support tools that enable EPA staff and partners to integrate climate adaptation planning into their work;

(6) Identify cross-EPA science needs related to climate adaptation;

(7) Partner with tribes to increase adaptive capacity;

(8) Focus on most vulnerable people and places;

(9) Measure and evaluate performance; and

10) Develop Program and Regional Office Implementation Plans.

From the Region 6 perspective, we believe priorities 2, 4, 7, 8, 9, and 10 are the most relevant and lend themselves to direct Regional action. The other priorities are more properly addressed at the EPA headquarters program office level. The Region will defer to headquarters in those areas and will respond when guidance is issued.

To further clarify the Regional roles, EPA's Office of Policy identified several common areas of focus for the Regions:

(a) Vulnerability assessments;

(b) Priority actions on climate adaptation;

(c) Agency-wide strategic measures on climate adaptation;

(d) Legal and enforcement issues;

(e) Training and outreach;

(f) Partnerships with tribes;

(g) Vulnerable populations and places; and

(h) Evaluation and cross-office pilot projects.

As a precursor to completing this priority actions section of the Regional Implementation Plan, Region 6 completed a vulnerability assessment which broadly covers the major climate change-induced conditions to which the Region is expected to be susceptible.

2.2 Selection Criteria

The criteria for selecting priority actions comprised two categories. First, the major Regional vulnerabilities identified above provided the substance from which priority actions were derived. Second, agency priorities numbered 2, 4, 7, 8, 9, and 10 informed the process by which the Region proposed to deal with these priority actions.

2.3 Impacts and Actions

Priority actions relating to the Regional vulnerabilities are summarized in Table 1 and the discussion below provides more detail.

In order to most effectively adapt our ways of conducting business to the realities of climate change, the Region proposes a process that relies on training, some infrastructure enhancements, and constant monitoring and evaluation of indicators that signal climate change in the Region. This approach lends itself to more quickly responding to the effects of climate change than by prescribing many specific actions now which may be deemed ineffective and inappropriate in short order. The discussion below reflects this philosophy. Nonetheless, Table 2 presents specific programs the Region anticipates continuing to emphasize in order to minimize the effects of climate change on Regional operations.

2.4 Priority Actions for Identified Regional Vulnerabilities

Priority Climate Change Adaptation Actions for 2016

1. Deliver Regional training on climate adaptation to managers and staff;
2. Consider options for the new Regional facility lease that use renewable energy power sources, energy efficient technologies, green infrastructure and low impact development approaches;
3. Mitigate drought impacts by setting water use efficiency goals and promotion of EPA's WaterSense™ program;
4. Continue to strengthen emergency planning and preparedness capabilities within the Region to enhance response capabilities for extreme weather events and natural disasters;
5. Work with Gulf Coast partners on coastal protection, restoration, and climate adaptation planning priorities; and
6. Expand partnerships with stakeholders to enhance climate adaptation opportunities and information sharing.

2.4.1 Higher mean temperatures, with more frequent and intense summer heat waves

The priority action in response to this anticipated impact would involve expanded training for Regional staff in the air program, pesticides program, environmental justice program, and in the Management Division. This training would emphasize the scientific basis and engineering implications of climate change for human health, the efficiencies and risks in employing new and/or alternate doses of existing pesticides, and safeguarding vulnerable urban populations. This latter concern may influence debate and decision-making about the robustness of ozone mitigation strategies in the Region. Also, Regional air program staff should understand the increasing role of energy production emissions in air quality implementation strategies. Management Division staff are likely to benefit from training that imparts better understanding of energy vulnerabilities and needs for Regional facilities.

Together with existing Executive Orders 13514 and 13423 and the expiration of the lease on the main Region 6 offices in Downtown Dallas in 2017, the Management Division should work with the General Services Administration to consider options for a facility that makes broad use of distributed energy generation such as solar, wind, and fuel cells, as well as highly energy efficient technologies such as ground-source heat pumps. This emphasis would greatly reduce the vulnerability of the Region to an increasingly stressed electricity grid and would significantly reduce the Regional office's carbon emissions. Other considerations for the new facility that would enhance energy efficiency improvement efforts include the use of WaterSense™ labeled products and the use of green infrastructure and low impact development approaches where feasible.

2.4.2 More frequent and intense droughts in central and western areas of Region 6

The use of existing programs and tools will be expanded to accomplish priority goals in this arena. Priority actions will include: set goals for enhancing water conservation in new Regional

Office space; building upon the existing Region 6 web page devoted to the topic of drought; promoting and expanding the use of tools such as Climate Ready Utilities and programs such as WaterSense™, Sustainable Communities, Green Infrastructure, and Healthy Watersheds leveraging and assisting states in using existing funding vehicles to support green infrastructure, such as SRF, Green Project Reserve, and Clean Water Act Section 319 grants.

Expanded training for Water Quality Protection Division and Environmental Justice-Tribal Affairs staff would focus on the increased pressures on agriculture, urban and rural residents, and the power generation industry. While this would focus on water availability, increased water quality concerns would also be part of this training, which would seek alternative ways to conserve, reuse, and process water. Management Division staff would receive training in implications for Regional facilities from increased droughts and water availability. In conjunction with Executive Orders 13514 and 13423, Management Division staff should consider enhanced water conservation measures. Multimedia Planning and Permitting Division staff should receive training to educate them about the role of intense and more frequent droughts and increased wildfires on regulatory programs such as the Regional Haze Program and achieving the Particulate Matter National Ambient Air Quality Standard (NAAQS).

2.4.3 Increase in extreme precipitation events

Given the intensive efforts in responding to hurricanes such as Katrina in 2005, the Region is very aware of the magnitude of labor and resources required to respond to major natural disasters. Because a climate change-forced future is likely to encourage stronger and perhaps more numerous hurricanes striking Louisiana and Texas, the Region's Emergency Response Branch in the Superfund Division will probably be even more active in this arena. Training for these staff is necessary to prepare them for this likely increase in effort, emphasizing opportunities for even more efficient operations; this training may also reveal a need for additional personnel or contractor capability.

Beyond training, the recent events from Hurricane Sandy in the northeast U.S. reveal a critical need for sufficient, uninterruptible power supplies, particularly critical for emergency responders. In the future, with electricity grids perhaps chronically weakened and stressed by the long-term effects of climate change, the demands of natural disasters such as major hurricanes may be significantly more challenging and long-lasting to electricity generation and transmission infrastructure. The same kinds of pressures can result from increased non-hurricane flooding. Therefore, Region 6 believes its Emergency Response Branch should be equipped with distributed generation equipment to produce the electricity it will need to ensure that power is supplied to field operations. Further analysis would be needed to determine the optimal mix of power modes (e.g., solar, wind, fuel cell, others). This infrastructure priority would require a dedicated budget commitment, one that would likely require negotiations between the Region and headquarters.

The Water Quality Protection Division and the Office of Environmental Justice and Tribal Affairs staffs would benefit from supplemental training, emphasizing the special anticipated needs for citizens increasingly impacted by flooding events, as well as temporary infrastructure dislocations (e.g., waste water treatment plans and water distribution systems).

2.4.4 Seasonal weather shifts

Water quality and quantity issues will drive adaptations that Region 6 staff should anticipate and to which the Region will conform policies and procedures. Priorities will be placed on working with state partners to explore existing infrastructure funding such as SRF to enhance resiliency, promoting watershed planning tools to address the loss of natural storage and to better absorb flashy runoff.

Promoting the use of EPA developed software tools among water utility groups such as Climate Ready Utilities and CREAT 2.0 software will enhance climate adaptation planning in this sector. Additionally, training of Regional Water Quality Protection Division and Multimedia Planning and Permitting Division staff members is a goal. Pesticides staff in the Multimedia Planning and Permitting Division should be trained to anticipate new and expanded pest and weed problems that will endanger public, agricultural, and natural flora and fauna health.

2.4.5 Increasing rates of relative sea level rise and continued coastal land loss

Sea level rise and coastal land loss have long been significant problems in Region 6. The Ecosystem Protection Branch will look for increased efficiencies in working with federal, state, and local partners with a goal of optimizing ongoing efforts to restore, protect, and enhance coastal habitats. The three Region 6 National Estuary Programs and the Coastal Wetland Planning, Protection and Restoration Act program will lead the charge and efforts will be made to improve the effectiveness of the limited resources available. Numerous other coastal protection programs will play a role and additional ways to better integrate them into other Regional programs will be evaluated.

Emerging priorities will involve providing technical and planning support for efforts such as the Gulf Ecosystem Restoration Task Force, the Gulf Ecosystem Restoration Council, the Gulf of Mexico Regional Planning Body as part of the National Ocean Council, and the Gulf of Mexico Alliance. Climate change adaptation goals will be addressed by establishing, refining, or expanding coastal restoration priorities.

Promoting the use of EPA developed tools, such as Climate Ready Estuaries software, among key stakeholders involved in protecting and restoring coastal environments will enhance climate adaptation planning. Internally, training to better familiarize Region 6 staff with long-term implications of sea level rise on “core programs” could be accelerated. Staff of the Water Quality Protection Division, the Office of Environmental Justice and Tribal Affairs, and the Superfund Division would be the main recipients of the training.

2.4.6 Outreach, Partnerships, Communication, and Awareness

Beyond those actions described the Region plans to enhance our outreach, partnership, and communication efforts. One of the top priorities would be to meet regularly with tribes, states, and other government entities about anticipated climate change impacts and adaptation challenges.

The Region has initiated this process by sponsoring specific climate change discussion sessions at the 2011 and 2012 Annual Tribal Environmental Summits, by convening the first Sustainable Practices Symposium for local elected officials in the Dallas-Fort Worth area in August 2012 (including anticipated climate change impacts and adaptation options), and by

hosting a climate change roundtable with agencies from Region 6 states in July 2008. The Region has sponsored numerous other specialized workshops.

In the future, the Region proposes to continue holding climate change sessions at the Annual Tribal Environmental Summits, sponsor climate change listening sessions at Regional Tribal Operation Committee meetings, speak to individual tribes about climate change, support sustainable practice/climate change workshops for local elected officials in the Region, and schedule at least annual meetings with critical agencies of governments in each Region 6 state. The Region will also continue its actions to encourage climate change mitigation and adaptation through approximately 30 national and regionally-initiated partnership programs.

Region 6 will also maintain close communications with state, local and tribal governments, non-governmental organizations, colleges and universities, the private sector, other federal agencies, and other EPA offices in order to properly sense and assess indicators of climate change in the Region. This process will help inform the Region as to next specific steps to take in coping with climate change.

Part 3: Measuring and Evaluating Performance

An important facet of both the priority actions relating to Regional vulnerabilities and those involving outreach, partnerships, and communication will be performance measurement and evaluation. To this end the Region plans to develop a methodology to assess its effectiveness in accomplishing specific priority actions that grow from this Regional Implementation Plan.

3.1 Background

The EPA Climate Change Adaptation Plan emphasizes the need for measuring and evaluating performance so that climate change adaptation is successfully integrated into the Agency's operations. The agency-wide FY 2014-2018 Strategic Measures address this need by including three such metrics. These include measures to integrate climate change science into at least five rule-making processes; to integrate climate change adaptation impacts and measures into at least five major grants, loans, contracts or technical assistance programs; and to integrate such science into at least five major models and/or decision-support tools.

EPA understands the transition will be a gradual one as we strive to account for projected climate change impacts into day-to-day operations. As the national Climate Change Adaptation Plan states:

> EPA recognizes that the integration of climate adaptation planning into its programs, policies, rules, and operations will occur over time. This change will happen in stages and measures should reflect this evolution. The earliest changes in many programs will be changes in knowledge and awareness (*e.g.,* increase in the awareness of EPA staff and their external partners of the relevance of adaptation planning to their programs). Building on this knowledge, they then will begin to change their behavior (*e.g.,* increase their use of available decision support tools to integrate adaptation planning into their work). As programs mature, there will be evidence of more projects implemented as a result of increased attention to climate-related programmatic issues. Finally, in the long-term, adaptation planning efforts will lead to changes in condition (*e.g.,* percentage of flood-prone communities that have increased their resilience to

storm events) to directly support EPA's mission to protect human health and the environment (U.S. EPA, 2012d).

3.2 Approach to Measuring and Evaluating Performance

Region 6 employs several tracking mechanisms to measure and evaluate performance of internal operations and programmatic activities and outcomes during the year, many of which relate directly to climate change adaptation. Each year, the Region is active in setting commitments, monitoring progress and reporting results under the various National Program Managers (NPM) Guidance documents issued by EPA program offices. In addition, Region 6 develops and reports semiannually on an Annual Plan designed to track additional measures either not covered or sufficiently emphasized in the NPM guidance. The Annual Plan showcases regional accomplishments in important program sectors and geographic and ecological regions that uniquely characterize the priorities and challenges faced by Region 6. The Region also tracks a variety of progress indicators under its Environmental Management System. As shown in Appendix A, Regional involvement in developing and reporting progress on climate adaptation and mitigation related initiatives is part of a cross division, multimedia reporting and tracking effort. Moreover, the Region recently began hosting what will become an annual "Earthapalooza" event which will serve as an Internal Educational Forum for Region 6 Employees to better acquaint them on climate change and sustainability topics (also presented in Appendix A). Another tracking mechanism for measuring and evaluating climate adaptation related progress involves the Region's Clean Energy and Climate Change (CECC) workgroup. Initially charged with developing a CECC strategic plan which was completed in 2008, the workgroup reports annually on progress made in furthering the goals and objectives outlined in the strategy, many of which relate to climate adaptation efforts.

The Region will continue to evaluate our operations and the dynamic needs of our customers in the midst of a changing climate. This will be an adaptive process in order to constantly identify any additional Regional priority actions that might be necessary. We will engage in ongoing communications with state, local, and tribal governments; non-governmental organizations; colleges and universities; the private sector; other federal agencies; and other EPA offices in order to properly sense and assess indicators of climate change in the Region. This process will help inform the Region as to next specific steps to take in coping with climate change.

3.3 Measures

As Table 1 indicates, Region 6 priority adaptation actions in response to climate change constitute significant amounts of personnel training. Most Divisions will require such training first to evaluate the climate change impacts from the perspective of the various environmental programs and then to evaluate the means with which the Region can best address the impacts. Aside from program specific training, the Region will commit to holding at least one annual training event on climate adaptation such as the "Earthapalooza" event to ensure employees are aware of the issue and opportunities on how to integrate adaptation into their daily work.

As part of implementing this plan, Region 6 will also develop a specific list of needed programmatic training courses and a schedule for delivery. We will establish a roster of Regional personnel that should receive this training and develop a post-training assessment survey to determine the effectiveness of the training. Deficiencies in knowledge acquisition will

be addressed through training revisions and/or course repetition. This training will be subject to the availability of sufficient resources.

Beyond the Region's training efforts, several priority actions relate to the operation of Regional office space, as reflected in the Regional Environmental Management System. These include evaluating alternatives for electricity, energy efficiency, water, and distributed generation infrastructure. Currently, it is not possible to measure these parameters given the way our leased space meters electrical and water use. Should alternatives that would allow these metrics to be tracked become available in the future, the Region will track electricity, energy, and water use in its office and laboratory space, comparing these totals against those totals prior to such improvements. In the case of any future acquisition of distributed generation equipment for use in Regional Emergency Response actions, the Region will investigate the feasibility of tracking the specific activities that required such power use and the amount of power produced and used in the field. It will also assess the overall value in deploying these types of units.

Additional programmatic metrics that will be tracked and reported on under this Implementation Plan include the following initiatives (with the Region 6 project lead given in parentheses):

1. Provide training for staff and managers on climate change and adaptive measures;
2. Expand Partnerships with stakeholders to leverage their support with climate change implementation efforts (6PD, 6SF, 6WQ);
3. Distribute Information on Availability of Assistance Agreements (e.g., grants) to stakeholders facilitate climate change adaptation planning and implementation (6WQ, 6MD);
4. Provide technical assistance to tribes and environmental justice communities on the development of climate change implementation plans (6PD, 6WQ);
5. Promote the use of tools such as Climate Ready Utilities and Climate Ready Estuaries among states, tribes and stakeholder groups (6WQ);
6. Promote energy efficiency at water utilities through a series of workshops, focusing on the US-Mexico Border area (6WQ);
7. Continue to require that 10% Regional Drinking Water and Clean Water State revolving fund programs support green projects (6WQ);
8. Meet with Tribal and Environmental Justice communities at least once a year to provide training on climate science and adaptation opportunities and practices (6PD, 6WQ);
9. Recruit 30 additional WaterSense™ partners each year as part of a Regional water efficiency and conservation campaign (6WQ);
10. Seek opportunities in permitting, compliance assistance and enforcement actions, remediation and site redevelopment options, as well as funding programs to further expand green infrastructure, low impact development, and other sustainable practices (Region 6);
11. Participate in outreach and pilot projects with states, local governments, tribes, non-governmental organizations, and the private sector focused on implementation of low-impact development (e.g., with the Texas Land-Water Sustainability Forum) (6PD);
12. Restore coastal habitat and reduce coastal land loss. Region 6 will work with a variety of partners and through several different programs to promote the development of scientific models, multi-use planning efforts, and implementation projects for coastal Louisiana and Texas. Working through the Barataria-Terrebonne National Estuary Program, the Coastal Bend Bays and Estuaries Program, the Galveston Bay Estuary

Program, and the Coastal Wetlands Planning, Protection and Restoration Act Program we will track and report on progress in terms of the number of acres restored, protected, or enhanced per year, with a current goal of at least 3,000 acres per year (6WQ);

13. Work with EPA headquarters to evaluate what, if any, specific Regional actions may be appropriate to include in the Agency's pilot rule-making processes; grants, loans, contracts or technical assistance programs; or scientific models or decision-support tools (Region 6);
14. Brownfields Cleanup and RLF recipients must meet the new term and condition which requires them to consider changing climate conditions when evaluating remedial options at a brownfields property. For Region 6, this new Term and Condition will apply to the following grantees: FY13: three cleanup and five RLF grantees; FY14: one cleanup and four RLF grantees (6SF);
15. The Region 6 Superfund Division has launched the "Greenovations" and "Green Bean" Awards. Both awards recognize outstanding efforts in sustainability, including promoting the utilization or production of renewable energy at Superfund sites. In May 2014, the Superfund Division awarded its first Greenovations Award to Waste Management of Oklahoma for an innovative alternative energy production project, a methane gas to liquids (diesel, paraffin wax, etc.), at a Superfund site in Oklahoma City. The Region 6 Superfund Division will present at least one of these awards annually (6SF).
16. Meet with State Agricultural Directors to discuss the President's Climate Change Management Plan and Adaptation practices;
17. Revise and finalize Region 6 Climate Change Adaptation Implementation Plan based on public comments;
18. Revise Region 6 climate change web page to expand coverage on adaptation planning;
19. Hold two climate adaptation workshops for environmental justice and tribal communities;
20. Pilot test a training module on climate adaptation for the Office of Policy;
21. Hold a climate adaptation and emergency planning and response workshop in New Orleans; and
22. Work in partnership with the Department of Transportation, the Middle Rio Grande Council of Governments, and other federal and state agencies to develop a climate change planning scenario project that identifies the benefits of adaptive practices for transportation and other infrastructure choices in light of a changing climate.

These measures will be tracked and reported on annually. In addition, the measures will be reviewed regularly and revised as needed to include new initiatives to promote climate adaptation. Higher priority measures that will receive particular focus during the next three years are presented in the text box below:

By 2016, EPA Region 6 will strive to:

1. Train all staff and managers on climate change adaptation;
2. Provide five climate adaptation workshops to Region 6 tribal and environmental justice communities;
3. Recruit 100 new WaterSense™ partners;
4. Expand the Region's extreme weather and natural disaster emergency planning and response capabilities;
5. Improve technical information transfer to state and tribes on climate science and adaptive measures by updates to our climate change website;
6. Require that at least 10% of Regional Clean Water and Drinking Water state revolving fund awards support green projects;
7. Hold three energy efficiency workshops at water utilities;
8. Protect or restore 9,000 acres of coastal wetlands;
9. Begin an annual "Greenovations" award program to recognize outstanding efforts in sustainability; and
10. Reach out to state environmental and agricultural directors to discuss the President's Climate Change Management Plan and Adaptation Measures.

3.4 Greening Assistance Agreements

In addition to the performance measures and tracking noted above, EPA Region 6 will identify opportunities to promote climate resilient investments in keeping with directives to federal agencies such as Executive Order 13653. While the draft Climate Change Adaptation Implementation Plan does not mandate any funding requirements in grant programs, EPA Region 6 will follow Executive Order 13653 relating to grants, which specifically directs federal agencies to:

(i) identify and seek to remove or reform barriers that discourage investments or other actions to increase the Nation's resilience to climate change while ensuring continued protection of public health and the environment;
(ii) reform policies and Federal funding programs that may, perhaps unintentionally, increase the vulnerability of natural or built systems, economic sectors, natural resources, or communities to climate change related risks;
(iii) identify opportunities to support and encourage smarter, more climate resilient investments by States, local communities, and tribes, including by providing incentives through agency guidance, grants, technical assistance, performance measures, safety considerations, and other programs, including in the context of infrastructure development; and
(iv) report on their progress in achieving the requirements identified above, including accomplished and planned milestones, in the Agency Adaptation Plans, developed in response to of Executive Order 13514, which calls for all Federal Agencies to develop a plan on how they will address climate change adaptation.

EPA Region 6 further notes that existing grant programs such as the CWA 319 program, and the DW and CWSRF programs can and have been used to support climate adaptation related activities such as green infrastructure projects, low impact development projects, green roof projects, as well as energy and water efficiency projects to name a few.

Part 4: Working with Tribes and Other Sensitive Populations

Two fundamental priorities of the National Climate Change Adaptation Plan involve working with tribes to improve their adaptation capacity and focusing on the most vulnerable peoples and places. Many climate change strategy documents conclude that tribal and other vulnerable populations will be the hardest hit by changes in climate because they rely on the land for subsistence and may be less able to readily adapt due to a lack of resources. The Region 6 Implementation Plan aims to improve and expand communications, training, and other outreach efforts with these groups to enable them to better adapt to climate change impacts.

4.1 Partnerships with Tribes

EPA values its unique government-to-government relationship with Indian 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* and the *2011 Policy on Consultation and Coordination with Indian Tribes*. These policies recognize and support the sovereign decision-making authority of tribal governments.

Supporting the development of adaptive capacity among tribes is a priority for the EPA. Tribes are particularly vulnerable to the impacts of climate change due to the integral nature of the environment within their traditional culture. There is a strong need to develop adaptation strategies that promote sustainability and reduce the impact of climate change on Indian tribes.

EPA engaged tribes through a formal consultation process in the development of the Agency's *Climate Change Adaptation Plan*. Tribes identified some of the most pressing issues as erosion, temperature change, drought and various changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. At the same time, tribes challenged EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative burdens are reduced.

This Implementation Plan identifies specific steps that will be taken to partner with tribal governments on an ongoing basis to increase their adaptive capacity and address their adaptation-related priorities. These collaborative efforts will benefit from the expertise provided by our tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change and has been used by tribes for millennia as a valuable tool to adapt to changing surroundings. Consistent with the principles in the 1984 Indian Policy, TEK is viewed as a complementary resource that can inform planning and decision-making.

Networks and partnerships already in place will be used to assist tribes with climate change issues, including Regional Tribal Operations Committees, the Institute for Tribal Environmental Professionals and the Indian General Assistance Program (IGAP). Additionally, efforts will be made to coordinate with other Regional and Program Offices in EPA, since climate change has

many impacts that transcend media and regional boundaries. Transparency and information sharing will be a focus, in order to leverage activities already taking place within EPA Offices and tribal governments.

4.1.1 Building Tribal Adaptive Capacity

Sixty-six federally recognized tribes are located in Region 6. Consistent with tribal sovereignty, Region 6 partners with these tribes on a government to government basis to strengthen our relationships so we are better able to fulfill our mission of protecting human health and the environment for all Region 6 residents. Tribal communities will potentially experience disproportionate impacts of climate change because of their reliance on natural resources, which support subsistence hunting, fishing, recreational and other important cultural practices. Moreover, a general lack of resources to implement adaptation measures will further compound climate change impacts. In response, Region 6 announced at the Spring Regional Tribal Operations Council meeting in Tulsa (April 3, 2013) the formation of a Region 6 Tribal Climate Change Adaptation Planning Workgroup. The purpose of the workgroup is to form a community of practice among EPA Region 6 and its tribal communities to assist in the development of climate adaptation plans. The objectives are:

1) Create a network of professionals to help inform the development of adaptation plans for Tribal communities;
2) Share scientific information, TEK, grant opportunities, adaptation tools, best practices, and success stories;
3) Provide tribes with guidance and feedback from EPA as they develop their adaptation plans; and
4) Replicate effective adaptation planning efforts.

EPA Region 6 will also partner with the South Central Climate Center (Norman, Oklahoma) and other federal agencies to deliver information and training and to announce the availability of grants, tools and pertinent resources to support adaptation activities.

4.2 Focusing on the Most Vulnerable People and Places

Certain parts of the population, such as children, the elderly, minorities and the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society.

This Implementation 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 Plan is conducted, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events, especially those that have impacted the Gulf coast of Louisiana and Texas (*e.g.,* Hurricanes Katrina, Rita, Ike, and Gustav.) and the subsequent recovery efforts.

Direct impacts on the vulnerable groups in areas experiencing rapid climate change may include not only changes in ecosystem function and production, but also human health impacts such as increased illnesses, injuries and deaths from heat waves, extreme weather events, flooding, and wildfires, as well as respiratory illnesses caused by deteriorations in air quality. Indirect health impacts could include illnesses and deaths that may arise from climate-related changes in ecosystems, migration of infectious agents and disease vectors, or reductions in agricultural and livestock production. Through the Office of Environmental Justice and Tribal Affairs and other program offices, EPA Region 6 will strive to build the adaptive capacity of populations in all areas of the region, but in particular those residing in the most vulnerable places.

In Region 6, people living in areas along the U.S.-Mexico Border and along coastal Louisiana are perhaps among the most vulnerable to climate change effects. Along the border, increases in ambient air temperatures, reduced air and water quality, drought, and the threat of wildfires represent perhaps the greatest climate change impacts. These stressors heighten the importance of a strategic management of water resources, rangelands, and air quality, which remain a critical part of the Region's environmental protection goals along the border.

Ecosystems in coastal Louisiana are already experiencing many stressors that threaten a way of life for people living in this area. Some of these include the loss of habitat and alterations in ecosystem functions due to factors such as land subsidence, eustatic sea level rise, saltwater intrusion, coastal development, habitat fragmentation, hydrologic and landscape modifications resulting from canals and levees, water and air pollution, and declining fishery resources. All of these can be compounded, if not accelerated, by climate change effects. Moreover, increased storm intensity for the area profoundly threaten human health and alter ecosystems, as evidenced by recent hurricanes Katrina, Rita, Gustav, and Ike.

Region 6 program staff and managers will continue to work with within existing networks such as the Region 6 U.S. Mexico Border Program Office, the Mexican Government, the Border Environmental Cooperation Commission and the North American Development Bank in the U.S. Mexico Border area, and with the Gulf of Mexico Program Office, the State of Louisiana and related coastal conservation and protection agencies to ensure they possess the adaptive capacity to integrate climate change considerations into existing programs, policies, operations, and funding considerations. Adaptive capacity will be strengthened through outreach and educational efforts, funding opportunities relating to climate adaptation, and the delivery of climate adaptation tools such as Climate Ready Utilities and Climate Ready Estuaries. In addition, Region 6 will continue to promote the Agency's water utility energy efficiency and WaterSense programs to further strengthen adaptation activities while introducing mitigation elements at the same time.

Part 5: Conclusions

Region 6 faces significant planning and implementation challenges as climate change occurs in the 21st century and will practice an overall anticipatory philosophy regarding climate change adaptation planning. As noted in the NCA3, climate change is happening now and the time to adapt is now. This Regional Implementation Plan has identified internal priority actions including infrastructure enhancement and training, which stem from five major identified climate change vulnerabilities. Externally, the Region has identified technical assistance efforts with a variety of partners, as well as enhanced outreach and communication to be important

priority actions to fully address those vulnerabilities. Measuring and evaluating new priority actions and ongoing adaptation initiatives will be important in gauging Regional effectiveness in fulfilling our mission. This Regional Implementation Plan is certainly not an endpoint. It is intended to be the first version of a plan that will change and mature as the Region's knowledge of, and experience with, climate change adaptation grows. The Region's most important goal remains to serve all its stakeholders in the most efficient and thorough means possible, even as climate changes.

Figures and Tables

Figure 1 – EPA-Region 6 Program Organization

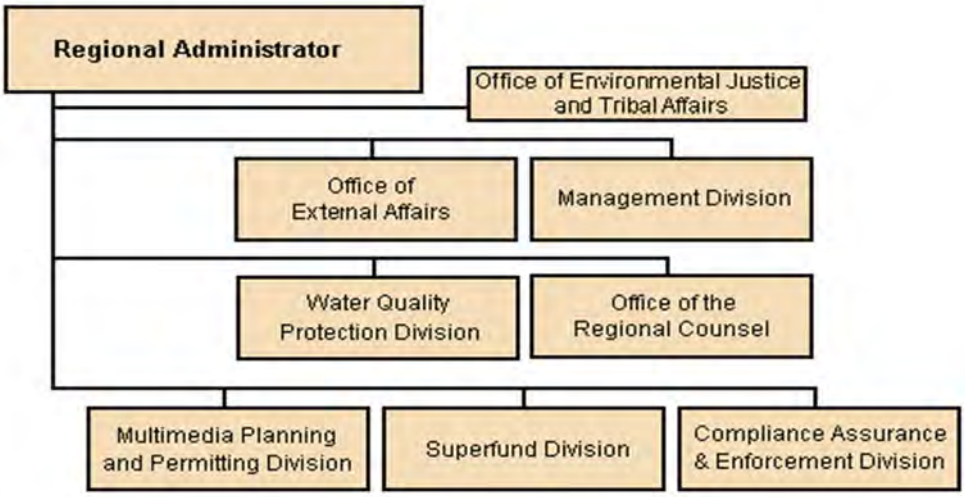

Table 1

EPA Region 6 Climate Change Vulnerabilities & Priority Actions

Anticipated Impacts	Consequences	Involved Programs	Priority Actions
A. Higher mean temperatures, with more frequent and intense summer "heat waves" (NCA3, 2014)	Higher O3 and other criteria air pollutants with increased difficulty in attaining health standards (Chang et al., 2010); Increased health risks from "heat island" impacts (Portier, et al., 2010);;	Multimedia Planning and Permitting Division; Management Division (facilities); Office of Environmental Justice and Tribal Affairs	Evaluate the potential for using distributed generation electricity & energy efficiency infrastructure enhancements in new Regional office space and energy infrastructure improvements to existing office space, contingent upon budget & GSA considerations; Training for Air, Pesticides, Environmental Justice/Tribal Affairs, and Management Division staff.
B. More frequent and intense droughts in central and western part of Region 6	Reduced agricultural yields; decreased power plant cooling capabilities; consumer rationing; decreased industrial water availability; more wildfires; increased blowing dust	Water Quality Protection Division; Management Division (facilities); Office of Environmental Justice and Tribal Affairs; Multimedia Planning and Permitting Div.	Evaluate the possibilities for enhancing water conservation in new Regional Office space; Build upon the existing Region 6 web page devoted to the topic of drought; promote tools such as Climate Ready Utilities and programs such as Water Sense, Sustainable Communities, Green Infrastructure, and Healthy Watersheds; Leverage and assist states in using existing funding vehicles to support green infrastructure, such as SRF, Green Project Reserve, and Clean Water Act Section 319 grants; Training for Water Quality Protection Division, Environmental Justice/Tribal Affairs, and Management Division staff.
C. Increase in extreme precipitation events	More extensive flooding and wind damage from hurricanes; increased stormwater runoff and flashfloods from other extreme weather events	Superfund Division; Water Quality Protection Division; Office of Environmental Justice and Tribal Affairs	Enhance emergency response capabilities for these types of events; Enhance the capabilities of the Center of Excellence for quickly getting water and wastewater facilities back on line following these events; Provide technical assistance for coastal habitat restoration and protection through such venues as the Urban Waters Initiative, three NEPs and CWPPRA; Provide technical assistance in watershed protection and planning through the 319 and CZARA programs in order to enhance flood water retention; Training for staff in Superfund and Emergency Response Branch, Water Quality Protection Division, and Environmental Justice/Tribal Affairs.

D. Seasonal weather shifts	High-country snow melt earlier in spring, with early floods and summer water deficits downstream; increased pests and non-native noxious weeds with longer warm-season periods	Multimedia Planning and Permitting Division; Water Quality Protection Division	Explore existing infrastructure funding such as SRF to enhance resiliency; Promote watershed planning tools to address the loss of natural storage and to better absorb flashy runoff; Training for Water Quality Protection Division and Pesticides Section staff
E. Increasing rates of relative sea level rise and continued coastal land loss	Accelerated loss and degradation of estuarine habitats, barrier islands, and shorelines in Louisiana and Texas; Increase in inland floods from coastal storms, local precipitation, and upstream flooding in major river systems	Water Quality Protection Division; Office of Environmental Justice and Tribal Affairs; Superfund Division	Provide technical and planning support for the Gulf Ecosystem Restoration Task Force, Gulf Ecosystem Restoration Council, National Ocean Policy, and Gulf of Mexico Alliance to establish restoration priorities; Develop and implement restoration projects through three National Estuary Programs, Climate Ready Estuaries Program, and CWPPRA; Training for staff in Superfund and Emergency Response, Water Quality Protection Division, and Environmental Justice/Tribal Affairs.

Table 2

Current Climate Change Partnerships

Lead Region 6 Division	Program
Multimedia Planning and Permitting Division	Ozone Advance, Energy Star, Federal Green Challenge, Landfill Methane Outreach Program, Repowering America, North Central Texas Environmental Stewardship Forum, Blue Skyways Collaborative, WasteWise, Urban Heat Island Mitigation, Energy Efficiency-Renewable Energy in SIPs, promoting ecological enhancements at RCRA sites
Water Quality Protection Division	WaterSense, Green Infrastructure, HUD-DOT-EPA Partnership for Sustainable Communities, National Estuary Program, Climate Ready Water Utilities Program, CWPPRA, National Ocean Council, Gulf Ecosystem Restoration Task Force and Council, Gulf of Mexico Program, Gulf Alliance, Gulf Tribal Climate Adaptation Advisory Workgroup
Management Division	Regional Environmental Management System, E.O. 13514 and 13423 compliance
Superfund Division	Superfund and Brownfields projects utilizing renewable energy
Office of Environmental Justice and Tribal Affairs	Environmental Justice Showcase Communities
Enforcement and Compliance Assurance Division	Partnering with Office of Regional Counsel to fulfill regulatory responsibilities while optimizing responses to climate change-forced water and air compliance issues
Office of Regional Counsel	Continuing coordination with R6 program offices to map out appropriate climate change adaptation support while ensuring regulatory fidelity

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Appendix

Copy of All Hands Memo Announcing Regional Involvement in Climate Adaptation and Mitigation Related Initiatives and the Announcement of "Earthapalooza" which will serve as an Internal Educational Forum for Region 6 Employees

This is being sent as R6 All Employee Memo - Please do not reply to this mass mailing
This memo and all Region 6 "All Employee Memos" may be viewed on the Region 6 Intranet
****
NO HARD COPY TO FOLLOW

April 4, 2013

MEMORANDUM

SUBJECT: How EPA Region 6 is Working to Achieve Better Environmental Practices

FROM: Ronnie Crossland */s/ Ronnie Crossland*
Acting Assistant Regional Administrator
for Management

TO: All EPA Region 6 Employees/SEEs/Contractors

As Earth Day approaches, I want to take this opportunity to highlight some of the exciting ways EPA Region 6 is working to achieve better environmental practices, and how we as individuals can each contribute. EPA is leading a change in how our society protects the environment and conserves resources for future generations by encouraging Americans to rethink the way we manage our resources. Not only are we taking steps within our own organization to reduce our environmental footprint through the hard work of our Environmental Management System Team, but we are also challenging other agencies, organizations, and municipalities to do the same through EPA's Sustainable Materials Management Program; exploring ways to "green" sports events and venues as part of EPA's Green Sports workgroup; and engaging in a pilot climate change mitigation initiative.

Below are highlights of these programs and what you can do to help.

Sustainable Materials Management (SMM) Programs:

The SMM Programs provide opportunities for businesses, universities and government entities to increase efficiency, reduce waste, and gain recognition for protecting human health and the environment. There are three SMM programs:

• *Food Recovery Challenge* (FRC) – Grocers, universities, stadiums, and other venues commit to a three-year goal for reducing the amount of food reaching landfills by learning to purchase leaner and divert food away from landfills for better uses. We currently have 143 participants signed on to the challenge and collectively diverted 71,521 tons of food from landfills in 2011.

Contact: Golam Mustafa

• *Electronics Challenge* (FEC) – Electronics manufacturers and retailers who become a partner of the Electronics Challenge commit to sending all their collected electronics to only certified electronics recyclers. Certification seeks to ensure environmental excellence in managing used electronics. EPA Region 6 has also lead by example by achieving the Federal Electronics Challenge Platinum award for ensuring environmental excellence in the way we purchase, use, and dispose of federally owned electronics.

Contact: Stephen Sturdivant

• *Federal Green Challenge* (FGC) – Federal Agencies commit to lead by example by reducing their facilities' environmental impact and save money in two of six areas: waste, purchasing, electronics, energy, water and transportation. We currently have 29 facilities representing 12 different federal agencies signed up as participants, including the EPA Region 6 facilities.

Contact: Joyce Stubblefield

Environmental Management System (EMS) Team:

The EMS team is a group of representatives from each division working towards encouraging improvement in EPA Region 6's designated Significant Environmental Aspects: Electricity Use, Vehicle Emissions and Fuel Use, Waste Reduction and Recycling, Electronics Stewardship and Green Purchasing. Along with a focus on the Significant Environmental Aspects, the EMS team helps Region 6 meet SMM program commitments. Through the EMS team:

• Our goal of 5% paper reduction each FY has been exceeded, FY 2012 being the best year by far
• The next big focus in our Regional Office will be green purchasing
• Region 6 joined the FGC, reducing their environmental impact in purchasing and electronics

Climate Change:

The Region's Clean Energy-Climate Change Workgroup, formed in 2008 with Divisional representatives, continues to track and report annually on climate change mitigation and adaptation activities in six sectors. These sectors include Greenhouse Gas Regulatory, Internal Conservation and Efficiency, Alternative and Renewable Energy and Green Remediation, Climate Change Adaptation, Sea Level Rise/Coastal Land Loss, and Greenhouse Gas Mitigation Partnerships. Many different activities which either directly or indirectly benefit climate stewardship are occurring throughout the Region and are captured within these sectors.

The Region is completing a Regional Climate Change Adaptation Implementation Plan, required by the Council on Environmental Quality. It will focus on assessing challenges to Regional operations from future climate change and taking steps to cope with these challenges. The Water Quality Protection Division and the Multimedia Planning and Permitting Division are taking the lead in drafting the plan,

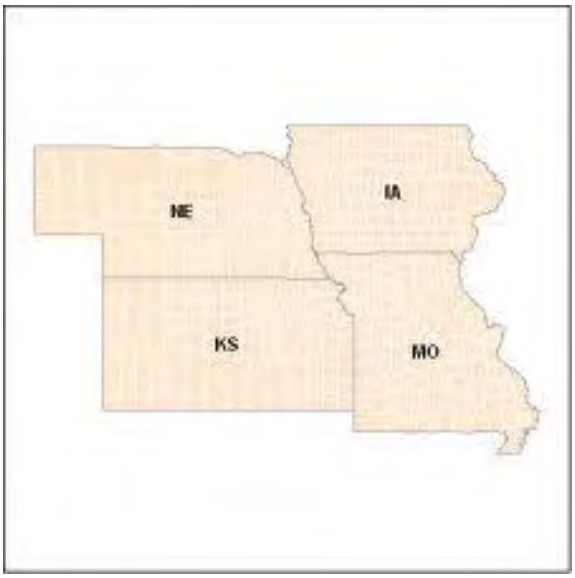
with input from the other Divisions. Also, the Multimedia Planning and Permitting Division is engaged in a pilot climate change mitigation initiative in 2013. This initiative focuses on encouraging voluntary greenhouse gas emissions from stationary/area sources and on accelerating the purchase of green power and installation of on-site renewable energy.

What can you do?

- Consider ways to reduce your food waste (Learn how to reduce food waste)
- Reduce paper usage by printing double sided or not printing at all
- Ensure electronic purchases are EPEAT certified and energy efficient options are enabled (EPEAT)
- Recycle all paper and #1 plastics
- Turn off equipment and lights when not in use
- Commute efficiently by utilizing public transportation, carpooling, walking or riding your bike when possible
- Participate in the EMS Team (contact Julia Alderete or David Bond for more information)

What's next?

- Come to the EarthApalooza open house on April 11 from 10 am – 2 pm in the 12th floor conference rooms to hear more about the SMM and EMS activities in Region 6
- Enjoy Earth Day themed movies the week of April 15



Region 7 Climate Change Adaptation Implementation Plan

Publication Number:
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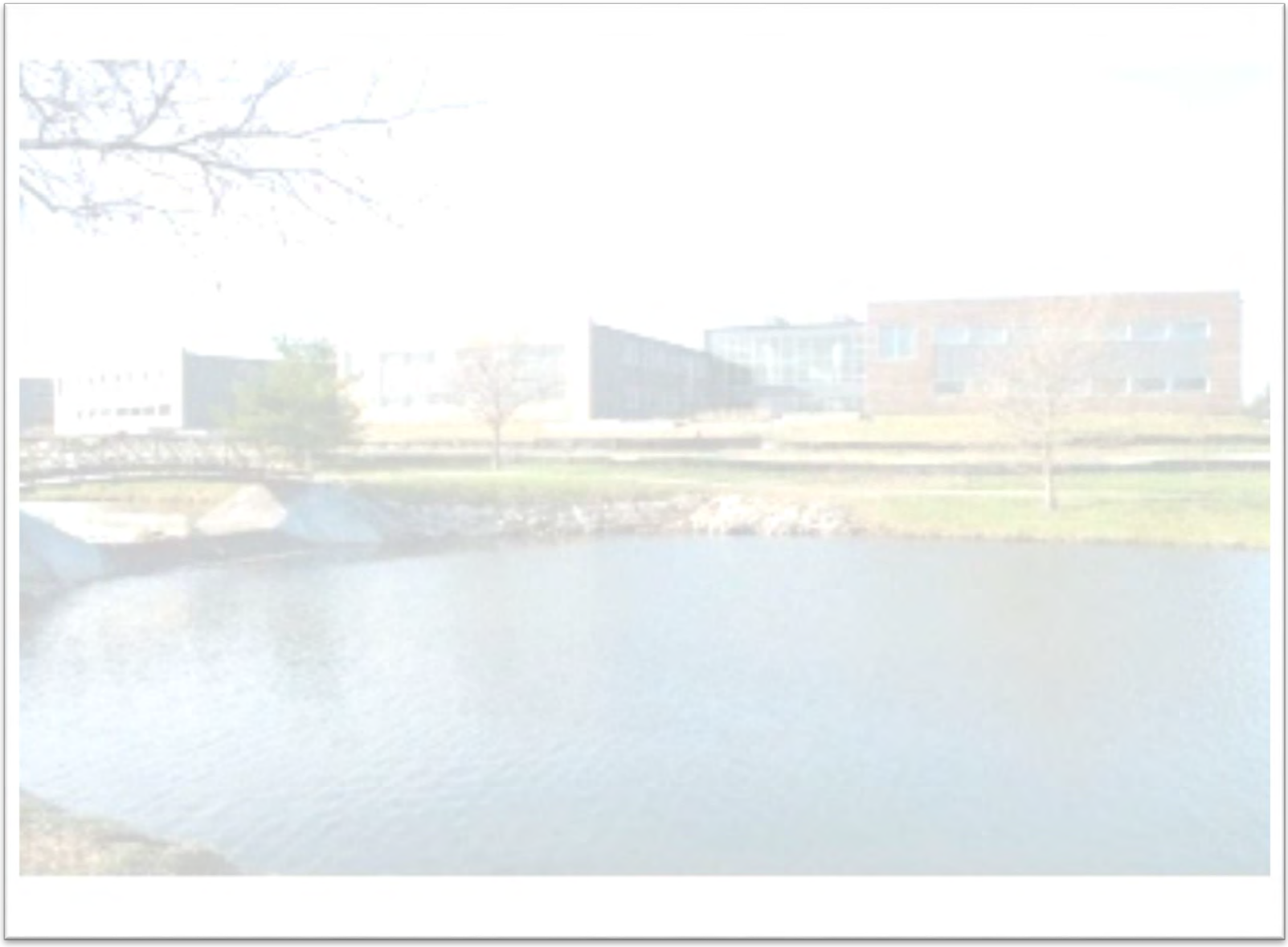

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Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Bob Perciasepe

Deputy Administrator

September 2013

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Appendix A: Descriptive Priority Action Matrix

Program Vulnerability Assessment

I. Background

This assessment contains a discussion of EPA Region 7 and the climate change impacts affecting the four-state region, as well as an examination of the risks they pose to key Region 7 Programs. It builds on the work presented in Part 2 of EPA's Agency-wide Plan, as well as the individual assessments completed by various Program Offices. It is structured by the goals in EPA's FY 2011-2015 Strategic Plan, and includes a table that summarizes the programmatic vulnerabilities discussed in the narrative. These goals include:

Goal 1: Taking Action on Climate Change and Improving Air Quality
Goal 2: Protecting America's Waters
Goal 3: Cleaning Up Communities and Advancing Sustainable Development
Goal 4: Ensuring the Safety of Chemical s and Preventing Pollution
Goal 5: Enforcing Environmental laws

Region 7 intends to fulfill its mission, despite the consequence of a changing climate. It will stay on course for meeting its goals, while building more resilient and climate-responsive programs. We will work with our partners to meet the challenges of climate change through frequent, effective coordination and decision-support.

II. Discussion of Climate Change Impacts in Region 7

Region 7 is located in the climate regions identified by the U.S. Global Change Research Program (GCRP): as the Great Plains and Midwest. The Region is bisected by the two climate regions along the state lines separating Nebraska from Iowa and Kansas from Missouri. The GCRP designates the states of Kansas and Nebraska as Great Plains, and the states of Iowa, and Missouri as the Midwest climate region.

EPA Region 7 is made up of two distinctly different sets of landscapes, as well as significant differences in population bases, and economic sectors making our response to climate change particularly challenging in its complexity. Our lands are managed by four states, nine tribal nations, and a host of federal agencies. These entities have diverse and often competing interests that include agriculture, energy development and production, environmental protection and stewardship, manufacturing, recreation, tourism, and commercial development. The roughly 13.8 million people in the region are concentrated in eight metropolitan areas including St. Louis, Kansas City, Des Moines, Wichita, Springfield, Omaha, Lincoln and Cedar Rapids. The remainder of the population is located in relatively isolated cities and towns often separated by large distances dominated by agricultural land-use.

The Intergovernmental Panel on Climate Change (IPCC), in its Fourth Assessment report in 2007[i], concluded that global warming due to human activities since 1750 is unequivocal. The report also indicates that climate variability and warming over the past century has already had measurable effects in the region, including increased temperatures, earlier timing of spring events, pole-ward and upward shifts in plant and animal ranges, drought, declining ecological health, heavy precipitation events, and habitat loss. One of the challenges in developing a climate change vulnerability assessment and priority actions is that the predictions (many of which are listed above) vary widely and so do the timeframes in which these impacts are predicted to occur. In the priority actions matrix, Region 7 briefly addresses and accounts for these variations. Nevertheless, climate change impacts are expected to intensify as greenhouse gases build up in the atmosphere, and continue to threaten our resources, agricultural, ecosystems and human health throughout the 21st century.

Because of the diversity and wide range of climate change impacts in Region 7, priority actions included in this are tailored to meet different needs based on eco-regions, other geographic considerations, population, economic activity, a specific impact, or a vulnerable population.
The following suite of climate change impacts and their affects on Region 7 Programs are discussed in the sections below. They may be discussed individually, or in combinations based on the focus of the Strategic Plan Goal under consideration.

1. Increased tropospheric ozone pollution
2. Increased concentrations of particulate matter in the air
3. Increased degradation of indoor air
4. Increasing extreme temperatures
5. Increasing heavy precipitation events
6. Increased water temperatures
7. Decreasing precipitation days and increasing drought intensity
8. Increasing risk of floods
9. Earlier timing of spring events - define
10. Increase in and changing mix of pests*

*Includes weeds, insects, mold, fungus, and disease

III. Region 7's Known Vulnerabilities to Climate Change Impacts

1. Goal 1: Taking Action on Climate Change and Improving Air Quality

A. **Tropospheric ozone pollution is likely to increase in certain regions due to the effects of climate change.** Tropospheric, or ground-level ozone, is created by photochemical reactions of short-lived pollutants in the atmosphere. Emissions from industrial facilities, electric utilities, motor vehicles, chemical solvents, controlled agricultural burning, and oil and gas production are some of the major sources of these pollutants in Region 7. High temperatures and regional air stagnation associated with climate change may lead to more ozone formation, even with the

same level of emissions. Some estimates have these changes occurring now. While tropospheric ozone is higher in urban areas, some rural areas with oil and gas production activities in Region 7 may also have high levels based on recent experiences in Region 8 regarding this industry. .[ii] Additionally, Region 7 has observed increased ozone as a result of prescribed burning of rangeland in advance of the growing season. Controlled burn events release volatile organic compounds, oxides of nitrogen and carbon monoxide at low altitudes. Controlled burning of agriculture and rangeland is applied in advance of the growing season to prepare the land for spring agriculture growth. As growing season shifts are an effect of climate change, the shift has the potential to lengthen the ozone season by increasing the months of the year when conditions are conducive to the formation of troposphere ozone. Vulnerable populations may be at a higher risk for health effects from exposure to ozone.

Increases in tropospheric ozone due to climate change may require greater pollution controls to attain or maintain the ozone National Ambient Air Quality Standard (NAAQS**).** Region 7 works with partners at state, local, and tribal levels to meet this standard through State Implementation Plans (SIPs) and other measures. These efforts may need to be adjusted as climate change progresses. Although Region 7's adaptive capacity with respect to this impact is dependent on national standard setting efforts, there are some points of leverage and voluntary actions that can be utilized.

B. **Particulate Matter (PM) levels (both fine and course) are likely to be affected through changes in frequency and intensity of wildfires, controlled burns and high winds.** There is evidence indicating that climate change will affect PM levels through changes in the frequency or intensity of wildfires, [iii] and the effects of drought on the land. The Intergovernmental Panel on Climate Change (IPCC) has reported with very high confidence that in North America, disturbances such as wildfires are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons. This could complicate EPA Region 7 efforts to protect public health and the environment from PM pollution. Vulnerable populations may be especially at risk from increased exposure to PM.

Certain areas of Region 7 utilize controlled burning of rangeland to reduce invasive vegetation and prepare the soil for new grass production for cattle grazing. Climate change has the potential to affect how prescribed burning is utilized in rangeland management necessitating changes in the timing of burning events to coincide with favorable conditions associated with precipitation, winds, temperature, and the spring growing season. Changes in climate will result in revised burning schedules and has the potential to impact air quality that effects vulnerable populations. Additionally, drought conditions associated with climate change can promote wind-borne dust or PM during high wind events. Wind-borne PM is principally associated with dry soil conditions and lack of adequate vegetative cover. Due to extensive agricultural activity in Region 7, the area is very susceptible to wind-borne PM in the early spring during the period between land preparation (tilling, fertilizing, and planting). During this period, the top soil is more susceptible to being distributed in the air during high wind events

and the problem is exacerbated if the soil is dry as a result of low precipitation or elevated temperatures which can be associated with climate change.

Region 7's adaptive capacity with respect to this impact may be limited. Increases in PM as a result of wildfires, controlled burns, and high winds may be considered "exceptional events," which are exempt from certain regulatory actions under the Clean Air Act and the National Ambient Air Quality Standards (NAAQS). Additionally, the challenge of fire mitigation and firefighting falls on national, regional, and local agencies with authorities peripheral of EPA's jurisdiction. However, there may be air monitoring or risk communication opportunities that the Region can utilize to assist other agencies in adapting to this impact."

C. **Climate change may worsen the quality of indoor air and increase exposure to contaminants.** Climate change may worsen existing indoor environmental problems, and introduce new ones due to temperature increases and an increased frequency or severity of extreme weather events. For example, warmer temperatures may affect the emergence, evolution and geographic ranges of pests, infectious agents and disease vectors[iv]. This may lead to shifting patterns of indoor exposure to pesticides as occupants and building owners respond to new infestations.[v] Additionally, heavy precipitation events may contribute to increases in indoor dampness and building deterioration, increasing occupants' exposure to mold and other biological contaminants, as well as emissions from building materials.

Residents may weatherize buildings to increase comfort and indoor environmental quality in addition to saving energy. Although in general these actions should be encouraged, this may lead to a reduction in ventilation and an increase in indoor environmental pollutants unless measures are taken to preserve or improve indoor air quality. EPA has developed practical guidance for improving or maintaining indoor environmental quality during home energy upgrades or remodeling in single-family homes and schools. EPA's guidance and protocols may need to be revised to include state and local considerations for projected climatic changes. In addition, these programs may need to increase partnerships with other agencies to address training needs and workforce development for building owners, managers, and others, as well as develop new tracking mechanisms to assess the effectiveness of weatherization and remodeling techniques as they relate to indoor environmental quality.

Residents may also spend more time indoors, and become more prone to health risks from indoor environmental conditions. Public health risks, particularly for vulnerable populations, may increase[vi]. For example, more people may be exposed to indoor air contaminants in homes in low-income areas because they have access to fewer resources to make adjustments to their dwellings, and because these homes tend to have greater occupant density.

Region 7 can utilize various EPA programs, tools, resources, and partnerships to adapt to this impact. For example, Region 7's Radon Program, Healthy Homes, and Healthy Schools initiatives are avenues through which public education could occur.

D. **Climate change may affect the response of ecosystems to the atmospheric deposition of sulfur, nitrogen, and mercury.** While there is limited scientific evidence on this topic, additional research is underway to better understand how patterns in the atmospheric deposition of sulfur, nitrogen, and mercury with projected changes in the climate and carbon cycle will affect ecosystem growth, species changes, surface water chemistry, and mercury methylation (a natural process which makes mercury biologically available to fish and humans) and bioaccumulation. The potential impacts could have consequences for the effectiveness of ecosystem protection from Region 7's emissions reduction programs.

Because of current fish consumption advisory programs[vii], there is already heightened awareness of the issue of mercury contamination in lakes, rivers and streams in Region 7. This may present an opportunity to adapt to the impact through partnerships and public education. Region 7 may want to provide additional educational focus for populations where subsistence fishing is pervasive.

2. <u>Goal 2: Protecting America's Waters</u>

A. **Climate change may affect EPA's ability to protect and restore watersheds, aquatic ecosystems and wetlands.** Warmer air temperatures will result in warmer water, potentially leading to low oxygen levels and hypoxia, harmful algal blooms, and changes in the toxicity of some pollutants. Aquatic life may be replaced by other species better adapted to the warmer water, and this process may occur at an uneven pace disrupting aquatic system health and allowing non-indigenous and/or invasive species to become established[viii]. Additionally, temperature increases may lead to water losses from increased evapotranspiration rates.

Heavier precipitation may increase flood risk, expand floodplain areas, increase the variability of stream flows, and increase erosion from high water velocity. An increase in storm event frequency and intensity can result in more nutrients, pathogens, and toxins being washed into water bodies, especially if they result in sewer overflows and wastewater bypasses.

Drought, changing patterns of precipitation, as well as increased evapotranspiration, may lead to reduced stream flow later in the summer, altering aquatic environments and increasing impairments. These impacts may also threaten certain aquatic ecosystems that are found the region, such as prairie potholes of Iowa, and floodplains of the Missouri and Mississippi Rivers, reducing the habitat they provide for plants and animals[ix].

These climate impacts may have adverse effects on Region 7's work to protect water quality, and the health of watersheds, aquatic ecosystems and wetlands. Additional water bodies may have trouble meeting water quality standards and may need to be listed as impaired. Nonpoint pollution control programs may need to be adjusted to reflect changing conditions. The scientific basis of water quality standard development and implementation could be threatened by shifting baselines. National Environmental Policy Act (NEPA) considerations may need to be

expanded to provide greater protections. Finally, the economic and cultural practices of tribal communities may be impacted.

These program vulnerabilities may require greater use of biological monitoring and assessment techniques, management techniques that build resilience into aquatic environments, and the management of wetlands for storm water control purposes and to buffer the impacts of drought. Region 7's adaptive capacity with respect to this impact is varied, and there may be numerous points of leverage and opportunities that can be explored.

B. **Drinking water, wastewater and storm water infrastructure may be affected.** Heavier precipitation may increase the risk of floods, expand floodplains, and cause more nutrients, pathogens, and toxins to be washed into water bodies[x]. This could damage or overwhelm water infrastructure, and lead to releases of waterborne diseases and pathogens. In urban areas, storm water collection and management systems may need to be redesigned to handle the increased capacity. Low stream flows due to drought, earlier spring runoff, reduction in snowpack (snowpack in the mountains and upstream effects summertime flows in rivers coursing across Region 7 including the Missouri River, both Platte Rivers, the Loup River, the Little Blue River and the Solomon River), and increased evapotranspiration may affect drinking water intakes and wastewater outfalls. Uncontrolled and controlled burning events also scorch soils, leading to more runoff and erosion. Drinking water and wastewater utilities will need to consider these climate change impacts and the concept of non-stationary[xi] in their planning activities. Additionally, vulnerable populations may have problems accessing safe drinking water due to these infrastructure challenges.

The Clean Water and Drinking Water State Revolving Funds (SRF) may be stressed as the need for additional investments in water infrastructure increases. Region 7 and its State partners may need to re-prioritize project requests due to increasing and changing needs at the local level. Tribes and other vulnerable populations may require special considerations with respect to climate change and water infrastructure challenges. Region 7's work to promote green infrastructure[xii] in urban areas may be more in demand to serve multiple purposes: manage storm water runoff, flood mitigation, air quality management, and urban heat island reduction. Additional resources and funding may be required to address this significant impact in Region 7.

C. **The quality and availability of safe drinking water may be affected.** Drought, changing patterns of precipitation, and increased evapotranspiration may result in changes to the availability and demand for drinking water. Competing uses of water in the agriculture, industry, and energy production sectors may also increase. These factors may shift demand to underground sources of water, or prompt development of reservoirs or other water retention strategies.

Wildfires can foul water and challenge water-treatment facilities. Heavy precipitation events may exacerbate the problem, leading to more runoff of sediment and other

contaminants into drinking water sources, requiring additional treatment. Drinking water intakes and wastewater outfalls could be overwhelmed or damaged, causing an increased incidence of waterborne diseases and pathogens. Increased water temperatures may also lead to an increased growth of algae and microbes that may affect drinking water quality.

Various Region 7 Programs protect drinking water quality, and are concerned with the availability of water supplies. National Pollutant Discharge Elimination System (NPDES) discharge permits for wastewater and storm water from municipal and other facilities may need to be adjusted to maintain water quality. As the need for water retention grows, NEPA reviews of water supply and storage projects may increase. There may also be a need to enhance or construct wetlands, requiring permits.

Limited water availability and drought in some regions may require drinking water providers to reassess the security of their water supplies, and consider alternative pricing, allocation, and water conservation options. Region 7's work to promote voluntary actions through the Sustainable Water Infrastructure programs, Climate Ready Water Utilities initiatives, and WaterSense, may be more in demand. Adapting to this impact may be compromised by a lack of resources.

D. **Agricultural production demands on ground and surface water resources may increase.** Agriculture is the main economic activity and greatest sector user of water resources in Region 7 states. The agriculture industry relies heavily on precipitation, surface and ground water resources to maintain production of food and feed products. Drought and changing patterns of precipitation may result in farmers, ranchers, and land owners relying more heavily on water from surface runoff and the ground to maintain agriculture-related production. This increase demand will result in reduced stream flows and reduction in water table levels which could adversely affect water quality and availability for human consumption and ecosystems.

Ground and surface water resources are managed and controlled under a variety of state and federal oversight entities. These include state boards and regional cooperatives or districts that manage ground water with drawl and surface water diversion within the state that is used for crop irrigation and drinking water. At the federal level agencies, such as the Bureau of Land Management (BLM) and the US Army Corp of Engineers, manage land activities and navigable waters of the United States both of which have a significant impact on water availability to the regional agriculture sector and drinking water systems.

The eastern states of Region 7 (Iowa and Missouri) located in the climate region defined by the GCRP as the Midwest rely predominantly on precipitation and surface water to support agriculture production. As the quantity and timing of precipitation varies as a result of climate change, the agriculture industry may not be able to rely on precipitation to provide the water necessary to sustain crop production. In response, a greater reliance on surface water and ground water may occur which will reduce the ground water levels. As the industry relies more

on ground water, there is greater potential for contamination and degradation of the resource due to the greater number of wells and decrease in ground water volume. Increased wells provide opportunities for surface contaminants to enter the resource, through poor well design or well completion. Ground water degradation also occurs as the resource is depleted and dissolved solids make up a greater percentage of the resource volume. In Missouri, where the majority of communities, and residents outside of municipalities, rely on ground water for drinking water, a reduction in ground water level and quality will negatively impact the public's access to affordable clean drinking water.

The western states of Region 7 (Kansas and Nebraska) located in the climate region defined by the GCRP as the Great Plains rely predominantly on ground water and to a lesser extent precipitation to support agriculture production. Nebraska ranks first nationally with over 8.5 million acres of irrigated land[xiii], and Kansas ranks 7th with over 2.7 million acres of irrigated land[xiv]. As the Great Plains region is more arid than the Midwest region, decreased precipitation is expected for this region under nearly all climate change modeling scenarios. Consequently, we anticipate that the agriculture sector in these two states will rely on groundwater resource to an even greater degree than currently to sustain current levels of agriculture production.

The main ground water resource in western Nebraska and Kansas is the Ogallala Aquifer, one of the largest aquifer systems in the world and the principal geologic unit of the High Plains Aquifer System. In 2005, the USGS estimated that total water withdraw from the aquifer amounted to approximately 9% since 1950, or 2.5 million acre feet of water from the aquifer's total water storage capacity of 2.9 billion acre feet[xv]. The Ogallala Aquifer, like most underground sources of water, depends on precipitation to recharge, and the rate of recharge does not match the rate of withdraw. In areas of western Nebraska, natural resource management districts have been put in place to regulate the number of wells and the amount of water than can be withdrawn from the aquifer as these areas have measured substantial reductions in the depth that fresh water can be accessed in the aquifer[xvi]. Like Missouri, communities located in Kansas and Nebraska depend almost entirely on ground water for public drinking water systems. In rural areas of both Nebraska and Kansas, we find that the vast majority of homes utilize ground water as the predominant source of water used in the home. As ground water resource are utilized more extensively (especially by the agriculture sector), the resource will become less available for use as a drinking and public water resource.

The Region 7 States and federal entities servicing the agriculture sector need to consider how greater reliance on ground and surface water resources will impact the resource as a result of climate change, as well as the impact on communities that share the ground water resource. We anticipate that Region 7's resources supporting public drinking water systems will be in greater demand as public utilities spend greater resources accessing clean water, and/or developing systems that reuse water. Additionally, the Agency may find it necessary to develop new programs to ensure the safety of ground

water resources from contamination due to increased pumping and an increased number of wells.

3. **Goal 3: Cleaning Up Communities and Advancing Sustainable Development**

   A. **Contaminated Sites and Waste Management may be threatened.** Heavy precipitation events, floods, and wildfires may threaten contaminated sites in Region 7 and the remedies put in place to cleanup and prevent releases of hazardous substances. Resource Conservation and Recovery Act (RCRA) activities to treat, store, or dispose of hazardous and non-hazardous waste may also be threatened. Extreme temperatures and other weather events may lead to a loss of electrical power, affecting the operations of treatment and waste management facilities. Landfill capacity may be insufficient to handle surges in hazardous and municipal wastes from floods and other extreme weather events.

   Region 7's Superfund, RCRA, and Brownfield programs may need to alter chemical containment strategies to ensure protection of groundwater and adjacent sites. RCRA permitting activities may increase or requirements may need to be updated to reflect current and future climate impacts. Current scientific monitoring and sampling protocols on sites may no longer be effective and may require adjustments. The adaptive capacity to this impact is largely dependent on available funding and resources, but there may be points of leverage or innovative technologies that could be utilized for site remediation or materials management.

   B. **Climate change may lead to an increased need for emergency response**. Due to an increase in heavy precipitation events, floods, and wildfires, as well as other extreme weather events like severe winds and tornados that may be exacerbated by climate change, Region 7's emergency response and disaster recovery efforts may increase. Subsequently, this may lead to limitations in the Region's response capabilities due to staff and financial resource constraints. The adaptive capacity to this impact is dependent on available funding and resources and the occurrence frequency of natural disasters regionally and nationally.

4. **Goal 4: Ensuring the safety of Chemicals and Preventing Pollution**

   A. **The ability to protect human health and ecosystems from chemical risks may be affected.** Climate change may affect exposures to a wide range of chemicals because of changing environmental conditions or use patterns. For example, it may lead to increased pest pressure and a changing mix of pests, affecting how, when, where, and what pesticides are used. The earlier timing of spring events, like increased temperatures and the emergence of leaves, flowers, and pollinators, may lead to a longer growing season and an increase in the quantity of pesticides used[xvii]. Other climate impacts like drought, extreme temperatures, and heavy precipitation may lead to abandoned fields, changes in crop mixes and farming methods, and increase runoff into streams and rivers, increasing exposures. There may also be an increase in spraying and other chemical use to control mosquitoes and rodents in response to certain

health threats. Vulnerable populations, particularly children, may be at a higher risk for health effects from exposure to pesticides.

Region 7's efforts to reduce exposures may be affected by these impacts. There may also be an increase in requests for emergency exemptions for unregistered pesticides, state/local special need registrations, as well as requests to approve additional or new end uses of registered products. These requests are handled by EPA Headquarters, but Region 7 monitors and supports them as appropriate to ensure a timely response. Additionally, Region 7's work to promote Integrated Pest Management and other sustainable agriculture practices may be more in demand. Region 7's adaptive capacity to this impact is largely dependent on available funding and resources.

5. <u>Goal 5: Enforcing Environmental Laws</u>

A. **Climate change may affect environmental monitoring and sampling in various media.** Heavy precipitation events, floods, and wildfires, as well as other extreme weather events like severe winds and tornados that may be exacerbated by climate change, could cause damage to Region 7's environmental monitoring assets and prevent access. This impact could delay our efforts to ensure compliance with environmental requirements by regulated entities, and take effective enforcement action in case of violations. Adapting to this impact may require a shift in resources and funding.

6. <u>Facilities and Operations</u>

A. **Operations of Region 7 facilities, including water and energy use, may be affected.** Increased temperatures may impact cooling requirements in the summer, but may decrease the need for heat in the winter. The operation of Region 7 facilities could also be affected by water shortages due to drought, electric power interruptions due to extreme weather events like heavy precipitation, tornadoes, and wildfires that affect local air quality and the health of personnel. Drought and extreme temperatures may also make it more difficult to maintain green infrastructure, upon which Region 7 relies for storm water management services, among other things, at its Regional Headquarters building in Lenexa, KS.

Region 7's adaptive capacity to this impact is reliant on resources to purchase available water and energy, and avoid the health impacts of reduced air quality. Personnel also have the capacity to work remotely for an extended period of time. Depending on the circumstances, this may alleviate some of the vulnerabilities to the operation of Region 7 facilities.

7. <u>Vulnerable Populations</u>

Partnerships with Tribes. EPA values its unique government-to-government relationship with Indian 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 and the *2011 Policy on Consultation and Coordination with Indian Tribes*. These policies recognize and support the sovereign decision-making authority of tribal governments.

Supporting the development of adaptive capacity among tribes is a priority for the EPA. 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 to develop adaptation strategies that promote sustainability and reduce the impact of climate change on Indian tribes.

EPA engaged tribes through a formal consultation process in the development of the Agency's *Climate Change Adaptation Plan*. Tribes identified some of the most pressing issues as erosion, temperature change, drought and various changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. At the same time, tribes challenged EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative burdens are reduced.

This Implementation Plan identifies specific steps that will be taken to partner with tribal governments on an ongoing basis to increase their adaptive capacity and address their adaptation-related priorities. These collaborative efforts will benefit from the expertise provide by our tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change and has been used by tribes for millennia as a valuable tool to adapt to changing surroundings. Consistent with the principles in the 1984 Indian Policy, TEK is viewed as a complementary resource that can inform planning and decision-making.

Networks and partnerships already in place will be used to assist tribes with climate change issues, including Regional Tribal Operations Committees, the Region 7 Office of Tribal Affairs, the Institute for Tribal Environmental Professionals and the Indian General Assistance Program (IGAP). Additionally, efforts will be made to coordinate with other Regional and Program Offices in EPA, since climate change has many impacts that transcend media and regional boundaries. Transparency and information sharing will be a focus, in order to leverage activities already taking place within EPA Offices and tribal governments.

Vulnerable populations may be at a higher risk from climate change impacts. Certain parts of the population, such as children, the elderly, minorities and the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in flood-prone areas. One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most

vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society.

This Implementation 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 Plan is conducted, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events (*e.g.,* Hurricane Katrina and Superstorm Sandy) and the subsequent recovery efforts.

Today, rural agriculture communities face an array of challenges. In 1950, 82 percent of the world's population was rural[xviii]. Rural communities now comprise 17 percent of the population and about 80 percent of the country's total land area[xix]. Such resource-based economies are vulnerable to the impacts of commodity prices, technological changes, land value dynamics, and other market influences. Many of these communities are experiencing unemployment, poverty, population loss, the aging of their workforces, and increasing demands for social services with fewer dollars to pay for them. In some rural areas, these are not new trends, but generations-old issues.

As a result of such economic impacts and challenges, estimates indicate a continued decline in our rural populations through 2050. Yet we have seen strength in agricultural production supports other parts of the economy, particularly in rural communities. Farms and ranches buy fertilizer and seed, invest in farm machinery, contract with custom operators, and support the many local businesses that come together to serve farms and farming families, including restaurants and health care service providers. High levels of production also benefit other businesses like grain elevators, bio-fuel refineries, and processed food manufacturers. According to the industry input-output accounts for 2010, every additional dollar of final output in the agriculture, fishing, and hunting industry raises gross output across all industries by approximately $2.20[xx].

Climate change has the potential to negatively influence the livelihood of our agriculture communities to a much greater extent than other vulnerable populations. Residents of remote communities have limited access to non-agriculture jobs and services. Alternative employment options can be limited due to long, expensive commutes. People who don't have access to personal vehicles or who do not drive, such as low-income residents and senior citizens, lack mobility and could have even less access to alternate jobs, healthcare, and other services.

Region 7 populations living with asthma are also a priority. For example, St. Louis is considered a national asthma "hot spot". Climate change, specifically with respect to air quality (i.e. ozone and particulate matter), indoor air quality, exposure to pests, and changes in heat and humidity will inevitably exacerbate complications associated with asthma. We will continue to monitor this vulnerable population and others like it as we adapt and respond to the challenges associated with climate change.

Addressing these challenges is critical, particularly within the Midwest and Region 7, where agriculture plays such a vital role in our state economies

There may be other vulnerable populations (which may ultimately be defined by the spatial nature of climate change impacts) who have yet to be identified. This may include metropolitan areas in harm's way due to an increasing risk of floods, rural towns that may be at risk of losing access to safe drinking water due to a reduction ground water levels, or agricultural communities facing a threat to their livelihood due to extreme drought. Over time, the most vulnerable populations in Region 7 may change as the impacts of climate change become more pronounced or shift. Identifying who the most vulnerable populations are at this time or may be in the future will be an ongoing challenge. They will need to be defined in the context of climate change impacts, but also in terms of socioeconomic and natural resource considerations.

8. <u>Emerging Issues</u>

During Region 7's internal planning sessions on climate adaptation, a number of emerging issues were discussed that require additional scientific research before they can be considered risks to the work of Region 7 programs. They include the following:

- Wind and extreme wind events might be increasing, affecting air quality, and the migration and deposition of pesticides and other pollutants population areas and ecosystems
- The emergence of cyanobacteria toxins in surface waters might be increasing due to increased water temperature – this may affect drinking water, requiring more treatment by water utilities
- Tropospheric ozone pollution levels could increase in rural areas which could cause damage to crops- causing lost production and result in increasing efforts to use chemicals such as fertilizers and pesticides to compensate for such losses
- Unconventional energy production development might increase, placing greater demand on water resources, creating additional potential for groundwater contamination, and exacerbating climate change impacts
- Electric system reliability may decrease due to lack of cooling water availability as a result of low river water events
- Releases from industrial activities, rail cars, and on the road commercial truck traffic accidents associated with extreme weather events

IV. Summary Table of Climate Change Vulnerabilities

Climate Change Impact	R7 Programmatic Impacts		
Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions
	High = 3 Med. = 2 Low = 1		
1.1 Increased frequency and intensity of wildfires	3	Protecting the public health and the environment by approving state programs to meet NAAQS and respond to natural disasters	Continue to partner with local, state and tribal stakeholders to optimize fire contingency plans, including SMPs and a new National Fire Policy, to maximize prevention and minimize impacts
1.2 Increasing extreme temperatures	2	Protect public health by promoting healthy indoor environments through voluntary programs and guidance	Maintain and increase knowledge of increasing health risks in indoor environments as a result of climate change Promote energy efficiency and energy star products & renewable energy strategies
1.3 Increasing heavy precipitation events	3	Protecting the public health and the environment by approving state programs to meet NAAQS and implementing programs in Indian Country	Provide education on the dangers and stress to air quality from open burning of flood related debris and other natural disasters
1.4 Increased concentrations of tropospheric pollutants such as ozone and fine particulate matter	1	Protecting the public health and the environment by approving state programs to meet NAAQS	Continue to partner with local and state stakeholders to closely monitor changes in pollution in our most vulnerable areas (metropolitan centers) and take action early (Ozone/PM Advance) to mitigate new impacts and firm action through SIPs, when appropriate.
2.1 Increasing heavy precipitation events	3	- Restoring and protecting watersheds, aquatic ecosystems and wetlands - Drinking water, wastewater and storm water infrastructure - The quality and availability of safe drinking water	Work with USACE, Section 404 programs, to incorporate climate change impacts in permits, compensation plans and draft EIS documents. Work with state agencies, water and waste water stakeholders to identify and plan for climate change challenges by using Climate Ready Water Utility tools. Work with States, USDA, and other local partners to prioritize watersheds with improvements to the sources of drinking water impacted by nutrients and other contaminants. Assessments for improvement includes ground water and surface water sources

Climate Change Impact	R7 Programmatic Impacts		
Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions
	High = 3 Med. = 2 Low = 1		
2.2 Decreasing precipitation days and increasing drought intensity	3	- Restoring and protecting watersheds, aquatic ecosystems and wetlands - Drinking water, wastewater and stormwater infrastructure - The quality and availability of safe drinking water	Increase public awareness of the role and importance of restoring and protecting watershed. Support adaptation in water resource planning efforts through collaborative dialogues with municipal officials, land-use planners, developers, water managers, and other stakeholders to protect long-term water availability and quality for all users Work within the region and outside agencies to incorporate water conservation practices, energy conservation and green infrastructure
2.3 Increased water temperatures	3	- Restoring and protecting watersheds, aquatic ecosystems and wetlands - Drinking water, wastewater and stormwater infrastructure - The quality and availability of safe drinking water	Work with states, stakeholders and communities to incorporate climate change considerations into their water quality planning Work with state strategies such as state revolving loan fund intended use plans, capacity development strategies to promote sustainable practices such as energy efficiency, water resilience, and asset management. Work with states to better assess potential impacts from increased water temperatures and establish appropriate water quality standards (e.g., designated uses, criteria to protect those uses). Develop attainable, implementable, and protective permit conditions.
2.4 Earlier timing of spring events	3	- Restoring and protecting watersheds, aquatic ecosystems and wetlands - Drinking water, wastewater and stormwater infrastructure - The quality and availability of safe drinking water	Work with stakeholders to protect drinking water, manage stormwater run-off planning, and manage consumptive water use from water ways

Climate Change Impact	R7 Programmatic Impacts		
Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions
	High = 3 Med. = 2 Low = 1		
3.1 Increasing heavy precipitation events	2	Cleaning up contaminated sites and waste -Use of Sustainable Materials Management and Pollution Prevention to prevent the generation of hazardous and solid waste	Promote the development and use of innovative(precipitation Neutral) technologies and practices for site remediation & materials management and emergency response Promote the principles of source reduction, reuse and recycle to make room for unexpected volume resulting from climate change events
4.1 – Decreasing precipitation days and increasing drought intensity	2	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available Promote the use of best management practices to reduce pesticide runoff into surface water after precipitation events due to drought-induced soil impermeability
4.2 - Increasing extreme temperatures	2	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available
4.3 - Increasing heavy precipitation events	2	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available Promote the use of best management practices to reduce pesticide runoff into surface water.
4.4 - Earlier timing of spring events	2	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available Coordinate with the Region's State Lead Agencies to ensure the availability and proper use of Section 18 Emergency Exemption registrations, Section 24(c) Special Local Need registrations, and Emergency Use Permits. Provide relevant information to Headquarters to be used during the pesticide registration/re-registration process.

Climate Change Impact	R7 Programmatic Impacts		
Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions
	High = 3 Med. = 2 Low = 1		
4.5 - Increase in and changing mix of pests	2	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available Coordinate with the Region's State Lead Agencies to ensure the availability and proper use of Section 18 Emergency Exemption registrations, Section 24(c) Special Local Need registrations, and Emergency Use Permits. Provide relevant information to Headquarters to be used during the pesticide registration/re-registration process. Provide states, Tribes and stakeholders with technical assistance and consultation to help them address emerging pesticide issues.
5.1 – Earlier timing of spring events	2	Conducting environmental sampling in various media to determine exposure and risk	Evaluate the Region's monitoring and sampling methods and strategies and make changes to accommodate shifts in seasons Maintain a situation awareness to identify any emerging pesticide enforcement issues Coordinate with the Region's state lead agencies to address pesticide misuse incidents
5.2 – Increased frequency and intensity of wildfires	2	Conducting environmental sampling in various media to determine exposure and risk	Focus on NAAQs and water standards compliance (increased run-off in fire areas)
6.1 – Decreasing precipitation days and increasing drought intensity	1	Continue to use the Region's EMS to promote staff water use efficiencies, monitor water availability through local provider, and work with Landlord to develop contingency plans for various levels of mandatory water use reductions if necessary	Continue to use the Region's EMS to promote sustainable business practices in energy and water efficiency
6.2 – Increasing extreme temperatures	1	Continue to use the Region's EMS to champion FMSD & SHEMD identified energy use reduction projects at the STC aimed at reducing air exchange rates in the laboratory spaces	Promote personal sustainable practices like fuel efficient transport and energy star product

Climate Change Impact	R7 Programmatic Impacts		
Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions
	High = 3 Med. = 2 Low = 1		
6.3 – Increasing risk of floods	1	Through the Region's COOP process, continue to train staff on need to prepare for emergency remote site work and advocate for better VPN continuity	Maintain the staff's capacity to work remotely

Region 7 Priority Actions:

Region 7 is addressing climate change adaptation in a variety of its programmatic areas of responsibility. We will continue to integrate climate change adaptation into our existing programs and identify new opportunities to address climate change adaptation as regulations change and new initiatives and priorities are instituted and funding opportunities (i.e. grants, IAGs, etc) are identified.

As EPA Region 7 has finite resources and cannot address all climate change adaptation needs, we have adopted criteria to screen potential actions. We will target climate change adaptation work based on the following criteria:

- What is the likelihood of the Regional program being impacted?
- Does the action support and align with other Region 7 priorities and actions?
- Is this a priority action for our partners (federal/state/tribal/local/NGOs) and are they able to work with us towards a solution?
- Does the action reduce the risk?
- Does the action protect a critical resource/investment?
- Would the action leverage a larger effort outside of EPA?
- Does EPA have a unique role or capacity to address this issue?
- What is the timeframe of the problem that this action would be addressing?
- Could the action be accomplished within current budgets or would additional funds be necessary?
- Does this action have durability/sustainability/stability?

Using these criteria, priority actions were determined for each strategic goal. At the end of the priority action is a total **number** of points it scored. This value was developed through a workgroup evaluation discussed in more detail in Appendix A. This information will help the Region as it determines how to focus its activities on program vulnerabilities given the finite resource and time. The work group will continue to revisit these values into the future.

Priority Actions:

Goal 1: Taking Action on Climate Change and Improving Air Quality

1.1: Continue to partner with local and state stakeholders to optimize fire contingency plan, including SMPs to maximize prevention and minimize impacts **(30)**

1.2: (a) Maintain and increase knowledge of increasing health risks in indoor environments as a result of climate change **(17)**

(b) Work with EPA programs to target climate adaptation efforts in the most vulnerable communities, including tribes **(29)**

1.3: Provide education on the dangers and stress to air quality from open burning of flood related debris **(24)**
1.4: Continue to partner with local and state stakeholders to closely monitor changes in pollution in our most vulnerable areas (metropolitan centers) and take action early (Ozone/PM Advance) to mitigate new impacts and firm action through SIPs, when appropriate. **(27)**

Goal 2: Protecting America's Waters

2.1: (a) Work with USACE Section 404 programs to incorporate climate change impacts in permits, compensation plans and draft EIS documents **(30)**

(b) Work with state agencies, water and waste water stakeholders to identify and plan for climate change challenges by using Climate Ready Water Utility Tools **(28)**

(c) Work with States, USDA and other local partners to prioritize watersheds with improvements to the sources of drinking water impacted by nutrients and other contaminants. Assessments for improvement includes ground water and surface water sources **(28)**

2.2: (a) Increase public awareness of the role and importance of restoring and protecting watersheds **(28)**

(b)Support adaptation in water resource planning efforts through collaborative dialogues with municipal officials, land-use planners, developers, water managers, and other stakeholders to protect long-term water availability and quality for all users **(27)**

(c) Work within the Region and outside agencies to incorporate water conservation practices, energy conservation and green infrastructure **(25)**

2.3: (a) Work with states, stakeholders and communities to incorporate climate change considerations into their water quality planning **(25)**

(b) Work with state strategies such as state revolving loan fund intended use plans, capacity development strategies to promote sustainable practices such as energy efficiency, water resilience an asset management **(30)**

(c) Work with states to better assess potential impacts from increased water temperatures and establish appropriate water quality standards (e.g. designated use criteria to protect those uses). Develop attainable, implementable, and protective permit conditions **(29)**

2.4: Work with stakeholders to protect drinking water, manage stormwater run-off planning, and manage consumptive water use from water ways **(27)**

Goal 3: Cleaning Up America's Communities and Advancing Sustainable Development

3.1: (a) Promote the development and use of innovative technologies and practices for site remediation & materials management **(23.5)**

(b) Promote the principles of source reduction, reuse and recycle to make room for unexpected volume resulting from climate change events **(25)**

Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution

4.1: (a) Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available **(19)**

(b) Promote the use of best management practices to reduce pesticide runoff into surface water after precipitation events due to drought-induced soil impermeability **(22)**

4.2: Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available **(19)**

4.3: (a) Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available **(19)**

(b) Promote the use of best management practices to reduce pesticide runoff into surface water **(22)**

4.4: (a) Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available **(19)**

(b) Coordinate with the Region's State Lead Agencies to ensure the availability and proper use of Section 18 Emergency Exemption registrations, Section 24(c) Special Local Need registrations and Emergency Use permits **(22)**

(c) Provide relevant information to Headquarters to be used during the pesticide registration/ re-registration process **(18)**

4.5: (a) Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available **(19)**

(b) Coordinate with the Region's State Lead Agencies to ensure the availability and proper use of Section 18 Emergency Exemption registrations, Section 24(c) Special Local Need registrations and Emergency Use permits **(22)**

(c) Provide relevant information to Headquarters to be used during the pesticide registration/ re-registration process **(18)**

(d) Provide States, Tribes and stakeholders with technical assistance and consultation to help them address emerging pesticide issues **(22)**

Goal 5: Enforcing Environmental Laws

5.1: (a) Evaluate the Region's monitoring and sampling methods and strategies and make changes to accommodate shifts in seasons **(16)**

(b) Maintain a situation awareness to identify any emerging pesticide enforcement issues **(18)**

(c) Coordinate with the Region's state lead agencies to address pesticide misuse incidents **(23)**

5.2: Focus on NAAQs and water standards compliance (increased run-off in fire areas) **(29)**

Facilities and Operations

6.1: Continue to use the Region's EMS to promote staff water use efficiencies, monitor water availability through local provider, and work with Landlord to develop contingency plans for various levels of mandatory water use reductions if necessary **(16)**

6.2: Continue to use the Region's EMS to champion FMSD & SHEMD identified energy use reduction projects at the STC aimed at reducing air exchange rates in the laboratory spaces **(17)**

6.3: Through the Region's COOP process, continue to train staff on need to prepare for emergency remote site work and advocate for better VPN continuity **(16)**

Other Priority Actions

Actions Related to Agency-Wide Strategic Measures

The *FY 2011-2015 EPA Strategic Plan* contains the Agency's first "strategic performance measures" for integrating climate adaptation into its activities.[xxi] These strategic performance measures commit the Agency to integrate adaptation planning into five major rulemaking processes and five major financial assistance mechanisms by 2015. They also call for the integration of adaptation planning into five

major scientific models or decision-support tools used in implementing Agency environmental management programs.

A. Integrate Adaptation Planning into Rulemaking Processes

- Explore opportunities to incorporate climate adaptation considerations into regional rulemaking processes such as SIPs and TMDLs, as well as related data collection and analyses, policy statements and guidance documents

B. Integrate Adaptation Planning into Financial Assistance Mechanisms

- Explore opportunities to incorporate climate adaptation considerations into competitive funding announcements in accordance with the October 18, 2011, EPA guidance memo jointly issued by the Office of Policy and the Office of Grants and Debarment - this may include a climate adaptation criterion wherever it is relevant to the program's mission and outcomes

Region 7 Monitoring and Evaluation of Priority Actions

Region 7 will bi-annually evaluate its climate change adaptation activities to assess progress toward mainstreaming climate change adaptation into programs, policies, rulemaking processes, and operations. Some metrics exist that will enable the Region to measure the results of its activities - others will need to be developed over time. Climate vulnerabilities and impacts will likely change over time. Consequently, the priority actions and the metrics we use to measure progress on their implementation may need to be revised or changed as the knowledge and understanding of the effects of climate change increases.

	Climate Change Impact	Focus of Associated Region 7 Program	Priority Actions	Evaluation Output	Evaluation Outcome
Goal 1	1.1 Increased frequency and intensity of wildfires	Protecting the public health and the environment by approving state programs to meet NAAQS and implementing programs in Indian Country	Continue to partner with local, state and tribal stakeholders to optimize fire contingency plans, including SMPs and a new National Fire Policy, to maximize prevention and minimize impacts	Fire prevention and contingency plans developed and shared.	NAAQS standards met
	1.2 Increasing extreme temperatures	Protect public health by promoting healthy indoor environments through voluntary programs and guidance	a) Maintain and increase knowledge of increasing health risks in indoor environments as a result of climate change b) Work with EPA programs to target climate adaptation efforts in the most vulnerable communities, including tribes	a) outreach events that reach public to increase knowledge of health risks in indoor environments b) number of people reached during outreach events, increase in energy star products purchased	Improved pro-active management of respiratory diseases and fewer emergency room visits.
	1.3 Increasing heavy precipitation events	Protecting the public health and the environment by approving state programs to meet NAAQS and implementing programs in Indian Country	Provide education on the dangers and stress to air quality from open burning of flood related debris and other natural disasters	Education of state and local officials and the general public	NAAQs standards met

	Climate Change Impact	Focus of Associated Region 7 Program	Priority Actions	Evaluation Output	Evaluation Outcome
	1.4 Increased concentrations of tropospheric pollutants such as ozone, fine particulate matter and course particulate matter	Protecting the public health and the environment by approving state programs to meet NAAQS	Continue to partner with local and state stakeholders to closely monitor changes in pollution in our most vulnerable areas (metropolitan centers) and take action early (Ozone/PM Advance) to mitigate new impacts and firm action through SIPs, when appropriate.	Number of partners educated Number of partners participating in Ozone/PM Advance initiatives	Protecting public health and environment by meeting NAAQs standards.
Goal 2	2.1 Increasing heavy precipitation events	- Restoring and protecting watersheds, aquatic ecosystems and wetlands - Drinking water, wastewater and storm water infrastructure - The quality and availability of safe drinking water	Work with USACE, Section 404 programs, to incorporate climate change impacts in permits, compensation plans and draft EIS documents. Work with state agencies, water and waste water stakeholders to identify and plan for climate change challenges by using Climate Ready Water Utility tools. Work with States, USDA, and other local partners to prioritize watersheds with improvements to the sources of drinking water impacted by nutrients and other contaminants. Assessments for improvement includes ground water and surface water sources	Meets and events with stakeholders discussing agricultural and natural resource plans , climate ready planning tools. Plans developed, watershed prioritized with focus on nutrients, permits incorporating provisions for climate readiness.	Drinking water, wastewater, and water infrastructure is designed to withstand heavy precipitation events Reduced soil erosion/improved water quality/protection of agricultural soils and natural resources Impaired waterbodies removed from 303d lists

	Climate Change Impact	Focus of Associated Region 7 Program	Priority Actions	Evaluation Output	Evaluation Outcome
	2.2 Decreasing precipitation days and increasing drought intensity	- Restoring and protecting watersheds, aquatic ecosystems and wetlands - Drinking water, wastewater and stormwater infrastructure - The quality and availability of safe drinking water	Increase public awareness of the role and importance of restoring and protecting watershed. Support adaptation in water resource planning efforts through collaborative dialogues with municipal officials, land-use planners, developers, water managers, and other stakeholders to protect long-term water availability and quality for all users Work within the region and outside agencies to incorporate water conservation practices, energy conservation and green infrastructure	Implementation of agriculture funding programs encouraging adoption of water conservation practices Conduct meetings and participate in events with stakeholders on a regular basis focused on water use, energy, conservation practices and green infrastructure	Ecosystems, drinking water, wastewater, and water infrastructure are designed and operated to withstand severe droughts Protection of long-term water availability and quality for all uses Stablized Ground water reduction trend

	Climate Change Impact	Focus of Associated Region 7 Program	Priority Actions	Evaluation Output	Evaluation Outcome
	2.3 Increased water temperatures	- Restoring and protecting watersheds, aquatic ecosystems and wetlands - Drinking water, wastewater and stormwater infrastructure - The quality and availability of safe drinking water	Work with states, stakeholders and communities to incorporate climate change considerations into their water quality planning Work with state strategies such as state revolving loan fund intended use plans, capacity development strategies to promote sustainable practices such as energy efficiency, water resilience, and asset management. Work with states to better assess potential impacts from increased water temperatures and establish appropriate water quality standards (e.g., designated uses, criteria to protect those uses). Develop attainable, implementable, and protective permit conditions.	Partnerships with water treatment facilities, developers and urban planners established or maintained Conduct stakeholder meetings on a regular basis Increased conservation program participation implementing riparian buffers State plans incorporating sustainable practices	Protection of long-term water quality for all uses Decreased stream water temperatures

	Climate Change Impact	Focus of Associated Region 7 Program	Priority Actions	Evaluation Output	Evaluation Outcome
	2.4 Earlier timing of spring events	- Restoring and protecting watersheds, aquatic ecosystems and wetlands - Drinking water, wastewater and stormwater infrastructure - The quality and availability of safe drinking water	Work with stakeholders to protect drinking water, manage stormwater run-off planning, and manage consumptive water use from water ways	Partnerships with stakeholders established or maintained Conduct stakeholder meetings on a regular basis Development of early season varieties	Protection of long-term water quality for all uses Drinking water, wastewater, and water infrastructure are designed to accommodate shifts in seasons Improved or sustained crop production yields
Goal 3	3.1 Increasing heavy precipitation events	-Cleaning up contaminated sites and waste -Use of Sustainable Materials Management and Pollution Prevention to prevent the generation of hazardous and solid waste	Promote the development and use of innovative(precipitation Neutral) technologies and practices for site remediation & materials management and emergency response Promote the principles of source reduction, reuse and recycle to make room for unexpected volume resulting from climate change events	Design, communicate and implement innovative technologies and practices at remediation sites to minimize precipitation impacts Increases in participation in SMM and P2 programs and challenges	Contaminated sites cleaned up designed and implemented in a way that effectively withstands heavy precipitation events Overall increase in national diversion rate of solid waste to landfill and increase in P2 metrics

	Climate Change Impact	Focus of Associated Region 7 Program	Priority Actions	Evaluation Output	Evaluation Outcome
	3.2 Changes in temperature	Cleaning up contaminated sites and waste Increase in promotion of Green Chemistry, Design for the Environment and E3 (Energy, Economy and Environment) and SMM focus areas	Identify points of leverage or external funding sources to build adaptive capacity Shift in focus of regional P2 program to promote SMM participation	Design, communicate and implement innovative technologies and practices at remediation sites to minimize temperature impacts Increase number of successful grant proposals including focus areas	Contaminated sites cleaned up designed and implemented in a way that effectively withstands temperature changes Emergency response efforts incorporate sustainability Flooding events are not further complicated by contamination
Goal 4	4.1 – Decreasing precipitation days and increasing drought intensity	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available Promote the use of best management practices to reduce pesticide runoff into surface water after precipitation events due to drought-induced soil impermeability	Outreach conducted on IPM when new agriculture practices/products are available	Human health is protected
	4.2 - Increasing extreme temperatures	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available	Outreach conducted on IPM when new agriculture practices/products are available	Human health is protected

	Climate Change Impact	Focus of Associated Region 7 Program	Priority Actions	Evaluation Output	Evaluation Outcome
	4.3 - Increasing heavy precipitation events	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available Promote the use of best management practices to reduce pesticide runoff into surface water.	Outreach conducted on IPM when new agriculture practices/products are available	Human health is protected
	4.4 - Earlier timing of spring events	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available Coordinate with the Region's State Lead Agencies to ensure the availability and proper use of Section 18 Emergency Exemption registrations, Section 24(c) Special Local Need registrations, and Emergency Use Permits. Provide relevant information to Headquarters to be used during the pesticide registration/re-registration process.	Outreach conducted on IPM when new agriculture practices/products are available	Human health is protected

	Climate Change Impact	Focus of Associated Region 7 Program	Priority Actions	Evaluation Output	Evaluation Outcome
	4.5 - Increase in and changing mix of pests	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available Coordinate with the Region's State Lead Agencies to ensure the availability and proper use of Section 18 Emergency Exemption registrations, Section 24(c) Special Local Need registrations, and Emergency Use Permits. Provide relevant information to Headquarters to be used during the pesticide registration/re-registration process. Provide states, Tribes and stakeholders with technical assistance and consultation to help them address emerging pesticide issues.	Outreach conducted on IPM when new agriculture practices/products are available	Human health is protected

	Climate Change Impact	Focus of Associated Region 7 Program	Priority Actions	Evaluation Output	Evaluation Outcome
Goal 5	5.1 – Earlier timing of spring events	Conducting environmental sampling in various media to determine exposure and risk	Evaluate the Region's monitoring and sampling methods and strategies and make changes to accommodate shifts in seasons Maintain a situation awareness to identify any emerging pesticide enforcement issues Coordinate with the Region's state lead agencies to address pesticide misuse incidents	Modify monitoring and sampling methods and strategies to address areas of weakness or vulnerability associated with seasonal shifts	Compliance monitoring remains an effective strategy for protecting human health and the environment.
	5.2 - Increasing heavy precipitation events and risk of floods	Conducting environmental sampling in various media to determine exposure and risk	Focus on NAAQs and water standards compliance (increased run-off in fire areas)	Increase the number of SEPs that support energy efficiency/ renewable energy and sustainable practices	Compliance monitoring remains an effective strategy for protecting human health and the environment.
Facilities & Operations	6.1 – Decreasing precipitation days and increasing drought intensity	Water use reductions at Regional Office and Science & Technology Center	Continue to use the Region's EMS to promote staff water use efficiencies, monitor water availability through local provider, and work with Landlord to develop contingency plans for various levels of mandatory water use reductions if necessary	Outreach to staff, management, and stakeholders (i.e. building owner, contractors, etc)	Sustained low water and energy usage at EPA facilities
	6.2 - Increasing extreme temperatures	Energy use reductions within the HVAC system at the STC	Continue to use the Region's EMS to champion FMSD & SHEMD identified energy use reduction projects at the STC aimed at reducing air exchange rates in the laboratory spaces	Identification and implementation of STC energy reduction projects	Reduction in overall energy usage rates

	Climate Change Impact	Focus of Associated Region 7 Program	Priority Actions	Evaluation Output	Evaluation Outcome
	6.3 – Increasing risk of floods	Continue to promote telework and improve remote secure access to the Region's/Agency's networks	Through the Region's COOP process, continue to train staff on need to prepare for emergency remote site work and advocate for better VPN continuity	Staff are able to work remotely	Routine Agency functions are sustained in a flood emergency situation

Conclusion

In R7 and elsewhere across the United States, predictions regarding climate change impacts vary widely and as a consequence so do the resulting vulnerabilities, making planning difficult. However, priority actions identified by the programs within the Region have the following common threads.

(1) Priority actions were constructed within the legal bounds of our existing environmental statutes.

(2) Priority actions are primarily extensions of existing or planned program actions which are tailored to address specific climate change vulnerabilities.

(3) Priority actions rely heavily on partnerships with R7 state, local and tribal environmental programs.

(4) Priority actions focus on communication, education and outreach intended to modify behavior and consumption patterns.

(5) To a certain extent, priority actions could be implemented through work re-prioritization without substantial supplemental resources.

Because of the diverse nature of the predictions and our constantly evolving environment, close monitoring of climate trends and program readiness are essential if we are to address our vulnerabilities in a timely, effective, and relevant way.

Region 7 will bi-annually review its segment of the plan. This review will incorporate determinations about climate conditions, weather impacts, regional vulnerabilities and vulnerable populations that will enable the Region to update the plan, if needed, and to give consideration to the sequence of priority action implementation.

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[xi] Non-stationarity in this context refers to the concept that past hydrologic and weather patterns may not be a good indicator of future conditions due to human-caused climate change.

[xii] Green infrastructure uses vegetation and soil to manage rainwater where it falls. By weaving natural processes into the built environment, green infrastructure provides not only storm water management, but also urban heat island mitigation, air quality management, and more.

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Appendix A

Region 7 Actions Matrix: Workgroup members used their best professional judgment to determine values for different vulnerabilities. When applying the criteria, offices did not evaluate vulnerabilities in relation to each other, but instead considered each vulnerability independently. These tables are not intended as a definitive ranking, but rather as a useful and informative exercise for the region as it determines how to focus its activities on program vulnerabilities. The workgroup will continue to revisit these values into the future."

	Climate Change Impact	R7 Programmatic Impacts			Regional Priority Actions Ranking Criteria									
	Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions	Support & Align with other R7 priorities & actions	Action is a priority action for our partners	Impact Action would have in reducing risk	Action Protects a critical resource/ investment	Action Leverages a larger effort outside of EPA	EPA has a unique role or capacity to address action	Timeframe when risk likely to occur:	Action can be accomplished within current budgets	Action has durability/ sustainability/ stability	Composite Score
		High = 3 Med. = 2 Low = 1			High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	Yes = 3 No = 1	Yes = 3 No = 1	0-10 yrs = 3 11-30 yrs = 2 31 – 100 yrs = 1	Yes = 3 No = 1	Yes = 3 Somewhat = 2 No = 1	
Goal 1: Taking Action on Climate Change & Improving Air Quality	1.1 Increased frequency and intensity of wildfires	3	Protecting the public health and the environment by approving state programs to meet NAAQS and respond to natural disasters	Continue to partner with local, state and tribal stakeholders to optimize fire contingency plans, including SMPs and a new National Fire Policy, to maximize prevention and minimize impacts	3	3	3	3	3	3	3	3	3	30
	1.2 Increasing extreme temperatures	2	Protect public health by promoting healthy indoor environments through voluntary programs and guidance	Maintain and increase knowledge of increasing health risks in indoor environments as a result of climate change Work with EPA programs to target climate adaptation efforts in the most vulnerable communities, including tribes	1 3	1 3	1 3	3 3	3 3	1 3	2 3	1 3	2 3	17 29

Climate Change Impact	R7 Programmatic Impacts			Regional Priority Actions Ranking Criteria									
Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions	Support & Align with other R7 priorities & actions	Action is a priority action for our partners	Impact Action would have in reducing risk	Action Protects a critical resource/ investment	Action Leverages a larger effort outside of EPA	EPA has a unique role or capacity to address action	Timeframe when risk likely to occur:	Action can be accomplished within current budgets	Action has durability/ sustainability/ stability	Composite Score
	High = 3 Med. = 2 Low = 1			High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	Yes = 3 No = 1	Yes = 3 No = 1	0-10 yrs = 3 11-30 yrs = 2 31 – 100 yrs = 1	Yes = 3 No = 1	Yes = 3 Somewhat = 2 No = 1	
1.3 Increasing heavy precipitation events	3	Protecting the public health and the environment by approving state programs to meet NAAQS and implementing programs in Indian Country	Provide education on the dangers and stress to air quality from open burning of flood related debris and other natural disasters	2	2	2	3	3	1	3	3	2	24
1.4 Increased concentrations of tropospheric pollutants such as ozone, fine particulate matter and course particulate matter	1	Protecting the public health and the environment by approving state programs to meet NAAQS	Continue to partner with local and state stakeholders to closely monitor changes in pollution in our most vulnerable areas (metropolitan centers) and take action early (Ozone/PM Advance) to mitigate new impacts and firm action through SIPs, when appropriate.	3	3	3	3	3	3	2	3	3	27

	Climate Change Impact	R7 Programmatic Impacts			Regional Priority Actions Ranking Criteria									
	Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions	Support & Align with other R7 priorities & actions	Action is a priority action for our partners	Impact Action would have in reducing risk	Action Protects a critical resource/ investment	Action Leverages a larger effort outside of EPA	EPA has a unique role or capacity to address action	Timeframe when risk likely to occur:	Action can be accomplished within current budgets	Action has durability/ sustainability/ stability	Composite Score
		High = 3 Med. = 2 Low = 1			High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	Yes = 3 No = 1	Yes = 3 No = 1	0-10 yrs = 3 11-30 yrs = 2 31 – 100 yrs = 1	Yes = 3 No = 1	Yes = 3 Somewhat = 2 No = 1	
Goal 2: Protecting America's Waters	2.1 Increasing heavy precipitation events	3	- Restoring and protecting watersheds, aquatic ecosystems and wetlands	Work with USACE, Section 404 programs, to incorporate climate change impacts in permits, compensation plans and draft EIS documents.	3	3	3	3	3	3	3	3	3	30
			- Drinking water, wastewater and storm water infrastructure	Work with state agencies, water and waste water stakeholders to identify and plan for climate change challenges by using Climate Ready Water Utility tools.	3	3	3	3	3	3	3	1	3	28
			- The quality and availability of safe drinking water	Work with States, USDA, and other local partners to prioritize watersheds with improvements to the sources of drinking water impacted by nutrients and other contaminants. Assessments for improvement includes ground water and surface water sources	3	3	3	3	3	3	3	1	3	28

Climate Change Impact	R7 Programmatic Impacts			Regional Priority Actions Ranking Criteria									
Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions	Support & Align with other R7 priorities & actions	Action is a priority action for our partners	Impact Action would have in reducing risk	Action Protects a critical resource/ investment	Action Leverages a larger effort outside of EPA	EPA has a unique role or capacity to address action	Timeframe when risk likely to occur:	Action can be accomplished within current budgets	Action has durability/ sustainability/ stability	Composite Score
	High = 3 Med. = 2 Low = 1			High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	Yes = 3 No = 1	Yes = 3 No = 1	0-10 yrs = 3 11-30 yrs = 2 31 – 100 yrs = 1	Yes = 3 No = 1	Yes = 3 Somewhat = 2 No = 1	
2.2 Decreasing precipitation days and increasing drought intensity	3	- Restoring and protecting watersheds, aquatic ecosystems and wetlands	Increase public awareness of the role and importance of restoring and protecting watershed.	3	3	3	3	3	3	3	1	3	28
		- Drinking water, wastewater and stormwater infrastructure	Support adaptation in water resource planning efforts through collaborative dialogues with municipal officials, land-use planners, developers, water managers, and other stakeholders to protect long-term water availability and quality for all users	3	3	3	3	3	3	3	1	2	27
		- The quality and availability of safe drinking water	Work within the region and outside agencies to incorporate water conservation practices, energy conservation and green infrastructure	2	1	3	3	3	3	3	1	3	25

	2.3 Increased water temperatures	3	- Restoring and protecting watersheds, aquatic ecosystems and wetlands - Drinking water, wastewater and stormwater infrastructure - The quality and availability of safe drinking water	Work with states, stakeholders and communities to incorporate climate change considerations into their water quality planning Work with state strategies such as state revolving loan fund intended use plans, capacity development strategies to promote sustainable practices such as energy efficiency, water resilience, and asset management. Work with states to better assess potential impacts from increased water temperatures and establish appropriate water quality standards (e.g., designated uses, criteria to protect those uses). Develop attainable, implementable, and protective permit conditions.	2 3 2	1 3 3	3 3 3	3 3 3	3 3 3	3 3 3	3 3 3	1 3 3	3 3 3	25 30 29
	2.4 Earlier timing of spring events	3	- Restoring and protecting watersheds, aquatic ecosystems and wetlands - Drinking water, wastewater and stormwater infrastructure	Work with stakeholders to protect drinking water, manage stormwater run-off planning, and manage consumptive water use from water ways	2	3	3	3	3	3	3	1	3	27

	Climate Change Impact	R7 Programmatic Impacts			Regional Priority Actions Ranking Criteria									
	Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions	Support & Align with other R7 priorities & actions	Action is a priority action for our partners	Impact Action would have in reducing risk	Action Protects a critical resource/ investment	Action Leverages a larger effort outside of EPA	EPA has a unique role or capacity to address action	Timeframe when risk likely to occur:	Action can be accomplished within current budgets	Action has durability/ sustainability/ stability	Composite Score
		High = 3 Med. = 2 Low = 1			High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	Yes = 3 No = 1	Yes = 3 No = 1	0-10 yrs = 3 11-30 yrs = 2 31 – 100 yrs = 1	Yes = 3 No = 1	Yes = 3 Somewhat = 2 No = 1	
			- The quality and availability of safe drinking water											
Goal 3: Cleaning Up Communities and Advancing Sustainable Development	3.1 Increasing heavy precipitation events	2	Cleaning up contaminated sites and waste	Promote the development and use of innovative(precipitation Neutral) technologies and practices for site remediation & materials management and emergency response	3	3	2	2	3	3	1.5	1	3	23.5
			-Use of Sustainable Materials Management and Pollution Prevention to prevent the generation of hazardous and solid waste	Promote the principles of source reduction, reuse and recycle to make room for unexpected volume resulting from climate change events	3	3	1	2	3	3	2	3	3	25

	Climate Change Impact	R7 Programmatic Impacts			Regional Priority Actions Ranking Criteria									
	Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions	Support & Align with other R7 priorities & actions	Action is a priority action for our partners	Impact Action would have in reducing risk	Action Protects a critical resource/ investment	Action Leverages a larger effort outside of EPA	EPA has a unique role or capacity to address action	Timeframe when risk likely to occur:	Action can be accomplished within current budgets	Action has durability/ sustainability/ stability	Composite Score
		High = 3 Med. = 2 Low = 1			High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	Yes = 3 No = 1	Yes = 3 No = 1	0-10 yrs = 3 11-30 yrs = 2 31 – 100 yrs = 1	Yes = 3 No = 1	Yes = 3 Somewhat = 2 No = 1	
Goal 4: Ensuring the Safety of Chemicals	4.1 – Decreasing precipitation days and increasing drought intensity	2	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available	2	1	2	3	3	1	2	1	2	19
				Promote the use of best management practices to reduce pesticide runoff into surface water after precipitation events due to drought-induced soil impermeability	3	3	2	3	3	1	2	1	2	22
	4.2 - Increasing extreme temperatures	2	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available	2	1	2	3	3	1	2	1	2	19

	Climate Change Impact	R7 Programmatic Impacts			Regional Priority Actions Ranking Criteria									
	Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions	Support & Align with other R7 priorities & actions	Action is a priority action for our partners	Impact Action would have in reducing risk	Action Protects a critical resource/ investment	Action Leverages a larger effort outside of EPA	EPA has a unique role or capacity to address action	Timeframe when risk likely to occur:	Action can be accomplished within current budgets	Action has durability/ sustainability/ stability	Composite Score
		High = 3 Med. = 2 Low = 1			High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	Yes = 3 No = 1	Yes = 3 No = 1	0-10 yrs = 3 11-30 yrs = 2 31 – 100 yrs = 1	Yes = 3 No = 1	Yes = 3 Somewhat = 2 No = 1	
	4.3 - Increasing heavy precipitation events	2	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available	2	1	2	3	3	1	2	1	2	19
				Promote the use of best management practices to reduce pesticide runoff into surface water.	3	3	2	3	3	1	2	1	2	22

	Climate Change Impact	R7 Programmatic Impacts			Regional Priority Actions Ranking Criteria									
	Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions	Support & Align with other R7 priorities & actions	Action is a priority action for our partners	Impact Action would have in reducing risk	Action Protects a critical resource/ investment	Action Leverages a larger effort outside of EPA	EPA has a unique role or capacity to address action	Timeframe when risk likely to occur:	Action can be accomplished within current budgets	Action has durability/ sustainability/ stability	Composite Score
		High = 3 Med. = 2 Low = 1			High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	Yes = 3 No = 1	Yes = 3 No = 1	0-10 yrs = 3 11-30 yrs = 2 31 – 100 yrs = 1	Yes = 3 No = 1	Yes = 3 Somewhat = 2 No = 1	
	4.4 - Earlier timing of spring events	2	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available	2	1	2	3	3	1	2	1	2	19
				Coordinate with the Region's State Lead Agencies to ensure the availability and proper use of Section 18 Emergency Exemption registrations, Section 24(c) Special Local Need registrations, and Emergency Use Permits.	1	3	2	1	3	3	2	3	2	22
				Provide relevant information to Headquarters to be used during the pesticide registration/re-registration process.	1	1	2	1	1	3	2	3	2	18

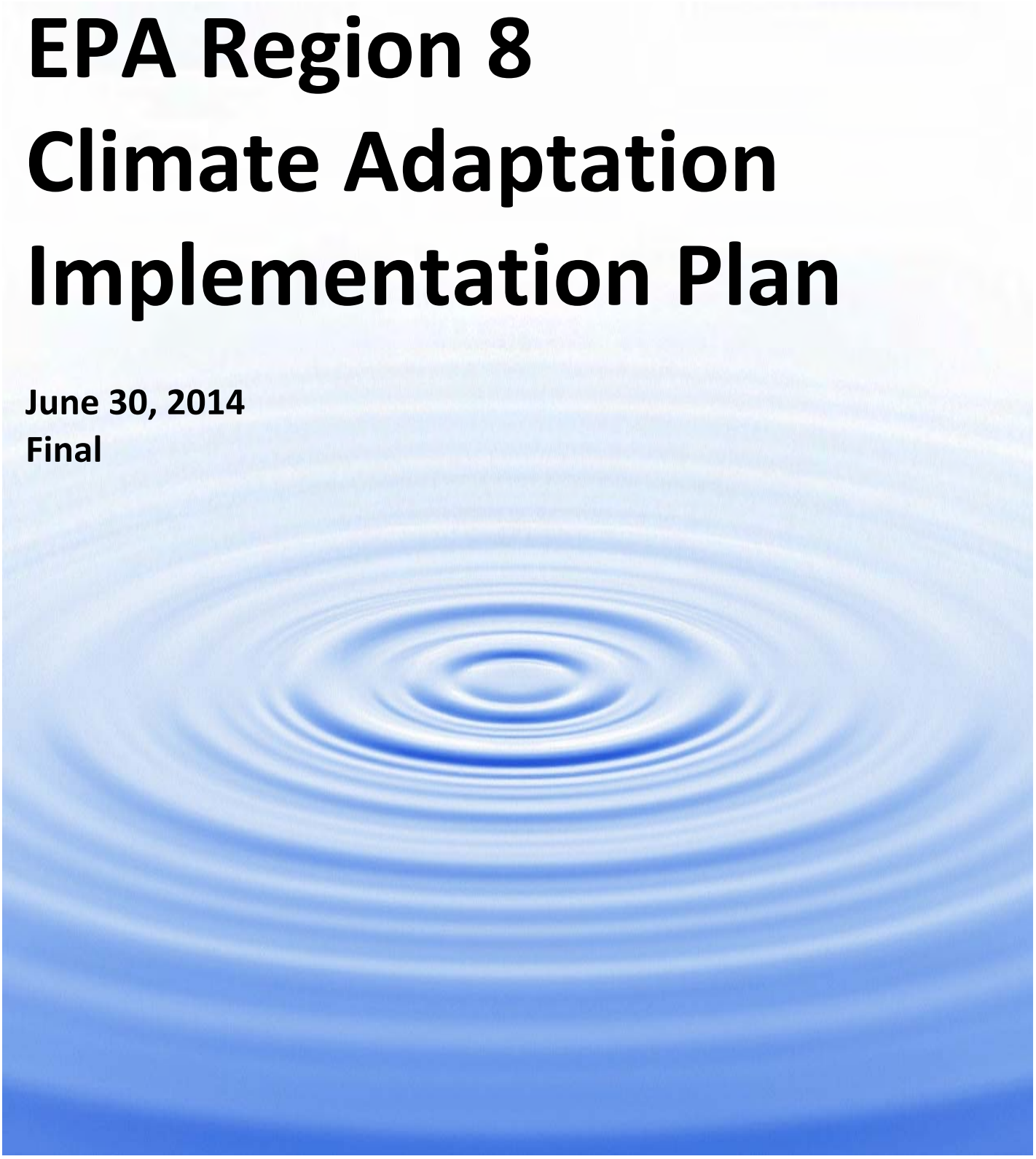
	4.5 - Increase in and changing mix of pests	2	Protecting human health and ecosystems from chemical risks	Continue to promote Integrated Pest Management (IPM) and other sustainable agriculture practices as new products and strategies become available	2	1	2	3	3	1	2	1	2	19
				Coordinate with the Region's State Lead Agencies to ensure the availability and proper use of Section 18 Emergency Exemption registrations, Section 24(c) Special Local Need registrations, and Emergency Use Permits.	1	3	2	1	3	3	2	3	2	22
				Provide relevant information to Headquarters to be used during the pesticide registration/re-registration process.	1	1	2	1	1	3	2	3	2	18
				Provide states, Tribes and stakeholders with technical assistance and consultation to help them address emerging pesticide issues.	2	3	1	1	3	3	2	3	2	22
Goal 5: Enforcing Environmental Laws	5.1 – Earlier timing of spring events	2	Conducting environmental sampling in various media to determine exposure and risk	Evaluate the Region's monitoring and sampling methods and strategies and make changes to accommodate shifts in seasons	2	1	1	2	1	1	2	1	3	16
				Maintain a situation awareness to identify any emerging pesticide enforcement issues	1	1	2	1	1	3	2	3	2	18

	Climate Change Impact	R7 Programmatic Impacts			Regional Priority Actions Ranking Criteria									
	Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions	Support & Align with other R7 priorities & actions	Action is a priority action for our partners	Impact Action would have in reducing risk	Action Protects a critical resource/ investment	Action Leverages a larger effort outside of EPA	EPA has a unique role or capacity to address action	Timeframe when risk likely to occur:	Action can be accomplished within current budgets	Action has durability/ sustainability/ stability	Composite Score
		High = 3 Med. = 2 Low = 1			High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	Yes = 3 No = 1	Yes = 3 No = 1	0-10 yrs = 3 11-30 yrs = 2 31 – 100 yrs = 1	Yes = 3 No = 1	Yes = 3 Somewhat = 2 No = 1	
				Coordinate with the Region's state lead agencies to address pesticide misuse incidents	2	3	2	3	3	1	2	3	2	23
	5.2 – Increased frequency and intensity of wildfires	2	Conducting environmental sampling in various media to determine exposure and risk	Focus on NAAQs and water standards compliance (increased run-off in fire areas)	3	3	3	3	3	3	3	3	3	29
Facilities & Operations	6.1 – Decreasing precipitation days and increasing drought intensity	1	Water use at R7 RO and STC	Continue to use the Region's EMS to promote staff water use efficiencies, monitor water availability through local provider, and work with Landlord to develop contingency plans for various levels of mandatory water use reductions if necessary	2	1	2	1	1	1	2	3	2	16

	Climate Change Impact	R7 Programmatic Impacts			Regional Priority Actions Ranking Criteria									
	Climate Change Impact	Likelihood Regional Program would be Impacted	Focus of Associated Region 7 Program	Priority Actions	Support & Align with other R7 priorities & actions	Action is a priority action for our partners	Impact Action would have in reducing risk	Action Protects a critical resource/ investment	Action Leverages a larger effort outside of EPA	EPA has a unique role or capacity to address action	Timeframe when risk likely to occur:	Action can be accomplished within current budgets	Action has durability/ sustainability/ stability	Composite Score
		High = 3 Med. = 2 Low = 1			High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	High = 3 Med. = 2 Low = 1	Yes = 3 No = 1	Yes = 3 No = 1	Yes = 3 No = 1	0-10 yrs = 3 11-30 yrs = 2 31 – 100 yrs = 1	Yes = 3 No = 1	Yes = 3 Somewhat = 2 No = 1	
	6.2 – Increasing extreme temperatures	1	Water and energy usage at EPA facilities	Continue to use the Region's EMS to champion FMSD & SHEMD identified energy use reduction projects at the STC aimed at reducing air exchange rates in the laboratory spaces	2	1	2	3	1	1	3	1	2	17
	6.3 – Increasing risk of floods	1	- Operations of Agency facilities, personnel safety, physical security and emergency communications - Emergency management, mission support (protective gear acquisition)	Through the Region's COOP process, continue to train staff on need to prepare for emergency remote site work and advocate for better VPN continuity	2	1	2	1	1	1	2	3	2	16

EPA Region 8 Climate Adaptation Implementation Plan

June 30, 2014
Final



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Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people

and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

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Introduction

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment. EPA's *Policy Statement on Climate Change Adaptation*, issued in June of 2011, calls for the Agency to anticipate and plan for future changes in climate, and incorporate considerations of climate change into its activities. In response, the EPA drafted an agency-wide Climate Adaptation Plan in June 2012.[i] This document recognized that climate change can pose significant challenges to EPA's ability to fulfill its mission. It also directed every Program and Regional Office within the EPA to develop an Implementation Plan detailing how they will integrate climate adaptation into their work, and address the priorities identified in the agency-wide plan. To promote consistency, the Implementation Plans have common areas of focus, as outlined below:

1. Program vulnerability assessment
2. Priority actions to address program vulnerabilities
3. Actions related to agency-wide strategic measures
4. Legal and enforcement issues
5. Training and outreach
6. Partnerships with tribes
7. Monitoring and evaluating performance

They are meant to be complimentary and work in conjunction with the Agency's Strategic Plan and Sustainability Plan, as well as the climate change strategies of various Program Offices, such as the Office of Water's *National Water Program 2012 Strategy: Response to Climate Change*.

Region 8 Program Vulnerability Assessment

I. Background

The Region 8 Program Vulnerability Assessment discusses some of the major climate change impacts affecting EPA Region 8, and examines the risks they pose to key Region 8 Programs. It builds on the work presented in Part 2 of the EPA's agency-wide Climate Adaptation Plan, as well as the individual vulnerability assessments completed by various national program and Regional Offices. The assessment is based on the goals in the EPA's FY 2011-2015 Strategic Plan, which include:

Goal 1: Taking Action on Climate Change and Improving Air Quality
Goal 2: Protecting America's Waters
Goal 3: Cleaning Up Communities and Advancing Sustainable Development
Goal 4: Ensuring the Safety of Chemical s and Preventing Pollution
Goal 5: Enforcing Environmental laws

The assessment also considers "Facilities and Operations," "Vulnerable Populations," and "Emerging Issues" that may or may not become vulnerabilities in the future. A summary table on page 15 of this document provides an overview of the programmatic vulnerabilities in the narrative.

Vulnerable populations are mentioned throughout the document. This term may refer to children, the elderly, minorities, the poor, the young, persons with underlying medical conditions and disabilities, those with limited access to information, indigenous populations, overburdened populations that live in environmental justice communities, and the homeless and outdoor workers who may have more exposure to heat and air pollution.[ii] Certain geographic locations may also contribute to vulnerability. For example, people living in rural or urbanized areas may have unique challenges depending on the impact under consideration.

The EPA's places a priority on helping people, places and infrastructure that are the most vulnerable to climate impacts, and seeks meaningful involvement from all parts of society. As the work of this Implementation Plan is conducted, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. Region 8 will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts.

Region 8 intends to fulfill its mission, even in the face of a changing climate. It will stay on course for meeting its goals, while building more resilient and climate-responsive programs. We will also assist our partners in meeting the challenges of climate change through effective coordination and decision-support.

II. Overview of Climate Change Impacts in Region 8

Region 8 straddles two different climate regions identified by the U.S. Global Change Research Program: the Great Plains and Southwest. The Great Plains region includes the Region 8 States of North and South Dakota, Wyoming, Montana, and the eastern half of Colorado. The Southwest region includes the western half of Colorado, including the Rocky Mountains, and the State of Utah.

Region 8 is made up of a diverse set of landscapes, population bases, and economic sectors making our response to climate change particularly challenging in its complexity. Our lands are governed by six states, 27 tribal nations, and a host of federal agencies, with over one-third of our land area publicly-owned.[iii] These entities have diverse and often competing interests that include agriculture, energy development and production, environmental protection and stewardship, industry, recreation, tourism, and urbanization. The roughly 10 million people in the region are concentrated in two main urban corridors, Salt Lake City and Denver, with the remainder located in relatively isolated cities and towns often separated by large distances.

The Intergovernmental Panel on Climate Change (IPCC), in its Fourth Assessment report in 2007,[iv] concluded that global warming due to human activities since 1750 is unequivocal. The report also indicates that climate variability and warming over the past century has already had measurable

effects in the Region, including increased temperatures, melting glaciers, reduced snowpack[1], earlier timing of spring events including snowmelt, latitude and elevation shifts in plant and animal ranges, drought, an increase in the frequency and intensity of wildfires, declining forest health, an increase in heavy precipitation events, and habitat loss. These effects are expected to intensify as greenhouse gases build up in the atmosphere, and continue to threaten our water resources, agricultural production, forests, wildlife habitats, alpine ecosystems, and human health throughout the 21st century.

The following suite of climate change impacts and their effect on Region 8 Programs are discussed in the sections below. They may be discussed individually, or in combination with one or more of the other impacts based on the focus of the Strategic Plan Goal under consideration. They are also premised on the measurable increase of greenhouse gases in the atmosphere, most notably carbon dioxide (CO_2) and methane (CH_4).[v]

1. Increased tropospheric ozone pollution in certain areas[vi]
2. Increased frequency and intensity of wildfires[vii]
3. Increasing extreme temperatures[viii]
4. Increasing heavy precipitation events[ix]
5. Effects on the stratospheric ozone layer[x]
6. Effects on response of ecosystems to atmospheric deposition of sulfur, nitrogen, and mercury[xi]
7. Increased water temperatures[xii]
8. Decreasing precipitation days and increasing drought intensity[xiii]
9. Increasing risk of floods[xiv]
10. Reduction in snowpack[xv] [xvi]
11. Earlier timing of spring events[2] [xvii]
12. Increased pest pressure and changing mix of pests[3] [xviii]

This vulnerability assessment focuses on evaluating how climate change may affect the EPA Region 8 mission and programs, using the best available science. This is an evaluation of program vulnerabilities rather than an assessment of all potential impacts of climate change. Therefore, it does not include a discussion of all impacts, whether negative or potentially positive.

[1] Additional factors related to reduction in snowpack that have been observed in the past century include a greater proportion of winter precipitation falling as rain rather than snow, a decrease in the duration and extent of snow cover, and a decrease in mountain snow water equivalent.

[2] Includes earlier snowmelt, runoff, and biological life cycle events, such as the emergence of leaves, flowers, and pollinators.

[3] Pest pressure refers to an increased number of existing pests, new pests, and invasive species; as well as an increased susceptibility of crops to pests. Pests include weeds, insects, rodents, mold, fungus and disease.

Because of the diversity and wide range of climate change impacts in Region 8, implementers of this Plan will need to tailor their actions to meet different needs based on climate regions, other geographic considerations, population, economic activity, a specific impact, or a vulnerable population.

III. Examination of Region 8 Program Vulnerabilities

A. Improving Air Quality

1. Tropospheric ozone pollution is likely to increase in certain areas due to the effects of climate change. Tropospheric, or ground-level ozone, is created by photochemical reactions of short-lived pollutants in the atmosphere. Emissions from industrial facilities, electric utilities, motor vehicles, chemical solvents, and oil and gas production are some of the major sources of these pollutants in Region 8. Higher temperatures and regional air stagnation associated with climate change may lead to more ozone formation, even with the same level of emissions[xix]. While tropospheric ozone is higher in urban areas, some rural areas with oil and gas production activities in Region 8 may also have high levels. Additionally, there is some evidence to suggest that background levels of tropospheric ozone are increasing in some areas, particularly at higher elevations, due to atmospheric transport.[xx] Climate change also has the potential to lengthen the ozone season by increasing the months of the year conducive to the formation of troposphere ozone. Vulnerable populations may be at a higher risk for health effects from exposure to ozone.

While there is consensus that tropospheric ozone levels will increase due to a changing climate, there are varying estimates of the magnitude of those increases. To the extent that it becomes apparent that a changing climate is preventing attainment of the ozone National Ambient Air Quality Standard (NAAQS)**,** Clean Air Act (CAA) provisions will require identification of additional control measures to reduce ozone precursor emissions. Region 8 will work with EPA Headquarters to determine appropriate actions if and when such control measures are needed. Additionally, Region 8 will continue to work with its partners at the state, local, and tribal level to meet the ozone NAAQS through State, Tribal or Federal Implementation Plans and other measures.

2. Particulate matter (PM) levels are likely to be affected through changes in the frequency and intensity of wildfires and drought. There is evidence indicating that climate change will affect PM levels through changes in the frequency or intensity of wildfires.[xxi] The IPCC has reported with very high confidence that in North America, disturbances such as wildfires are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons. Forest fires are likely to increase in frequency, severity, distribution and duration in the Intermountain West and the West due to climate change. This, in addition to the recent pine beetle outbreak in the Rocky Mountains, is changing the fire regime in the area and complicating EPA Region 8 efforts to protect public health and the environment from PM pollution. Additionally, drought conditions may increase dust storms and contribute to degraded air quality due to PM.[xxii] Vulnerable populations may be especially at risk from increased exposure to PM.

Region 8's capacity to adapt to this impact is related to the approval of "exceptional events," which allows states and tribes to exempt elevated levels of PM due to wildfires and drought, and avoid regulatory actions under the CAA NAAQS. Additionally, even though the challenge of fire mitigation and firefighting falls on national, regional, and local efforts outside of the EPA's jurisdiction, the Region's National Environmental Policy Act (NEPA) Program has a role to play in terms of the review of forest vegetation management plans. There may also be air monitoring or risk communication opportunities that can help the Region adapt to this impact.

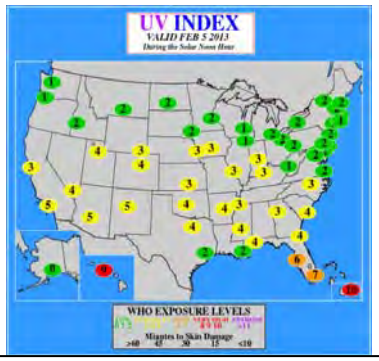
3. Climate change may worsen the quality of indoor air and increase exposures. Climate change may worsen existing indoor environmental problems, and introduce new ones due to temperature increases and an increased frequency or severity of extreme weather events.[xxiii] For example, warmer temperatures may affect the emergence, evolution and geographic ranges of pests, infectious agents and disease vectors.[xxiv] This may lead to shifting patterns of indoor exposure to pesticides as occupants and building owners respond to new infestations. Additionally, heavy precipitation events may contribute to increases in indoor dampness and building deterioration, increasing occupants' exposure to mold and other biological contaminants, as well as emissions from building materials.

As homes and buildings are constructed or renovated to achieve greater energy efficiency, exposure to indoor air pollution could increase if careful attention is not paid to factors such as ventilation rates.[xxv] EPA's ENERGY STAR® program as well as the Department of Energy's Better Buildings Initiative and organizations such as the U.S. Green Building Council (USGBC), Building Performance Institute (BPI) and Residential Energy Services Network (RESNET) are keenly aware of this issue and prescribe adequate ventilation rates for both new construction and renovated existing homes so that healthy indoor quality and energy efficiency can go hand in hand.

Residents may also spend more time indoors to avoid the heat and increased levels of certain air pollutants such as tropospheric ozone and particulate matter, and become more prone to health risks from indoor environmental conditions. Public health risks, particularly for vulnerable populations, may increase.[xxvi] For example, more people may be exposed to indoor air contaminants in homes in low-income areas because they have access to fewer resources to make adjustments to their dwellings, and because these homes tend to have greater occupant density.

Region 8 can utilize various EPA programs, tools, resources, and partnerships to adapt to this impact. For example, Region 8's Radon and ENERGY STAR® Programs, and Green and Healthy Homes and Clean, Green and Healthy Schools initiatives are avenues through which public education could occur.

4. Climate change may alter the effects of and strategic priorities within the EPA's regulatory and voluntary programs to help restore the stratospheric ozone layer. The interactions between climate change and the stratospheric ozone layer are complex.[xxvii] Climate change affects the stratospheric ozone layer through changes in chemical transport, atmospheric composition, and temperature. In turn, changes in stratospheric ozone can have implications for the



U.S. Environmental Protection Agency
UV Index Forecast
http://www2.epa.gov/sunwise/uv-index

climate of the troposphere. Additionally, climate change may exacerbate the health effects of ozone layer damage at some latitudes and mitigate them at others. The topics of ozone depletion and climate change are also linked because the most common ozone-depleting substances (ODS) are also potent greenhouse gases.

If climate change influences stratospheric ozone concentrations over Region 8, there may be an increased risk to public health and the environment from changing patterns of ultraviolet (UV) irradiation. Because Region 8 already has relatively high UV radiation levels due to its elevation, there is already heightened public awareness of the issue. Existing tools and resources could be utilized to communicate any increased risks. Additionally, climate change may lead to an increased use of cooling devices in commercial, residential, and transportation applications, as well as an increased use of insulation foams - many of which contain ODS or their substitutes. Such a shift in demand might impact how Region 8 plans and operates its programs concerned with the production and use of ODS. Adapting to this impact may require a shift in resources.

5. Climate change may affect the response of ecosystems to the atmospheric deposition of sulfur, nitrogen, and mercury. While there is limited scientific evidence on this topic, additional research is underway to better understand how patterns in the atmospheric deposition of sulfur, nitrogen, and mercury with projected changes in the climate and carbon cycle will affect ecosystem growth, species changes, surface water chemistry, and mercury methylation and bioaccumulation. The potential impacts could have consequences for the effectiveness of ecosystem protection from Region 8's emissions reduction programs.

Because of current fish consumption advisory programs,[xxviii] there is already heightened awareness of the issue of mercury contamination in lakes, rivers and streams in Region 8. This may present an opportunity to adapt to the impact through partnerships and public education.

B. <u>Protecting America's Waters</u>

1. Climate change may affect the EPA's ability to protect and restore watersheds, aquatic ecosystems and wetlands. Warmer air temperatures will result in warmer water, potentially leading to low oxygen levels and hypoxia, harmful algal blooms, and changes in the toxicity of some pollutants. Aquatic life may be replaced by other species better adapted to the warmer water, and this process may occur at an uneven pace disrupting aquatic system health and allowing non-indigenous and/or invasive species to become established.[xxix] Additionally, temperature increases may lead to water losses from increased evapotranspiration rates.

Heavier precipitation may increase flood risk, expand floodplain areas, increase the variability of streamflows, and increase erosion from high water velocity. An increase in storm event frequency and intensity can result in more nutrients, pathogens, and toxins being washed into water bodies, especially if they result in sewer overflows and wastewater bypasses.

Drought, changing patterns of precipitation, reduced snowpack, earlier spring runoff, and increased evapotranspiration, may lead to reduced streamflow later in the summer, altering aquatic environments and increasing impairments. Certain aquatic ecosystems that are unique to the region may also be threatened, such as prairie potholes, reducing their water recharge function and the habitat they provide for plants and animals.[xxx]

The Prairie Pothole region in North and South Dakota. *U.S. Fish and Wildlife Service*

Additionally, the recent pine beetle outbreak in the Rocky Mountains has altered the hydrological functioning of these ecosystems by influencing snow distribution and snowmelt in complex ways. Other considerations that affect the timing of snowmelt include dust events and rain on snow.

These impacts may have adverse effects on Region 8's work to protect water quality, and the health of watersheds, aquatic ecosystems and wetlands, and recovery of threatened fish species like bull trout in western Montana. Additional water bodies may have trouble meeting water quality standards and may need to be listed as impaired, requiring a total maximum daily load (TMDL). Nonpoint pollution control programs may need to be adjusted to reflect changing conditions. Source water protection practices may need to be enhanced. The baselines used in water quality standard development and implementation could shift, requiring new scientific analysis. Finally, certain economic and cultural practices of tribal communities related to water may be impacted.

These program vulnerabilities may require greater use of biological monitoring and assessment techniques to understand trends, management techniques that build resilience into aquatic environments, and the increased management of wetlands for stormwater control purposes and to buffer the impacts of drought. The current trend of research may need to be refocused to address shifts in water quality. Region 8's capacity to adapt to this impact is varied, and there may be numerous points of leverage and opportunities that can be explored.

2. Drinking water, wastewater and stormwater infrastructure may be affected. Heavier precipitation may increase the risk of floods, expand floodplains, and cause more nutrients, pathogens, and toxins to be washed into waterbodies.[xxxi] This could damage or overwhelm water infrastructure, and lead to releases of waterborne diseases and pathogens. In urban areas, stormwater collection and management systems may need to be redesigned to handle the increased capacity. Low stream flows due to drought, earlier spring runoff, reduction in snowpack, and increased evapotranspiration may affect drinking water storage and distribution systems, intakes, and wastewater outfalls. Wildfires create ash and debris that ends up in water reservoirs, rivers, canals and pipelines, and ultimately into municipal water-treatment facilities. Fires also scorch soils, leading to more runoff and erosion. Drinking water and wastewater utilities will need to consider these impacts and the concept of non-

stationarity[4] in their planning activities. Additionally, vulnerable populations may have problems accessing safe drinking water due to these infrastructure challenges.

Hayman Fire Impacts on Water Infrastructure

The Hayman Fire ignited on Saturday, June 8, 2002, in the mountains southwest of Denver, Colorado. It spread rapidly, driven by strong winds and drought conditions. By the time it was declared to be under control on July 18, it had burned nearly 138,000 acres – Colorado's largest wildfire in recorded history.

Since the fire, precipitation events have resulted in massive soil erosion and dumped enormous quantities of sediment into Denver Water's reservoirs and intake systems. The domestic water supplier to the City of Denver has expended tens of millions of dollars in water quality treatment, sediment and debris removal,
slope reseeding, and infrastructure projects as a result of the fire.

Smoke plume from the Hayman fire.
Photo: USDA Forest Service

Moriarty, K. and Cheng, T., 2012. Hayman Fire Research Summary, 2003--2012. Colorado Forest Restoration Institute and Colorado State University, Fort Collins, Colorado. Prepared for the Hayman Fire Science Symposium, June 21-22, 2012.

The Clean Water and Drinking Water State Revolving Funds (SRF) may need to be increased as the need for additional investments in water infrastructure increases. Region 8 and its state and tribal partners may need to re-prioritize project requests due to increasing and changing needs at the local level. Tribes and other vulnerable populations may require special considerations with respect to climate change and water infrastructure challenges. Region 8's work to promote green infrastructure[5] in urban areas may be more in demand to serve multiple purposes: manage storm water runoff, flood mitigation, air quality management, and urban heat island reduction. Region 8 has particular expertise in green roofs, and has just completed a multi-year scientific investigation into the use of this technology at its regional office in Denver, Colorado. Additionally, Region 8 is using the science of biomimicry to assist in developing stormwater management systems that will adapt and evolve over time. These tools, along with additional resources and funding, may be required to address this significant Region 8 impact.

3. The quality and availability of safe drinking water may be affected. Drought, changing patterns of precipitation and snowmelt, increased evapotranspiration, and reduced snowpack may result in changes to the availability and demand for drinking water. Competition for water for agriculture, industry, fire protection, and energy production may also increase, especially in areas experiencing population growth. These factors may shift demand to underground aquifers, or prompt development of reservoirs or other water retention strategies.

[4] Non-stationarity in this context refers to the concept that past hydrologic and weather patterns may not be a good indicator of future conditions due to human-caused climate change.

[5] Green infrastructure uses vegetation and soil to manage rainwater where it falls. By weaving natural processes into the built environment, green infrastructure provides not only stormwater management, but also urban heat island mitigation, air quality management, and more.

Soil erosion and increased runoff following wildfires can foul water and challenge water-treatment facilities. Heavy precipitation events may exacerbate the problem, leading to more runoff of sediment and other contaminants into drinking water sources, requiring additional treatment. Drinking water intakes and wastewater outfalls could be overwhelmed or damaged, causing an increased incidence of waterborne diseases and pathogens. Increased water temperatures may also lead to an increased growth of algae and microbes that may affect drinking water quality. These impacts may have adverse affects on the ability of public water supplies to meet drinking water standards.

Various Region 8 Programs protect drinking water quality, and are concerned with the availability of water supplies. National Pollutant Discharge Elimination System (NPDES) discharge permits for wastewater and stormwater from municipal and other facilities may need to be adjusted to maintain water quality. Enforcement flexibility may be appropriate in the face of prolonged impacts. As the need for water retention grows, NEPA reviews of water supply and storage projects may increase. There may also be a need to enhance or construct wetlands, requiring permits.

Limited water availability and drought in some regions may require drinking water providers to reassess the security of their water supplies, and consider alternative pricing, allocation, and water conservation options. Region 8's work to promote voluntary actions through the Sustainable Water Infrastructure and Climate Ready Water Utilities initiatives, and WaterSense, may be more in demand. Adapting to this impact may be compromised by a lack of resources.

C. <u>Cleaning Up Communities</u>

1. Contaminated sites and waste management may be threatened. Heavy precipitation events, floods, drought and wildfires may threaten contaminated sites in Region 8 and the remedies put in place to cleanup and prevent releases of hazardous substances. The treatment, storage and/or disposal of hazardous and non-hazardous waste may also be threatened. Extreme temperatures and other weather events may lead to a loss of electrical power, affecting the operations of treatment and waste management facilities. Landfill capacity may be insufficient to handle surges in hazardous and municipal wastes from floods and other extreme weather events.

Region 8's Superfund, Resource Conservation and Recovery Act (RCRA), and Brownfield programs may need to alter chemical containment strategies to ensure protection of groundwater and adjacent sites. RCRA permitting activities may increase or permit requirements may need to be updated to reflect current and future climate impacts. Current scientific monitoring and sampling protocols on sites may no longer be effective and may require adjustments. Adapting to this impact will be largely dependent on available funding and resources, but there may be facility operational changes or innovative technologies that could be utilized for site remediation or sustainable materials management.

2. Climate change may lead to an increased need for emergency response and recovery. Due to an increase in heavy precipitation events, floods, drought, and wildfires, as well as other extreme weather events like severe winds and tornados that may be exacerbated by climate change, Region 8's emergency response and disaster recovery efforts may increase. The 2011 National Disaster Recovery

Framework (NDRF)[xxxii] gives structure to, and expands, the nation's commitment to these activities. EPA is listed as a possible resource agency in five of the six NDRF Resource Support Function (RSF) areas. In recent years, Region 8 has been involved in response and recovery activities in several communities, including Windsor, Colorado (tornado), the Spirit Lake Nation (flooding), Minot, North Dakota (flooding), and Jamestown, Colorado (flooding).

The most common program areas involved in recovery efforts include: remediation of indoor pollutants such as mold and asbestos, debris management, project permitting (for drinking water, waste water, and storm water management), Brownfield assessments, sustainable community design, and climate resiliency. Coordination and collaborative efforts with federal, state, tribal, and local entities is a vital part of these recovery efforts.

Adapting to this impact will be dependent on effective disaster risk management, proactive actions to incorporate climate change considerations into permitting and funding mechanisms pre-disaster, and the availability of resources to respond to events when they happen.

D. <u>Ensuring the Safety of Chemicals</u>

1. **The ability to protect human health and ecosystems from chemical risks may be affected.** Climate change may affect exposures to a wide range of chemicals because of changing environmental conditions or use patterns. For example, it may lead to increased pest pressure and a changing mix of pests, affecting how, when, where, and what pesticides are used. The earlier timing of spring events, like increased temperatures and the emergence of leaves, flowers, and pollinators, may lead to a longer growing season and an increase in the quantity of pesticides used.[xxxiii] Other climate impacts like drought, extreme temperatures, and heavy precipitation may lead to reduced crop yields, fields taken out of production, changes in crop mixes and farming methods, and increase runoff into streams and rivers, increasing exposures. There may also be an increase in spraying and other chemical use to control mosquitoes and rodents in response to certain health threats, as well as mountain pine beetles. Vulnerable populations, particularly children, may be at a higher risk for health effects from exposure to pesticides.

Region 8's efforts to reduce exposures may be affected by these impacts. There may also be an increase in requests for emergency exemptions for unregistered pesticides, state/local special need registrations, as well as requests to approve additional or new end uses of registered products. These requests are mostly handled by EPA Headquarters, but Region 8 monitors and supports them as appropriate to ensure a timely response. Additionally, Region 8's work to promote Integrated Pest Management and other sustainable agriculture practices may be more in demand. Region 8's adaptive capacity to this impact is largely dependent on available funding and resources.

E. <u>Enforcing Environmental Laws</u>

1. Climate change may affect environmental monitoring and sampling in various media. Heavy precipitation events, floods, and wildfires, as well as other extreme weather events like severe winds

and tornados, could cause damage to Region 8's environmental monitoring equipment and prevent access to sampling locations. Additionally, increased air and water temperatures, and the earlier timing of spring events like snowmelt and runoff, could affect data quality and the baselines on which they rely. Environmental sampling methods and strategies may also be compromised and require modifications. This impact may affect the Region's ability to ensure compliance with environmental requirements by regulated entities, and take effective enforcement action in case of violations. These impacts may also require monitoring for a suite of chemicals not typically analyzed. Adapting to this impact may require a shift in resources and funding.

2. Climate may lead to more claims of force majeure. Force majeure is a common clause in an enforcement mechanism, like a consent decree, that can free the responsible party from liability or obligation when an extraordinary event occurs. Such events may include heavy precipitation, floods, wildfires, severe winds, and tornados. With climate change causing more such events, we can expect the regulated community to begin to assert this claim more frequently than before.

F. Facilities and Operations

1. Operations of Region 8 facilities, including water and energy use, may be affected. Increased temperatures may impact cooling requirements in the summer, but may decrease the need for heat in the winter. The operation of Region 8 facilities could also be affected by water shortages due to drought, electric power interruptions due to extreme weather events like heavy precipitation, and wildfires that affect local air quality and the health of personnel. Drought and extreme temperatures may also make it more difficult to maintain the viability of green roofs, upon which Region 8 relies for stormwater retention services, among other things, at its Headquarters building in Denver, CO. Region 8's adaptive capacity to this impact is reliant on resources to purchase available water and energy, and avoid the health impacts of reduced air quality. Personnel also have the capacity to work remotely for an extended period of time. Depending on the circumstances, this may alleviate some of the operational vulnerabilities of Region 8 facilities.

G. Vulnerable Populations

1. Vulnerable populations may be at a higher risk from climate change impacts. As stated above, populations vulnerable to climate change impacts may include children, the elderly, minorities, the poor, the young, persons with underlying medical conditions and disabilities, those with limited access to information, indigenous populations, overburdened populations that live in environmental justice communities, and the homeless and outdoor workers who may have more exposure to heat and air pollution.[xxxiv] Certain geographic locations may also contribute to vulnerability.

EPA Region 8's Green Roof

The green roof on the EPA Region 8 Headquarters building located in Denver, CO, has been the subject of a research study to compare its thermal and water management characteristics against a conventional roof. Results show that the green roof is cooler during hot weather and warmer during cold weather because the plant materials and growth medium enable thermal storage and evaporative cooling as moisture transitions between liquid, vapor and solid physical states. It also has significantly higher stormwater retention.

Slabe, T. and O'Connor, T. 2011. DRAFT - Thermal Characteristics of an extensive green roof and a gravel ballasted roof in high elevation, semi-arid, temperate Denver, Colorado, U.S.A. EPA/R-600/XXX-08. December, 2011.

The EPA Region 8 Headquarters' green roof with study plots and instrumentation. The solar panels provide beneficial shade during hot weather. Photo: EPA Region 8.

There may be other vulnerable populations who have yet to be identified. These populations may include metropolitan areas in harm's way due to an increasing risk of floods, rural towns that may be at risk of losing access to safe drinking water due to a reduction in snowpack, or agricultural communities facing a threat to their livelihood due to extreme drought. Over time, the most vulnerable populations in Region 8 may change as the impacts of climate change become more pronounced or shift. Identifying who the most vulnerable populations are at this time or may be in the future will be an ongoing challenge. These populations will need to be defined in the context of climate change impacts, but also in terms of socioeconomic and natural resource considerations.

Tribes are particularly vulnerable to the impacts of climate change due to the integral nature of the environment within their traditional lifeways and culture. Region 8 places a priority on the development of adaptation strategies that promote sustainability and reduce the impact of climate change on tribes.

The EPA values its unique relationship with tribes, and recognizes and supports the sovereign decision-making authority of tribal governments. A formal consultation process was used to engage tribes in the development of the EPA's agency-wide Climate Adaptation Plan. Tribes identified some of the most pressing issues as erosion, temperature change, drought, and various changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information, supporting baseline research to better track the effects of climate change, developing community-level education and awareness materials, and providing financial and technical support. At the same time, tribes challenged the EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative burdens are reduced.

This Implementation Plan identifies specific steps that will be taken to partner with tribal governments to increase their adaptive capacity and address their adaptation-related priorities. These collaborative efforts will benefit from the expertise provide by our tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change, and has been used by tribes for millennia as a valuable tool to adapt to changing surroundings. It is viewed as a complementary resource that can inform planning and decision-making.

Networks and partnerships already in place will be used to assist tribes with climate change issues, including Regional Tribal Operations Committees, the Institute for Tribal Environmental Professionals, and the Indian General Assistance Program. Additionally, efforts will be made to coordinate across the Agency to facilitate transparency and information sharing, since climate change has many impacts that transcend media and regional boundaries.

H. Emerging Issues

During Region 8's internal planning sessions on climate adaptation, a number of emerging issues were discussed that require additional scientific research before they can be considered potential risks to Region 8 programs. They include the following:

- Wind and extreme wind events might be increasing, affecting evapotranspiration and the migration and deposition of pesticides and other pollutants into ecosystems, and increasing public health risks;
- The emergence of cyanobacteria toxins in surface waters might be increasing due to increased water temperature and nutrients – this may affect the safety of drinking water, requiring more treatment by water utilities; and
- Tropospheric ozone pollution levels might be increasing in some rural areas, and along with increased levels of CO2, may have negative effects on ecosystems (and consequences for ecosystem protection programs), and crops (potentially causing an increase in the use of pesticides).

IV. Summary Table of Climate Change Vulnerabilities

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 8 PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated Region 8 Program**	**Likelihood Region 8 Program will be Affected by Impact [f]**	**Example of Risks if Region 8 Program were Impacted**
Improving Air Quality	• Increased tropospheric ozone pollution in certain regions	• Likely	• Protecting public health and the environment by approving state programs to meet the National Ambient Air Quality Standards (NAAQS) and implementing programs in Indian Country	• High	• Could become more difficult to attain NAAQS for ozone in many areas with existing ozone problems
	• Increased frequency and intensity of wildfires and drought	• Likely	• Protecting public health and the environment by approving state programs to meet the National Ambient Air Quality Standards (NAAQS) and implementing programs in Indian Country	• High	• Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) pollution in areas affected by more frequent wildfires and drought
	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very Likely • Likely	• Protect public health by promoting healthy indoor environments through voluntary programs and guidance	• Medium	• Could increase public health risks in indoor environments, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 8 PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated Region 8 Program**	**Likelihood Region 8 Program will be Affected by Impact [f]**	**Example of Risks if Region 8 Program were Impacted**
	• Effects on the stratospheric ozone layer	• Likely	• Restoring the stratospheric ozone layer • Preventing UV-related disease • Providing an effective transition to safer alternatives	• Low	• Unable to restore ozone concentrations to benchmark levels as quickly at some latitudes
	• Effects on response of ecosystems to atmospheric deposition of sulfur, nitrogen, and mercury	• Likely	• Ecosystem protections from Agency emissions reduction programs	• Low	• Could have consequences for the effectiveness of ecosystem protections under certain programs

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 8 PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated Region 8 Program**	**Likelihood Region 8 Program will be Affected by Impact [f]**	**Example of Risks if Region 8 Program were Impacted**
Protecting America's Waters	• Increasing heavy precipitation events • Decreasing precipitation days and increasing drought intensity • Increased water temperatures • Earlier timing of spring events • Reduction in snowpack • Increasing risk of floods	• Likely • Likely • Very Likely • Very Likely • Very likely • Likely	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, increased erosion, as well as increased pollutant loads in runoff, may foul streams and threaten public health • Could become more difficult to attain water quality standards in many areas, including the chemical, biological, and physical integrity of Waters of the U.S. • The current trend of research may need to be refocused to address shifts in water quality • Could act as a threat to the institutional process of protecting water quality through water quality standard development and implementation • Runoff may shift to earlier in spring, resulting in reduced streamflow later in summer, altering aquatic environments and increasing impairments • Shifts in aquatic habitat and species may threaten the economic and cultural practices of tribal communities • Certain aquatic ecosystems (e.g., prairie potholes) may be threatened • Additional source water protection may be needed • Enforcement flexibility may be needed in the face of prolonged impacts

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 8 PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated Region 8 Program**	**Likelihood Region 8 Program will be Affected by Impact [f]**	**Example of Risks if Region 8 Program were Impacted**
	• Increasing heavy precipitation events • Increasing flood risk • Increased frequency and intensity of wildfires • Earlier timing of spring events • Decreasing precipitation days and increasing drought intensity • Reduction in snowpack	• Likely • Likely • Likely • Very Likely • Likely • Very likely	• Drinking water, wastewater and stormwater infrastructure	• High	• Water infrastructure could be overwhelmed or damaged, compromising the ability to treat, which may lead to an increased incidence of waterborne disease • Drinking water intakes and wastewater outfalls could be affected by both high and low flows • Drinking water and wastewater utilities will need an 'all hazards' approach to planning for emergencies and extreme weather events • Vulnerable and economically deprived communities may have problems accessing safe drinking water • Low flows could cause a drinking water system cross connection due to lack of water pressure, exposing potable water to unwanted contaminants
	• Increased water temperatures • Increasing heavy precipitation events • Decreasing precipitation days and increasing drought intensity • Reduction in snowpack • Increased frequency and intensity of wildfires • Earlier timing of spring events	• Very likely • Likely • Likely • Very likely • Likely • Very Likely	• The quality and availability of safe drinking water	• High	• High water temperatures and increased storm-water runoff may increase the need for drinking water treatment, raising costs • Water supplies may be affected, forcing communities to seek alternative sources • Water demand may shift to underground aquifers or prompt development of reservoirs or other water retention strategies • May need to expand monitoring to accommodate a shift in contaminants • The rate and number of violations of drinking water standards may increase

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 8 PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated Region 8 Program**	**Likelihood Region 8 Program will be Affected by Impact [f]**	**Example of Risks if Region 8 Program were Impacted**
Cleaning Up America's Communities	• Increasing heavy precipitation events • Increasing risk of floods • Increasing extreme temperatures • Increased frequency and intensity of wildfires	• Likely • Likely • Very likely • Likely	• Cleaning up Contaminated Sites and Waste Management	• Medium	• Increased risk of contaminant release from EPA CERCLA, RCRA and Brownfield Sites • May need to alter selected remedies to ensure protection • Current scientific monitoring and sampling protocols on sites may no longer be effective • Increased requests for regulatory flexibilities due to debris from extreme weather events
	• Increasing heavy precipitation events • Increasing risk of floods • Increased frequency and intensity of wildfires • Decreasing precipitation days and increasing drought intensity	• Likely • Likely • Likely	• Emergency Response and recovery	• Medium	• Increased need for emergency response and recovery assistance • Possible limitations to response and recovery assistance capabilities due to staff and financial resource constraints • Need to incorporate climate change considerations in permitting and funding mechanisms across various media pre-disaster

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 8 PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated Region 8 Program**	**Likelihood Region 8 Program will be Affected by Impact [f]**	**Example of Risks if Region 8 Program were Impacted**
Ensuring the Safety of Chemicals	• Decreasing precipitation days and increasing drought intensity • Increasing extreme temperatures • Increasing heavy precipitation events • Earlier timing of spring events • Increased pest pressure and changing mix of pests	• Likely • Very likely • Likely • Very likely • Very likely	• Protecting human health and ecosystems from chemical risks	• Medium	• Changes in planting timing or location may affect the volume and timing of agricultural chemical use, which could impact water quality and pesticide exposures to people and the environment • Weeds, diseases, and insect pests benefit from warming, and weeds also benefit from a higher carbon dioxide concentration, increasing stress on crop plants and requiring more attention to pest and weed control • Emergency exemptions for unregistered pesticides, state/local special need registrations, as well as requests to approve additional or new end uses of registered products, may increase
Enforcing Environmental Laws	• Earlier timing of spring events • Increasing risk of floods • Increased frequency and intensity of wildfires • Increasing heavy precipitation events • Increased water temperatures	• Very likely • Likely • Likely • Likely • Very likely	• Conducting environmental monitoring and sampling in various media	• Medium	• Environmental sampling methods and strategies may be compromised and require modifications • Sampling locations and equipment may be compromised, making reliable data collection difficult or impossible • Claims of force majeure may increase

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 8 PROGRAMMATIC IMPACTS [c]		
	Climate Change Impact [d]	**Likelihood of Impact [e]**	**Focus of Associated Region 8 Program**	**Likelihood Region 8 Program will be Affected by Impact [f]**	**Example of Risks if Region 8 Program were Impacted**
Facilities and Operations	• Decreasing precipitation days and increasing drought intensity • Increasing extreme temperatures • Increasing heavy precipitation events • Increased frequency and intensity of wildfire	• Likely • Very likely • Likely • Likely	• Operations of Region 8 facilities, including water and energy use	• Low	• Increased temperatures may impact cooling requirements and lower heating needs • Facilities could be located in areas with water shortages or electric power interruptions • Wildfires could affect local air quality • Could be more difficult to maintain green roofs for storm-water retention services

Footnotes for Summary Table of Climate Change Vulnerabilities

[a] This table summarizes vulnerabilities by the five goals in the EPA's Strategic Plan. Please note that the table also summarizes vulnerabilities to EPA facilities and operations, which is not part of the EPA Strategic Plan goal structure but is an important element of the EPA's vulnerability assessment. Please see Section II of this document for a fuller discussion of impacts.

[b] Climate Change Impacts are based upon peer-reviewed scientific literature.

[c] Programmatic Impacts are based upon EPA best professional judgment at this time.

[d] Impacts can vary by season and location.

[e] In general, the sources cited in this section use Intergovernmental Panel on Climate Change (IPCC) likelihood of outcome terminology where the term 'very likely' means 90-100% probability and the term 'likely' means 66-100% probability. For some impacts in the table, the likelihood determination was made using EPA best professional judgment at the time.

[f] **High** assumes the program will be affected by the impact; **Medium** assumes the program could be affected under some conditions by the impact; **Low** assumes that there is a potential for the program to be impacted or uncertainty currently exists as to the potential nature and extent of the impact. This assessment is based on best professional judgment within Region 8 at this time. Please note, this column does not reflect several important considerations. For example, it does not distinguish timeframes (current, near-term, long-term). It also does not account for regional and local variations, and does not reflect the priority of actions the agency may undertake now or in the future.

V. Conclusion

Region 8 intends to continue to fulfill its mission, despite a changing climate, by building more resilient and climate-responsive programs through effective coordination and decision-support with our partners. The vulnerability assessment of our programs will need to be updated as climate change advances, and programmatic focus areas and scientific information change over time.

Priority Actions to Address Program Vulnerabilities

The Region has proposed priority actions that can be accomplished concurrent with or as a part of its ongoing activities, or as additional resources become available. Some will require "national-level" action before the Region can address the priority – these are noted as such in the sections below. By listing an action as a priority, the Region is not making a budgetary commitment to take or complete that action, or to take or complete it by a particular point in time.

I. Introduction

The following priority actions address the program vulnerabilities discussed above.

A. Improving Air Quality

1. Tropospheric ozone pollution is likely to increase in certain areas due to the effects of climate change.

- Continue discussions related to the nexus of climate change and increased levels of tropospheric ozone pollution with state, local, and tribal partners, and proactive steps to address the issue based on innovation and sustainability.
- Region 8 will work with EPA HQ to determine appropriate actions if and when control measures are needed to reduce ozone precursor emissions.
- Promote urban heat island mitigation to reduce factors that contribute to tropospheric ozone formation.
- Continue to work with our state, tribal, local, and other federal agency partners to consider the impact of climate change on ozone monitoring in the context of broader monitoring plans and network design.

2. Particulate matter (PM) levels are likely to be affected through changes in the frequency or intensity of wildfires and drought.

- Coordinate as requested with the Agency for Toxic Substances and Disease Registry (ATSDR), as well as state agencies and local health departments, to interpret data and communicate wildfire PM risks and adaptive measures to the public.
- Utilize the Region 8 Children's Health and Clean, Green and Healthy Schools Programs to communicate wildfire PM risks and adaptive measures to the public.
- Coordinate as requested with the Indian Health Service to communicate wildfire PM risks and adaptive measures to the Tribes.

3. Climate change may worsen the quality of indoor air and increase exposures.

- Continue to coordinate with Region 8's leads for Green and Healthy Homes Initiative, the Children's Environmental Health Coordinator, and the Clean, Green and Healthy Schools Initiative to provide information to the public regarding occupant exposure to indoor pollutants as a result of climate change.

4. Climate change may alter the effects of and strategic priorities within the EPA's regulatory and voluntary programs to help restore the stratospheric ozone layer.

- Stay informed via Headquarters on trends in Region 8 levels of ultraviolet (UV) radiation. [National-Level Action Required]
- Determine if the use of ODS is increasing due to climate change (e.g., through an increased use of cooling devices and insulation foams), and if such a shift in demand might impact Region 8 programs concerned with the proper handling of such materials. [National-Level Action Required]

B. <u>Protecting America's Waters</u>

1. Climate change may affect the EPA's ability to protect and restore watersheds, aquatic ecosystems and wetlands.

- Support evaluation of hydrologic assumptions associated with TMDLs with respect to a changing climate to see how they might be affected and if adjustments might be appropriate, as well as biological monitoring and assessment techniques to assess trends. [National-Level Action Required]
- Promote early collaboration among federal agencies/state/tribes, as well as project sponsors, on water supply projects and other water infrastructure to encourage the consideration of climate change impacts and a better integrated project review process.
- Support organizations to characterize and map the type, distribution, and conditions of wetlands on a watershed scale.
- Host a headwaters protection discussion with key stakeholders to frame a discussion on climate change impacts, and the adaptation and resiliency measures that might be appropriate and practicable in these areas, especially related to the most vulnerable communities.
  Consider that water quality standards might not be met, especially regarding sediments and nutrients due to wildfires and extreme weather events, and that changes to water quality standards may be appropriate to reflectchanging conditions due to climate change.

2. Drinking water, wastewater and stormwater infrastructure may be affected.

- Work with states and tribes to integrate climate considerations into their water programs.
- Support water utilities in their on-going work to incorporate climate change considerations into their disaster management and water infrastructure planning programs.
- Work with regulated federal facilities on construction of facilities with a footprint greater than 1 acre to ensure the facilities are designed, planned and constructed to manage storm water through low-impact procedures and vegetation to reduce pollutant loading and flow-related pollution.
- Continue education and outreach on the use of green infrastructure; actual implementation of green infrastructure in planning, design, and construction; the use of a systems approach such as biomimicry; and the results of Region 8's green roof pilot project.
- Work with states and tribes to consider how funding mechanisms, such as the SRF, could support the increased need for additional investments in water infrastructure.

3. The quality and availability of safe drinking water may be affected.

- Consider the potential public health impacts of emerging and unregulated contaminants to determine if there is an imminent threat in the absence of any regulations.
- Continue education and outreach on the WaterSense Program, the Climate Ready Water Utilities Program, and the Community-Based Water Resiliency (CBWR) Initiative.

4. General

- Support the Office of Water's nine common climate adaptation actions for regional Water Programs through on-going and distinctive activities to the maximum extent practicable [with the exception of activity #7 related to the Climate Ready Water Utilities and Climate Ready Estuaries Programs].

C. <u>Cleaning Up Communities</u>

1. Contaminated sites and waste management may be threatened.

- Promote the development and use of innovative technologies and practices for site remediation and materials management.
- Continue education and outreach with state and tribal partners on the impacts of climate change, and how these considerations might be incorporated into RCRA permitting and other activities.
- Consider how to support regulatory flexibilities to manage debris associated with extreme weather events.

2. Climate change may lead to an increased need for emergency response and recovery.

- Work with EPA Headquarters and other relevant agencies to encourage coordination between the National Response Framework (NRF) and the National Disaster Recovery Framework (NDRF) to take advantage of the short policy window for incorporating sustainability and climate adaptation into redevelopment considerations. [National-Level Action Required]
- Work with ATSDR, FEMA, and EPA Headquarters to identify where disaster exacerbated environmental problems intersect with known human health threats to help prioritize when EPA deploys limited recovery resources. [National-Level Action Required]
- Through EPA's working relationships with FEMA Region 8 and other EPA Regions, develop and implement best management practices to build community resiliency that consider sustainability and climate adaptation.
- Continue to emphasize the need to plan for and prioritize funding set asides for disaster afflicted communities in programs like Brownfields, the Partnership for Sustainable Communities, the SRF, and other grant funding programs. [National-Level Action Required]

D. <u>Ensuring the Safety of Chemicals</u>

1. The ability to protect human health and ecosystems from chemical risks may be affected.

- Support states in their requests to EPA Headquarters (OPP) for emergency exemptions, special need registrations, and additional or new end uses of registered products. [National-Level Action Required]

- Encourage EPA Headquarters to make agriculture-related grants a priority to facilitate agricultural adaptation to climate change.
- Continue to promote Integrated Pest Management and other sustainable agriculture practices.

E. Enforcing Environmental Laws

1. Climate change may affect environmental monitoring and sampling in various media.
- Consider that environmental monitoring and sampling methods and strategies in Region 8 may be compromised due to the impacts of climate change.

F. Facilities and Operations

1. Operations of Region 8 facilities, including water and energy use, may be affected.
- Maintain the staff's capacity to work remotely.
- Work to reduce the physical footprint of Region 8 facilities.

G. Vulnerable Populations

1. Vulnerable populations may be at a higher risk from climate change impacts.
- Develop a methodology to identify the populations in Region 8 who are the most vulnerable to the impacts of climate change – utilize tools such as the Social Vulnerability Index,[xxxv] the Water Supply Sustainability Risk Index,[xxxvi] the Spatial Hazard Events and Losses Database for the United States,[xxxvii] and relevant outputs of the global climate models.
- Explore opportunities to collaborate with tribes, other EPA regional offices, other federal agencies, non-governmental organizations, etc., to share information and experiences related to adaptation.
- Work with tribal partners and other relevant organizations (such as ITEP - Institute for Tribal Environmental Professionals) to provide climate information, tools and training, that would assist tribes in preparing for observed and expected climate changes, and meeting their environmental regulatory responsibilities.
- Embark on a process to include adaptation into the tribal grant making function.
- Periodically review and assess emerging scientific and TEK understanding on relevant climate vulnerabilities and projections, and incorporate into programmatic work, as appropriate. [National-Level Action Required]

Other Priority Actions

I. Introduction

The following priority actions aren't specifically tied to the program vulnerabilities discussed above, but are key elements of building adaptive capacity into Region 8 Programs, and those of our state and tribal partners. They are meant to be initiated and conducted within a 1 to 3 year period of time. Some actions will be on going, while others will be completed by the end of this timeframe.

A. Agency-Wide Strategic Measures

The *FY 2011-2015 EPA Strategic Plan* contains the Agency's first "strategic performance measures" for integrating climate adaptation into its activities.[xxxviii] These strategic performance measures commit the Agency to integrate adaptation planning into five major rulemaking processes and five major financial assistance mechanisms by 2015. They also call for the integration of adaptation planning into five major scientific models or decision-support tools used in implementing Agency environmental management programs.

1. Integrate Adaptation Planning into Rulemaking Processes

- Explore opportunities to incorporate climate adaptation considerations into regional rulemaking processes.

2. Integrate Adaptation Planning into Financial Assistance Mechanisms

- Explore opportunities to incorporate climate adaptation considerations into competitive funding announcements in accordance with the October 18, 2011, EPA guidance memo jointly issued by the Office of Policy and the Office of Grants and Debarment - this may include a climate adaptation criterion wherever it is relevant to the program's mission and outcomes.

3. Integrate Adaptation Planning into Models or Decision-Support Tools

- Explore opportunities to incorporate climate adaptation considerations into models or decision-support tools.

B. Legal and Enforcement Issues

The EPA derives its authority to act from the U.S. Constitution and the laws passed by Congress. The Agency is committed to ensuring that its actions are constitutional, authorized by statute, consistent with Congress's vision and intent, and otherwise legally supported. The 2011 *EPA Policy Statement on Climate-Change Adaptation* called on the Agency to "identify for the Office of General Counsel areas where legal analysis is needed to carry out agency actions called for in this policy statement." In certain circumstances, Region 8 may need to determine the extent of its legal authorities or responsibilities to incorporate adaptation measures into proposed actions.

- Address any legal and enforcement issues that may arise through the Office of Regional Counsel (ORC) and Legal Enforcement Program (LEP), in consultation with the Office of General Counsel (OGC) and the Office of Enforcement and Compliance Assurance (OECA), as necessary. [National-Level Action Required]

C. Training and Partnerships

A central element of the Region's efforts to adapt to a changing climate will be to increase staff's awareness of how climate change may affect their work by providing them with the necessary data, information, and tools. Additionally, states, tribes, and local communities share responsibility for protecting human health and the environment, and partnerships with the EPA are at the heart of this. Additionally, it will be important to work with EPA Headquarters and other Regional Offices on pilot projects that test climate adaptation approaches that are broadly applicable. These partnerships will

be critical for efficient, effective and equitable implementation of climate adaptation strategies, which will evolve over time.

- Ensure that technical staff and their partners have access to training on the importance of climate adaptation, and how they can incorporate climate adaptation considerations into their work. [National-Level Action Required]
- Ensure that technical staff and their partners have access to specific approaches, data, and tools for integrating climate adaptation into decision-making processes.[6] [National-Level Action Required]
- Develop a Region 8 climate adaptation communication strategy to enhance external climate change communication, which may include state and tribal partners, municipalities, industry, the public, and other relevant parties. Update the Region's website with information on climate change impacts and risks, and the programs, tools, and resources available to stakeholders to enhance adaptation and resiliency.
- Work with state, tribal, and local partners and their advocacy organizations (such as the Western Urban Water Coalition), using a diversity of approaches, to build adaptive capacity and encourage climate adaptation planning using the framework of existing programs (such as the SRF), and various tools and resources (such as the Climate Ready Water Utilities Program). .
- Work with other federal agencies and international partners to enhance understanding of climate change, leverage collective knowledge about climate adaptation planning, reduce duplication, and avoid conflicting efforts.
- Work with EPA Headquarters and other Regional Offices on pilot projects that test climate adaptation approaches that are broadly applicable to learn what works and why. [National-Level Action Required]

D. <u>NEPA</u>

- Through NEPA reviews, encourage consideration of long-term climate change impacts, and discuss how the lead agency could mitigate impacts on water supply and environmental resources. Climate change influences on the project may translate into modified design and operational assumptions for determining resource supplies, system demands, system performance requirements, and operational constraints.
- Through NEPA reviews, encourage energy development projects to disclose water quantity needs and impacts on sources (groundwater, surface water, reservoirs).
- Through NEPA reviews, encourage assessment of the risks of climate change (particularly flooding) to transportation systems and services.

Monitoring and Evaluating Performance

Region 8 will evaluate its climate change adaptation activities on an annual basis to assess progress toward mainstreaming climate change adaptation into programs, policies, rulemaking processes, and operations. Based on lessons learned about the most effective climate change adaptation strategies, Region 8 can make adjustments to its approach.

[6] Tools include such things as the EPA's Climate Ready Water Utilities CREAT decision-support tool, the EPA Global Change Research Program's Integrated Climate and Land Use Scenarios (ICLUS), and community-based social marketing strategies.

Some metrics exist that will enable Region 8 to measure the results of its activities - others will need to be developed over time. In general, these metrics will reflect:

- *changes in knowledge* (*e.g.,* number of staff/partners taking formal training to increase their awareness of the importance of adaptation planning)
- *changes in behavior* (*e.g.,* increases in the use of decision support tools to integrate climate adaptation planning into activities such as infrastructure planning decisions)
- *changes in state/condition* (*e.g.,* changes in the ability of communities to withstand more frequent and intense storm events and avoid, for example, combined sewer overflows)

Region 8 recognizes that the integration of climate adaptation planning will occur over time. This will happen in stages, and measures should reflect this evolution. The earliest changes in many programs may be changes in knowledge and awareness, followed by changes in behavior and the use of adaptation tools, and then implementation of projects that build adaptive capacity and lead to changes in state and condition.

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EPA Region 9 Climate Change Adaptation Implementation Plan

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Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation*

Plan therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Bob Perciasepe
Deputy Administrator

September 2013

EPA Region 9
Climate Change Adaptation Implementation Plan

I. Purpose

This Climate Change Adaptation Implementation Plan (Plan) outlines actions the United States Environmental Protection Agency (EPA) Region 9 will take to become more resilient to our changing climate.

EPA issued a Policy Statement on Climate-Change Adaptation in June, 2011[1]. The Policy Statement recognizes that climate change can pose significant challenges to EPA's ability to fulfill its mission and calls for the Agency to anticipate changes in climate and incorporate considerations of climate change into its activities. In accordance with the Policy Statement, EPA issued an Agency-wide Draft Climate Change Adaptation Implementation Plan[2] on February 8, 2013, describing how the agency intends to adapt to climate change and assist its partners in doing the same. Subsequently, each of the EPA's national program offices, and its ten regional offices, developed Climate Change Adaptation Implementation Plans, specific to their programs and regions. Many programs throughout EPA have already begun to address the implications of climate change.

Region 9 intends to fulfill its mission by building a more resilient and climate-responsive program. We will assist our partners in meeting the challenges of climate change through financial and technical assistance, effective coordination and decision-support to increase their resilience.

Vision of the Future EPA (from U.S. EPA Climate Change Adaptation Plan, 2013)

We live in a world in which the climate is changing. Changes in climate have occurred since the formation of the planet. But humans are now influencing Earth's climate and causing it to change in unprecedented ways.

It is in this rapidly changing world that EPA is working to fulfill its mission to protect human health and the environment. Many of the outcomes EPA is working to attain (e.g., clean air, safe drinking water) are sensitive to changes in weather and climate. Until now, EPA has been able to assume that climate is relatively stable and future climate will mirror past climate. However, with climate changing more rapidly than society has experienced in the past, the past is no longer a good predictor of the future. Climate change is posing new challenges to EPA's ability to fulfill its mission.

It is essential that EPA adapt to anticipate and plan for future changes in climate. It must integrate, or mainstream, considerations of climate change into its programs, policies, rules and operations to ensure they are effective under future climatic conditions. Through climate adaptation planning, EPA will continue to protect human health and the environment, but in a way that accounts for the effects of climate change.

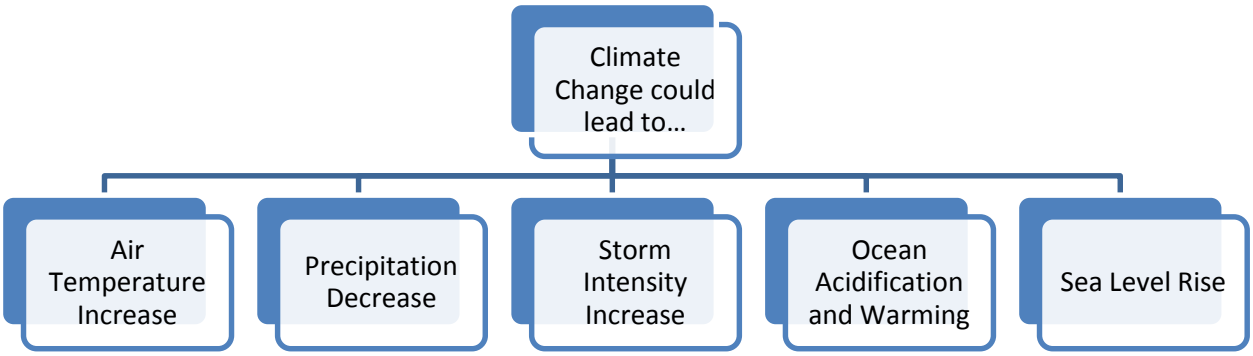
II. Impacts from Climate Change in EPA Region 9

Around the world, a cascade of effects is expected to result from climate change. Most of these changes will be felt somewhere in Region 9. Those changes will vary from the arid southwest deserts to the Pacific Islands to the Northern California coastal forests. Some changes are more certain than others. Changes may be local, or cover the whole region. Below are some examples of climate change impacts that are likely to occur in Region 9.

- Air temperatures will increase;
- Precipitation may decrease in some areas;
- Storm events may be more severe;
- Oceans will become more acidic and warm; and
- Sea level will rise.

Figure 1 illustrates the impacts that are likely to result from each of these climatic changes.

Figure 1: **Adverse Impacts of Climate Change**



- Tropospheric ozone increase
- Heat event increase
- Snow fall and pack decrease
- Runoff season change
- Wildfire increase
- Water temperature increase
- Species changes

- Water supply change
- Freshwater flow decrease
- Wildfire increase
- Soil moisture decrease
- Species changes

- Flooding
- Damage to communities and infrastructure (inland and on coast)
- Damage to habitats (inland and on coast)
- Erosion increase (inland and on coast)

- Coral reef decline
- Aquaculture decline
- Species changes

- Salt water intrusion to groundwater
- Coastal erosion
- Damage to communities and infrastructure
- Damage to habitat

III. Vulnerabilities for EPA Region 9 Communities, Populations, Habitats, and Programs

The term "vulnerability" refers to the degree to which a community or habitat is susceptible to, or unable to cope with, the adverse effects of climate change. This section discusses the communities, populations, and habitats in Region 9 that are most vulnerable to climate change, and where EPA's mission intersects with the challenges that these vulnerable communities and habitats face. This section also identifies where EPA's ability to meet its own mission and goals is at risk from climate change.

Certain parts of the population, such as children, the elderly, minorities, the poor, persons with underlying medical conditions or disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies, and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society.

This 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 Plan is conducted, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events (e.g., Hurricane Katrina and Superstorm Sandy) and the subsequent recovery efforts.

The EPA has not conducted a quantitative assessment of vulnerabilities within Region 9. Rather, we have drawn on the best available science, the detailed assessments of others, and our own best professional judgment. Summaries of selected writings are provided in Appendix B.

A. Definitions

Vulnerable communities include those which are in the path of potentially large climate-related impacts and have limited ability or interest in re-locating. For example, traditional communities may have important customs tied to specific locations. This includes some Native American Tribal communities on the main land and Pacific Island communities on islands or atolls. A community's traditions may also include specific vulnerable plant or animal species only found in certain areas. Major climate change impacts (i.e., sea level rise, coastal erosion, fire, or flood) could physically destroy an entire community or the most vulnerable segments. Some communities (indigenous or not) that are in the path of climate change impacts may not have financial resources to adequately prepare or to relocate.

Vulnerable populations include individuals who are at risk because of existing health issues. The populations most vulnerable to climate change often include, but are not limited to, the communities that are the focus of EPA's environmental justice program. Children, the elderly, the poor, the infirm, and tribal and indigenous populations are among the most vulnerable. For example, the elderly tend to

be more susceptible to heat stroke due to their bodies' decreased ability to cool down and complications with existing chronic ailments (e.g., diabetes).[3]. In addition, people on fixed incomes have limited financial resources to protect their health (e.g., incurring electric bill charges for running an air conditioner during an extreme heat event). Individuals with asthma are more susceptible to the impacts of increased ozone and particulate matter in the air[4].

Vulnerable habitats are at risk when the resources and conditions they depend on change or are eliminated. For example, a wet montane meadow dependent on snowmelt runoff all summer may not survive if mountain snows dry up before summer's end. A coral reef may not survive if storms wash sediment from the land and the coral is smothered. A protective mangrove forest may be flooded and destroyed by storm wave over wash and sea level rise[5], allowing storms to erode a newly exposed coastline and formerly protected communities.

The effectiveness of EPA programs will be at risk if they cannot meet the EPA mission and goals in the face of climate change. EPA must consider climate change impacts and vulnerabilities in the regular course of work (e.g., reviewing grant applications, permit applications and NEPA documents; planning for emergency response; considering air pollution impacts to communities). Public health could be put at risk if drinking water supply pipes are washed away in a storm. The biological integrity of a restored coastal wetland system could be lost due to sea level rise. Wildfires and dust storms could put more particulate matter into the atmosphere which could reduce air quality and negatively impact human health. EPA's emergency response capabilities may be called on more frequently as extreme weather events increase. EPA owned or rented facilities may be directly impacted (e.g., due to sea level rise) or indirectly impacted (e.g., power line failures) by climate change. During and following extreme weather events, the ability of EPA personnel to access communication systems, or respond in person, may be impeded by storm damage and flooding.

B. Vulnerabilities in Region 9

Climate change exacerbates our existing environmental problems, and makes it more challenging for EPA to fulfill its mission to protect public health and the environment Anticipated climate change impacts, their likelihood of occurrence, and their effects on EPA programs are described in Appendix A, "Challenges that Climate Change Poses to EPA Region 9 Program Effectiveness".

In order to understand the challenges that EPA programs will face, it is important to understand the vulnerabilities that the Region 9 communities, populations and habitats will face. Climate change vulnerability varies from one geographic area to another within Region 9, due to the variation in interactions of the ocean, the landscape and the atmosphere. The climate change challenges that Federally-recognized Tribes within Region 9 face are of particular concern to EPA. This section provides background on vulnerabilities within Region 9 geographic zones, and in Indian Country.

B. 1. Vulnerabilities in Geographic Regions of Region 9

Region 9 lies within 3 of the 8 geographic regions defined by the *National Water Program 2012 Strategy: Response to Climate Change*[6] – the Southwest, the Montane, and the U.S. Pacific Islands and Territories. Unless otherwise referenced, the following descriptions of vulnerabilities in these three geographical regions (sections B.1.a., B.1.b., and B.1.c.) are from this same 2012 EPA document. These regional designations are based largely on those defined by the US Global Change Research Program.[3]

B.1.a. The Southwest Region: Much of the southwest is arid with relatively high air temperatures. Several mountain ranges, as well as the Pacific Ocean, influence climate and water resources in certain parts of the Region. Water is stored as snowpack during the winter and released to streams in the spring and early summer, helping to meet increasing water demands**.** There are three major river systems: the Sacramento-San Joaquin, the Colorado, and the Rio Grande. Several huge water storage and conveyance projects divert water from rivers for more widespread use by agriculture and growing cities. The lack of rainfall and the prospect of future droughts becoming more severe is a significant concern, especially because the Southwest continues to lead the nation in population growth.

- Warmer temperatures will reduce mountain snow packs, and peak spring runoff from snow melt will shift to earlier in the season, leading to and increasing the shortage of fresh water during the summer. A longer and hotter warm season will likely result in longer periods of extremely low flow and lower minimum flows in late summer. Water supply systems that have no storage or limited storage (e.g., small municipal reservoirs) may suffer seasonal shortages in summer;
- The magnitude of projected temperature increases for the Southwest, particularly when combined with urban heat island effects for major cities such as Phoenix, Albuquerque, Las Vegas, and many California cities, represents significant stresses to health, energy, and water supply in a region that already experiences very high summer temperatures;
- Reduced ground water supply due to a lack of recharge will be of concern;
- Warmer ocean temperatures may decrease productivity by stopping entrainment of deep supplies of nutrients. The resulting reductions in commercial species will need to be addressed to support continued production of fisheries and aquatic life;
- Increased frequency and altered timing of flooding will increase risks to people, ecosystems, and infrastructure. Increased flood risk is likely to result from a combination of decreased snow cover on the lower slopes of high mountains, and an increased percentage of winter precipitation falling as rain and therefore running off more rapidly;
- Sea levels are rising and contributing to the loss of wetlands and infrastructure located along coastal corridors; and
- The magnitude and frequency of wildfires have increased over the last 30 years which severely impacts water quality in streams, creeks, rivers, lakes, and estuaries.

B.1.b. The Montane Region: The Montane region within EPA Region 9 includes the glaciated mountain tops and down-slope watersheds of the Sierra Nevada and Cascades. These areas are unique in that they rely on winter snow accumulation for their water supply. Sensitive ecological communities include bogs and fens. Montane glaciers and snowfields are reservoirs of water for the human populations and ecological communities at lower elevations.

Most ecosystems in the North American Montane Region are predicted to slowly migrate and shift their distribution towards the north in response to warming temperatures. However, the alpine areas are often distributed as small, isolated regions surrounded by other habitats. These areas can be disconnected from each other by wide stretches of land used for timber production, ranching, or other uses. Instead of shifts in latitude, alpine vegetation and animals will be limited to shifts in altitude, unless connections between suitable habitats can be made.[7]

- A warmer climate will cause lower-elevation habitats to move into higher zones, encroaching on alpine and sub-alpine habitats;
- High-elevation plants and animals will lose habitat area as they move higher with some "disappearing off the tops of mountains;"
- Rising temperatures will increase the importance of connections between mountain areas;
- Rising temperatures may cause mountain snow to melt earlier and faster in spring, shifting the timing and distribution of runoff. This in turn affects the availability of freshwater for natural systems and for human uses. Earlier melting leads to drier conditions for the balance of the water year, with increased fire frequency and intensity;
- Water supplies will become increasingly scarce, calling for trade-offs among competing uses, and leading to conflict;
- Increased frequency and altered timing of flooding will increase risks to people, ecosystems, and infrastructure;
- Projected increases in temperature, evaporation, and drought frequency add to concerns about the region's declining water resources; and
- Climate change is likely to affect native plant and animal species by altering key habitats such as the wetland ecosystems known as montane fens or playa lakes.

B.1.c. The Pacific Islands Region: The Pacific Islands region in EPA Region 9 encompasses the Hawaiian Islands, as well as the United States affiliated Pacific islands, including the territories of American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), and Guam. The Pacific Islands are more vulnerable to climate change than nearly any other region in the United States. Key vulnerabilities include availability of freshwater, adverse impacts to coastal and marine ecosystems, and exposure to hazards including sea level rise and inundation.

- Rising sea levels, higher sea temperatures, and ocean acidification associated with climate change are further degrading coral reefs already stressed by overfishing and pollution. Their loss diminishes ecological heritage, shoreline protection, food supply from the sea, and results in a decline in income from ecotourism in the Pacific Island communities where tourism is one of the largest industries;
- Potential for extended drought, due to a change in rain-delivering weather systems. Due to the geographic isolation of the Pacific Islands and the challenges of delivering freshwater from other regions, a drought could have major impacts on freshwater supply. A severe drought would impact water supplies for drinking water, agriculture irrigation, and industry. Key freshwater and brackish habitats would likely be impacted [8]. The western Pacific already experiences the highest rate of Category 4 and 5 storms. Climate change may bring more frequent and higher energy storms resulting in potentially catastrophic damage to island infrastructure. This degree of damage could cripple the economies of Pacific Island communities for significant periods of time, not only impairing economic development but also the ability of local governments to ensure delivery of basic water and sewer and other public health services; and

- Sea level rise has multiple implications for Pacific Island communities:
    - For the low-lying atolls, entire islands may be submerged within a generation and may result in environmental refugees seeking new homes;
    - For some low-lying islands, sea level rise can result in "wash over," in which islands, or portions of islands, are submerged by waves during large storm events. This results in salt water contamination of agricultural lands, significantly decreasing the productivity of those lands. This loss of agricultural productivity has an acute impact on the largely subsistence-based economies of these communities;
    - For many of the islands, sea level rise has an immediate, and accelerated impact on coastal erosion, which affects water quality, coral reef health, coastal infrastructure, available land, and culturally significant sites; and
    - Sea level rise increases the potential for salt water intrusion into the sole source aquifers upon which many Pacific Islands rely for drinking water. There are few or no readily accessible alternative drinking water options when a community is confronted with the loss of productivity of a sole source aquifer.

Appendix B provides summaries of selected studies conducted on climate change vulnerabilities in the geographic areas of Region 9.

B.2. Vulnerabilities on Tribal lands in Region 9

The US EPA Draft Climate Change Adaptation Implementation Plan[2], issued on February 8, 2013, includes a discussion of the importance of EPA working with the Tribes to assist them in successfully adapting to climate change:

"Indigenous people are among the most vulnerable communities in North America.[9] Tribes are more vulnerable to climate change impacts because of their dependence upon a specific geographic area for their livelihoods, the degree to which those geographic areas embody climate-sensitive environments, and their unique cultural, economic, or political characteristics and contexts. Also, tribes generally have fewer resources to prepare for, respond to, and recover from natural hazards, including those related to climate change.[10] The disproportionate vulnerability of tribes to climate change affects EPA's mission to protect human health and the environment in Indian country."

"Drought is perhaps the most pervasive climate-induced weather impact on tribes. Water is at the heart of many tribal cultures and the foundation of their livelihoods, economies, subsistence, and treaty rights. Water is essential to the sustainability of the fish, wildlife, and plants on which tribes rely. The recent trend toward more severe and frequent droughts, especially in the American Southwest, threatens the very underpinnings of tribal communities. The Southwest is already in the midst of a 10-15 year drought, and climate projections suggest the Southwest may transition to a more arid climate on a permanent basis over the next century and beyond.[11] In fact, climate observations indicate that this transition may have already begun.[12]"

IV. Priority Actions

EPA Region 9 is already addressing climate change adaptation in several program areas. We will continue to pursue the best opportunities for integrating climate change into our existing programs, and identify new climate change adaptation needs where EPA's involvement is critical.

As EPA Region 9 cannot immediately address all climate change adaptation needs, we have adopted criteria to screen potential actions. EPA Region 9 will target its climate change adaptation work, based on the following criteria:

- Does the action target one of the most severe and immediate vulnerabilities?
- Does the action focus on one of the most vulnerable populations and/or geographic areas?
- Does EPA Region 9 have the capacity (personnel and funding resources) and ability (knowledge, skills, and authority) to take the action and contribute to a solution?
- Is this a priority action for our partners (federal/state/territory/tribal/local government and non-government) and are they able to work with us towards a solution?
- Does the action support and align with other EPA Region 9 priorities and actions?

In Sections A and B below, we describe a substantial number of priority actions that EPA Region 9 plans to implement as climate change adaptation measures. We include both region-wide adaptation actions and program-specific actions. In addition, below are five specific adaptation actions that reflect EPA Region 9's strong commitment to climate change adaptation. The region intends to provide particular emphasis and focus on these adaptation actions over the next year.

** Implement the Region 9 Coral Reef Strategy and provide leadership to reduce local pollution and increase coral reef climate change resiliency.*

** Hold at least one roundtable discussion session with federal and state agencies, and other key climate change adaptation stakeholders, to discuss climate change vulnerabilities and coordinate efforts to build climate change resiliency.*

** Provide a key venue at R9 RTOC Meetings to identify key tribal climate change adaptation issues and success stories, as well as technical and financial resources to build resiliency, and provide a forum for information sharing, training, and capacity building. Support elevation of appropriate issues to the Tribal Science Council, promoting Region 9 tribes' participation with ORD on climate change issues and in climate change discussions.*

** Support EPA's state counterparts in Arizona, California, Hawaii, and Nevada in climate adaptation efforts, potentially including developing an annual summary of their climate change adaptation*

successes, summarizing regional highlights for building climate change resiliency, or promoting success stories on climate change adaptation.

** Provide training to the EPA Region 9 workforce on climate change impacts and adaptation opportunities. Provide training on incorporating climate change into the Region's programmatic operations.*

A. Region-Wide Themes for Climate Change Adaptation

1. Mainstream Climate Change into EPA's Work.

Critical to carrying out the EPA mission is our ability to integrate climate change considerations into our everyday work. EPA Region 9 has been active in this area since developing our *Energy and Climate Change Strategy* in 2007. This Strategy led to the formation of our Clean Energy & Climate Change Office, which serves the entire Region, and the establishment of a cross-divisional Clean Energy and Climate Change Team (ETeam). Drawing upon the foundation laid in the EPA Office of Water Climate Change Strategy and the CCA Plans which other EPA regions and Headquarters offices are preparing, EPA Region 9 will continue to integrate climate adaptation into existing programs and activities to maximize their effectiveness. This will include the following steps and activities:

a. Strengthen adaptive capacity for EPA Region 9 and our partners. EPA Region 9's ETeam and Regional Science Council have worked together to offer a series of climate change training sessions to all Region 9 staff. In order to continue to integrate climate change into EPA Region 9's existing programs effectively, EPA Region 9 will continue to train our staff, and build our capacity for adaptation actions. We anticipate that future training sessions will focus within the EPA Region 9 office, but will also likely extend to our federal, state, tribal and local partners.

To assist our partners in taking actions most relevant to their particular climate change vulnerabilities, EPA is invested in supporting the partners' own decision-making. The term "decision-support tools" is used to describe documents or programs that help organizations understand what questions to ask, or what data to gather, so they can decide what actions to take to increase their climate change resilience.

- Provide training opportunities to our staff to increase their understanding of climate change vulnerabilities in our Region, and how to best incorporate climate change adaptation into our work. As needs and expertise vary between EPA Region 9 programs and between individuals, ask staff what their specific priority climate change adaptation training needs and preferences are. Provide training that is the most urgent or will fill the biggest information gaps.
- Work with EPA Region 9 Science Council, EPA national Program Offices, the EPA-wide training program in the Office of Human Resources, and outside partners, to provide access to on-line and in-person training opportunities. This includes access to a library of webinars and

recordings of classes that make the best use of current technology. [Work with EPA Headquarters]

- Encourage our partners to integrate climate change adaptation effectively into their work. Share existing decision-support tools and training opportunities on climate change adaptation, especially where training is local or available on-line.
- Where resources allow, and our expertise exists, provide decision-support tool information directly to partners (e.g., targeted training sessions). Look for opportunities to coordinate with partners (federal, state, territory, and tribal agencies, and non-government organizations) on climate change adaptation training sessions.
- On a regular basis, update climate change content on EPA Region 9 websites – for both climate-related and programmatic web pages. Encourage other organizations to link to our climate change web pages. Include links to EPA climate change web pages in communications to partners about related issues.

b. Integrate Climate Change Adaptation into Funding Mechanisms. Incorporating climate change consideration into funding actions will help build the climate change adaptation capacity of our partners, and make it less likely that funds will be spent on projects that will be damaged or destroyed by sea level rise or extreme storm events, or other climate change impacts.

- Continue to incorporate the consideration of climate change impacts and adaptation measures into financial mechanisms, such as grants and contracts. The number of EPA Region 9 funding mechanisms that are now considering climate change adaptation continues to grow. Existing funds include General Assistance Program grants to tribes, San Francisco Bay Water Quality Improvement Fund (SFBWQIF) grants and Wetland Program Development Grants. Other grant funds that could include climate change adaptation consideration are the Clean Water Act Section 319 (nonpoint source control) and Section 106 (water quality monitoring), Brownfields, and the Strong Cities-Strong Communities (SC2).
- Encourage States to require climate change adaptation consideration in their State Revolving Fund loan programs. [Work with other Regions and EPA Headquarters]
- Implement EPA Region 9's Greening Grants Policy, encouraging grantees to not only reduce their carbon footprint, but also implement sustainable measures which are important to successful climate change adaptation (e.g., water and energy conservation).

2. Focus on severe vulnerabilities.

Three severe potential impacts in EPA Region 9, relative to EPA's mission, are:

1) decreased water availability due to drought and loss of snow pack;
2) flooding due to more extreme weather events and sea level rise; and
3) degradation of coral reefs due to ocean acidification and bleaching.

In focusing on these particular vulnerabilities, EPA will consider where it can best contribute to the work of federal, state, tribal, and local agencies, and non-governmental organizations. While many of the

specific actions targeting these vulnerabilities are described in the EPA Region 9 program-specific section, below, some of the general areas of adaptation we will pursue are described here.

a. Decreased water availability due to drought and loss of snow pack. EPA Region 9 water resources are already limited on the mainland and on the Pacific islands.

- Promote water use efficiency, conservation, and recycling.
- Promote the protection and restoration of wetlands and riparian areas in order to protect the quality and quantity of surface and groundwater supplies.
- Promote the use of Green Infrastructure for more sustainable stormwater management (e.g., reducing polluted runoff to surface waters, providing flood mitigation, enhancing drinking water supplies).
- Work with our states, tribes, and local partners to prepare for potential water shortages. Provide water resource managers and utilities with access and training for existing decision-support tools; collaborate on new tool development and training; and use EPA funds and resources to leverage other water resource and infrastructure funds for climate change adaptation.

b. Flooding as a result of more extreme weather events and sea level rise. The areas of EPA Region 9 most susceptible to sea level rise are Hawaii, the Pacific Island territories, and coastal California – including the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay Delta Estuary).
With particular focus on these coastal areas, EPA Region 9 will use its Geographic Information System (GIS) mapping capabilities, and available tools from government and non-government partners, to better target adaptation actions. Region 9 will consider improved mapping of hazardous waste sites to illustrate climate change vulnerabilities of these locations (e.g., sea level rise, storm event flooding), especially around vulnerable communities and ecosystems. This information can be used to help prioritize EPA Region 9's adaptation actions and help our partners prioritize their own work.

c. Degradation of coral reefs due to ocean acidification and bleaching. Climate change and related increased atmospheric carbon dioxide levels are triggering ocean warming, acidification, sea level rise, and increased storm intensity, all of which pose major threats to the future of coral reefs.

- EPA Region 9 will implement our coral reef strategy to protect and help increase the resilience of these fragile ecosystems in the face of climate change.
- EPA Region 9 will use the Clean Water Act and other authorities to improve protection of coral reefs in Hawaii, the U.S. territories, and other U.S.-affiliated Pacific islands, especially by controlling land-based sources of pollution which impact coral reefs.

3. Focus on the most vulnerable populations and geographic areas.

a. Tribes. Tribes in EPA Region 9 are increasingly concerned about the effects of a changing climate on their communities, resources and traditional cultural practices. Tribes in EPA Region 9 already experience temperature extremes and droughts, which have negatively affected their lands. Some Tribes are drawing on their oral histories and their Traditional Ecological Knowledge (TEK) to document past and current conditions, assess changes, and plan for adaptation.

EPA values its unique government-to-government relationship with Indian 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 and the 2011 Policy on Consultation and Coordination with Indian Tribes. These policies recognize and support the sovereign decision-making authority of tribal governments.

Supporting the development of adaptive capacity among tribes is a priority for the EPA. 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 to develop adaptation strategies that promote sustainability and reduce the impact of climate change on Indian tribes.

EPA engaged tribes through a formal consultation process in the development of the Agency's Climate Change Adaptation Plan. Tribes identified some of the most pressing issues as erosion, temperature change, drought and various changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. At the same time, tribes challenged EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative burdens are reduced.

This Plan identifies specific steps that will be taken to partner with tribal governments, on an ongoing basis, to increase their adaptive capacity and address their adaptation-related priorities. These collaborative efforts will benefit from the expertise provided by our tribal partners and the TEK they possess. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change and has been used by tribes for millennia as a valuable tool to adapt to changing surroundings. Consistent with the principles in the 1984 Indian Policy, TEK is viewed as a complementary resource that can inform planning and decision-making.

Networks and partnerships already in place will be used to assist tribes with climate change issues, including Regional Tribal Operations Committees, the Institute for Tribal Environmental Professionals and the Indian General Assistance Program (IGAP). Additionally, Region 9 will pursue effective coordination among EPA Regional and Program Offices, since climate change has many impacts that transcend program and regional boundaries. Transparency and information sharing will continue, in order to leverage activities already taking place within EPA Offices and tribal governments.

- Support and encourage the use of General Assistance Program (GAP) grants, and other available funds for climate change adaptation, as particular funds allow (e.g., education of staff and

members, assessing their community and environment, developing climate change adaptation plans).

- Continue to provide funding for sustainable water infrastructure on tribal lands, in coordination with the Indian Health Service.
- Use the Regional Tribal Operations Committee as a forum for climate change adaptation information sharing, training, and capacity building.
- Exchange information with the National Tribal Science Council on national tribal climate change adaptation needs and directions, as appropriate. [Work with EPA Headquarters]
- Coordinate with other federal agencies who work directly with tribes to determine the best way to collaborate on climate change adaptation support.
- Consult with tribes on major proposed EPA climate change actions, in accordance with our established tribal consultation policies.

b. Islands. Hawaii and the United States Pacific Island territories of American Samoa, Commonwealth of the Northern Mariana Islands (CNMI), and Guam are among the most vulnerable areas on the planet for climate change impacts. Within decades, it may not be viable to live on some currently-populated Pacific islands. Sea level rise, coastal erosion, extreme drought, an increase of severe storms, and a reduction of food supply, all threaten sustainable human habitat on some islands. The EPA Region 9 Pacific Islands Office and the EPA Region 9 program offices will work with island governments, and other partners, to address critical climate change adaptation vulnerabilities (e.g., shortage of freshwater supplies, impacts to coastal and marine ecosystems including coral reefs, and hazards associated with rising sea levels and storm events including damage to wastewater and stormwater infrastructure, crop damage, saltwater intrusion into aquifers, and inundation of low-lying islands).

- Support and encourage the use of grants to local environmental agencies and other entities for climate change adaptation.
- Continue the use of water and wastewater construction funds to support sustainable water infrastructure in the Pacific islands in light of anticipated climate change impacts.
- Use the tools at EPA's disposal, including funding, technical assistance, and enforcement to protect coral reefs from land-based sources of pollution.
- Factor climate change impacts and climate change adaptation into emergency preparedness and emergency response in the Pacific islands.
- Coordinate with, and participate in, local Pacific island climate change and renewable energy working groups and task forces.
- Coordinate with other federal agencies who work with the Pacific islands on climate change adaptation.

c. California Coast (including the Bay Delta Estuary). The California coast and the Bay Delta Estuary are at risk from climate change. Storm events and sea level rise are expected to impact coastal watersheds, tidal wetlands, and low-elevation infrastructure. California state and local agencies, federal agencies, and non-government organizations are already working together to begin to address climate change impacts. EPA Region 9 will continue work with these partners to determine where our abilities and resources can be best applied to facilitate climate change adaptation.

B. Program-Specific Climate Change Adaptation Actions

Each EPA Region 9 program office will continue to work with its counterpart office at EPA Headquarters, and with other partners, to determine how to best integrate key climate change actions into current work. EPA Region 9 will continue to identify new priority actions that are critical to building climate change resilience. Existing and potential EPA Region 9 priority actions for climate change adaptation are identified below. EPA Region 9 intends to continue to pursue current actions and take on new priorities, as resources allow.

1. Air Program

EPA Region 9's Air Division is pursuing work that has benefits for climate change adaptation. It is anticipated that increased temperatures due to climate change have the potential to increase the formation of photochemical smog. Thus, Air Division will need to adapt to this reality and will focus on reducing air quality impacts of climate change through efforts to reduce NOx and other smog and PM2.5-forming pollutants. The EPA Region 9 Air Division anticipates the following actions in 2014.

- Focus on reduction of tropospheric photo-chemical smog, or ozone, as climate change is anticipated to increase the potential for ozone formation.
    - Work with other Regions and HQ air program managers, as appropriate, to develop a strategy, in context to other programmatic priorities, on how to incorporate climate adaptation into air quality programs (e.g., SIP, permits).
    - Work with California's Air Resources Board (ARB) as they further "Vision 2050" to address increases in ozone formation as temperatures increase.
    - Provide leadership and administer Clean Air Technology Initiative grants in South Coast and San Joaquin Valley Air Districts.
    - Leverage additional public and private resources for zero and low-emission technology deployment.
    - Work with local air pollution control agencies that are preparing multi-pollutant clean air plans that anticipate increased temperatures due to climate change (e.g., Bay Area Air Quality Management District).
    - In anticipation of additional air quality challenges, evaluate additional staff needs to handle the larger workload.
- Use ORIA-generated messages and local resources to educate the public regarding mold and other indoor air quality issues. Work with local air pollution control agencies to assure consistent messaging.
    - Public inquiries may increase due to extreme weather events. Additional regional staff time may be needed to answer calls from the public.

2. Water Program

Much of the work of the EPA Region 9 Water Program - to protect and improve water quality and enhance aquatic resources - also contributes to the resilience of watersheds. In fact, many of the tools and approaches used today (e.g., wetlands and floodplain restoration, watershed management, green infrastructure implementation, and water conservation) will be even more critical under changing climatic conditions. Hence, the Water Program's priority for climate change adaptation is to accelerate these existing efforts. We will focus not only on restoring impaired watersheds, but also protecting higher quality watersheds to increase their resilience to climate change impacts.

The near-term EPA Region 9 Water Program priority actions are described below, arranged under the 4 main water programmatic elements identified in the "*National Water Program 2012 Strategy: Response to Climate Change*" – Infrastructure, Watersheds and Wetlands, Coastal and Ocean Waters, and Water Quality.

a. Infrastructure

- Reach out to utilities and provide webinars to inform them about and encourage use of Climate Ready Water Utilities (CRWU) tools, including the Climate Resilience Evaluation and Awareness Tool (CREAT), vulnerability assessments, training workshops, and other tools.
- Work with the states to support use of Drinking Water State Revolving Fund (DWSRF) monies to train water utilities on American Water Works Association (AWWA's) Water Audit Software (if appropriate permission is obtained) to identify customized and cost-effective water savings opportunities, and continue to promote use of SRF for leak detection or repair. EPA will consider conducting a webinar(s) on the AWWA software as well.
- Encourage water utilities (and others, including schools) to become EPA WaterSense partners.
- Work through the interagency partnerships coordinated by our Sustainable Infrastructure program to leverage funding to support sustainable water infrastructure and water use efficiency projects.
- Encourage the reuse of water through collaboration with state and tribal governments, utilities and non-government partners.
- Communicate the advantages and successes of green infrastructure through the EPA Region 9 website and outreach opportunities; assemble case studies of utilities that have successfully implemented adaptation planning. Encourage implementation of green infrastructure through numerous EPA funding programs, including SRF, SFBWQIF, National Estuary Program, Clean Water Act Section 319 Nonpoint Source, and US-Mexico Border Infrastructure.
- Develop model language for National Pollutant Discharge Elimination System (NPDES) permits to require asset management planning that accounts for existing facility replacement and maintenance, as well as potential upgrades needed to deal with sea level rise, increased flood risk, and drought conditions where appropriate. [Work with EPA Headquarters]

- Promote climate change adaptation planning through enforcement orders and consent decrees, as appropriate.

b. Watersheds and Wetlands

- Enhance EPA Region 9's efforts to restore impaired waters and improve aquatic ecosystems, in order to increase watershed resilience to climate change. Actions include targeted project implementation in priority watersheds, based on Total Maximum Daily Load (TMDL) determinations and watershed plans, and collaboration in these watersheds with federal, state, territory, tribal and local agency partners to leverage additional resources and expertise to achieve meaningful results.
- Work with the State of California and the California Water Quality Monitoring Council to identify healthy watersheds through an integrated assessment, and to support the implementation of California's Healthy Streams Partnership (report expected in December, 2013).
- Continue to deliver outreach on the Climate Change Handbook (EPA's effort with CDWR and COE for Integrated Regional Water Management Planning) to assist water planners in integrating climate change considerations into their water resource plans, particularly outside California.
- Develop model language for commenting on Clean Water Act Section 404 permits (impacts to wetlands) to request that project alternatives consider sea level rise and flood risk, as well as decreasing stressors on wetlands (and other waters of the US) sensitive to climate change (e.g., coral reefs, alpine fens). Develop model climate change adaptation language for Section 404 permit-related wetland mitigation banks. Incorporate green infrastructure provisions, for management and use of runoff, into appropriate wetland permits and CWA Section 401 certifications for water quality**.** [Work with EPA Headquarters]
- Incorporate the consideration of climate change adaptation into watershed-related EPA grant requests for proposal (RFPs) and other funding mechanisms. Encourage, or require, applicants to protect and restore aquatic landscapes to make existing communities more climate-ready (e.g., more robust riparian habitat and wetlands, more groundwater recharge areas, less runoff of pollution directly into water ways).
- Encourage states and tribes to conduct water quality monitoring under Clean Water Act section 106, to gather water quality information that can also be used to track potential changes to water quality from climate change.
- For the San Francisco Bay, seek opportunities to support and work with climate change adaptation efforts underway, through our participation on the Bay Conservation and Development Commission, the Habitat Goals Project, and other San Francisco Bay Forums.
- Collaborate with nongovernment partners and key agencies [i.e., California Department of Water Resources (CDWR), US Bureau of Reclamation (USBR), the US Army Corps of Engineers (ACOE), and the US Natural Resource Conservation Service (NRCS)] to implement the Central Valley Flood Protection Plan, by:
  - setting back levees to reconnect creeks and rivers with floodplains (thereby increasing capacity for flood retention and groundwater recharge);

- restoring riparian forest to the floodplains to recover fish and wildlife populations and improve water quality; and
- providing landowners with incentives for levee setbacks and revenue for resulting ecosystem services, in collaboration with the agricultural community.

c. Coastal and Ocean Waters

- Work with the three EPA Region 9 National Estuary Programs (San Francisco Estuary Partnership, Morro Bay Estuary Program and Santa Monica Bay Partnership) to facilitate sharing of climate change information and tools, including those developed under the Climate Ready Estuaries Program (e.g., technical guidance, toolkits, reports, and studies).
- Continue appropriate involvement in the West Coast Governor's Alliance on Ocean Health.
- Continue participation in updating the San Francisco Bay Wetlands Goals Report, which will incorporate an improved understanding of the impact of climate change on bay habitats. Engage in other climate change adaptation efforts with partners in the Bay Delta Estuary, as appropriate.
- Implement key elements of the EPA Region 9 Coral Reef Strategy to reduce local stress on coral reefs systems (i.e., land-based pollution from point and non-point sources) which compounds the vulnerability of coral reefs to ocean acidification and rising sea-surface temperatures. Use available EPA resources to identify effective adaptation methods and reduce local stress on coral reefs, and facilitate information exchange with our partners.
- Pacific Islands Office and Water Division will coordinate with the Pacific islands, state, territory and local agencies, other federal agency offices, and other partners to identify the most critical vulnerabilities. EPA Region 9 will continue to take into consideration the differences among individual islands. Encourage the use of EPA funds to leverage capital funds for infrastructure improvements, and conduct outreach and training for Pacific Island staff and other stakeholders about taking climate change into consideration and building resilience. Current priorities include long-term protection of drinking water supplies and improving wastewater management.

d. Water Quality

- Ensure that NPDES stormwater permits consider climate change impacts and require the use of stormwater retention and infiltration approaches (and other appropriate green infrastructure provisions) for new development and redevelopment.
- Share information with other states, tribes, and EPA regions about California's laws and policies which encourage and set goals for water recycling. This could include indirect potable water reuse, gray water reuse, and rainwater harvesting.
- Consistent with the Bay Delta Action Plan:
  - Collaborate with the California State Water Resources Control Board to set water quality standards that factor in expected changes in precipitation and snowpack.

3. National Environmental Policy Act Review Program.

In its review of NEPA documents prepared by other federal agencies, EPA Region 9 will seek to have climate change-related environmental effects, and climate change adaptation measures appropriately disclosed and considered in accordance with emerging guidance from the Council on Environmental Quality.

4. Pesticides Program.

The EPA Region 9 Pesticides Office will evaluate how to incorporate climate change adaptation into its existing activities, and examine where it may be most important to consider climate change adaptation. The program will provide information specific to EPA Region 9 to the national program office for pesticide registration reviews, and will help to ensure that climate change impacts in EPA Region 9 are taken into account. The regional program will also determine how to best work with partners and stakeholders (e.g., state, tribe and Pacific island regulatory partners, pesticide applicators, growers, farmworkers, etc.) to help them better prepare to adapt to climate change and to incorporate sustainable pest control practices as conditions and species shift. The Program will also assist state, tribe and Pacific island partners with responding to potential increased need for compliance monitoring to ensure that climate change impacts do not result in pesticide misuse.

5. Waste Program:

The EPA Region 9 Waste Program will evaluate how to incorporate climate change adaptation into its existing activities, and examine where it may be most important to consider climate change adaptation. The program will consider improved mapping of hazardous waste sites that accounts for climate change vulnerabilities (e.g., sea level rise, storm event flooding, increased wildfire risk, high heat events, and droughts), especially around vulnerable communities and ecosystems. Any effective decision-support tools identified will be shared with states, territories, tribes, and other EPA regions and Headquarters Program Offices.

6. Superfund Program:

The Region 9 Superfund Program will continue to identify opportunities to consider climate change adaptation in our remedial decision-making, and in the design, operation and effectiveness evaluation of our remedies. An important part of this effort will be continuing staff education on the effects of a changing climate on the environment and on effective means of accounting for this change in our decision-making and long term planning (removal and remedial cleanups, RE-Powering America, Brownfields grants, Regional Support Corps emergency response).

The Region 9 Superfund Program will include climate change vulnerabilities (e.g. sea level rise, storm event flooding, increased wildfire risk, high heat events and droughts), especially around vulnerable communities and ecosystems, in Five Year Reviews of Superfund sites with remedies in place. The program will also consider opportunities to share effective decision-support tools with other EPA regions and Headquarters Program Offices. Climate change may lead to climate-related events that result in an increased need for emergency response support. Consequently, the EPA Region 9 Superfund Program will continue to focus on providing sufficient staffing for emergency response, including support from the EPA R9 Response Support Corps.

V. Measuring and Evaluating Performance

A critical element of our climate change adaptation strategy is the measurement and evaluation of our regional efforts. We will evaluate our climate change adaptation actions on an ongoing basis to assess our progress toward mainstreaming climate change adaptation into the Region's programs, policies, rules, and operations. Evaluating progress of our adaptation actions is particularly important because so much of what we are doing with climate change adaptation is new and there will be a lot of "learning by doing." Based on the lessons we learn, and lessons drawn from the efforts of our national programs, regional counterparts, and other key partners and stakeholders, we can make adjustments to the way adaptation is integrated into our activities.

The Region will conduct an annual evaluation of our progress and performance under this implementation plan, with a particular focus on the priority actions in Section IV. The initial focus of our evaluation will be a narrative assessment of our successes and accomplishments, what efforts and strategies are working well – and why – as well as an identification of those activities that are not proving successful, the reasons, and any recommendations for new or different approaches that would yield better results and outcomes. This type of evaluation will best allow the Region to highlight our progress, and learn from our efforts in order to continually improve the effectiveness of our climate change adaptation mainstreaming efforts.

Although the Region is not identifying any specific "performance measures" for our climate change adaptation work at this time, we anticipate that such measures could be developed in future years as we more fully integrate climate change efforts into our regional programs. In addition, the Region will continue to coordinate with our Headquarters counterparts to provide input for the existing Agency-wide strategic performance measures from the FY 2011–2015 EPA Strategic Plan, as well as any annual performance measures being established by the national program managers. These national measures, which focus on integrating climate change adaptation into the Agency's rulemaking processes, distribution of financial and technical resources, and development of information tools, represent a framework within which we anticipate developing future performance measures for our regional climate change adaptation mainstreaming efforts.

Footnotes

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Appendix A: Challenges that Climate Change Poses to EPA Region 9 Program Effectiveness

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 9 PROGRAMMATIC IMPACTS [c]		
	Type of Climate Change Impact [d]	**Likelihood of Climate Change Impact [e]**	**Focus of Associated Region 9 Program**	**Likelihood Region 9 Program will be Affected by Impact [f]**	**Example of Risks to Public Health and Environment if Region 9 Program were Impacted**
Goal 1: Taking Action on Climate Change and Improving Air Quality	• Increased tropospheric ozone pollution in certain regions	• Likely[1]	• Protecting public health and the environment by • approving state programs to meet the National Ambient Air Quality Standards (NAAQS), and • implementing programs in Indian Country.	• High	• Could become more difficult to attain NAAQS for ozone in many areas with existing ozone problems.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 9 PROGRAMMATIC IMPACTS [c]		
	Type of Climate Change Impact [d]	**Likelihood of Climate Change Impact [e]**	**Focus of Associated Region 9 Program**	**Likelihood Region 9 Program will be Affected by Impact [f]**	**Example of Risks to Public Health and Environment if Region 9 Program were Impacted**
	• Increased frequency and intensity of wildfires	• Likely[2]	• Protecting public health and the environment by • approving state programs to meet the National Ambient Air Quality Standards (NAAQS), and • implementing programs in Indian Country.	• High	• Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) pollution in areas affected by more frequent wildfires.
	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very Likely[3] • Likely[3,6]	• Protect public health by promoting healthy indoor environments through voluntary programs and guidance.	• Med.	• Could increase public health risks in indoor environments; including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 9 PROGRAMMATIC IMPACTS [c]		
	Type of Climate Change Impact [d]	**Likelihood of Climate Change Impact [e]**	**Focus of Associated Region 9 Program**	**Likelihood Region 9 Program will be Affected by Impact [f]**	**Example of Risks to Public Health and Environment if Region 9 Program were Impacted**
	• Effects on the stratospheric ozone layer	• Likely[4]	• Restoring the stratospheric ozone layer, • Preventing UV-related disease, and • Providing a smooth transition to safer energy alternatives.	• Low	• Unable to restore ozone concentrations to benchmark levels as quickly, at some latitudes.
	• Effects on response of ecosystems to atmospheric deposition of sulfur, nitrogen, and mercury.	• Likely[5]	• Agency emissions reduction programs provide some ecosystem protection.	• Low	• Could have consequences for the effectiveness of ecosystem protections under certain programs.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 9 PROGRAMMATIC IMPACTS [c]		
	Type of Climate Change Impact [d]	**Likelihood of Climate Change Impact [e]**	**Focus of Associated Region 9 Program**	**Likelihood Region 9 Program will be Affected by Impact [f]**	**Example of Risks to Public Health and Environment if Region 9 Program were Impacted**
	• Increasing heavy precipitation events • Increasing intensity of hurricanes and typhoons • Decreasing precipitation days and increasing drought intensity • Sea-level rise • Ocean acidification (continued below)	• Likely[3,6] • Likely[3] • Likely[6] • Very likely[7] • Certain[8]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands. (continued below)	• High	• Increased heavy precipitation and storm events increase number of sewer overflows and wastewater bypasses, increased coastal and inland erosion, as well as increased pollutant loads in runoff, and may combine to damage waterway channels, coastlines and infrastructure, decrease water quality, and threaten public health. • Sea level rise would flood coastal wetlands and eliminate them if they cannot migrate up slope and inland. • Ocean acidification will increase stress on shellfisheries and continue~~d~~ stress on coral reefs. (continued below)

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 9 PROGRAMMATIC IMPACTS [c]		
	Type of Climate Change Impact [d]	**Likelihood of Climate Change Impact [e]**	**Focus of Associated Region 9 Program**	**Likelihood Region 9 Program will be Affected by Impact [f]**	**Example of Risks to Public Health and Environment if Region 9 Program were Impacted**
Goal 2: Protecting America's Waters	• Increased water temperatures • Earlier timing of spring snowmelt events • Reduction in snowpack • Increased frequency and intensity of wildfires	• Very Likely[9] • Very Likely[10] • Very likely[11] • Likely[2]	• (Continued) Restoring and protecting watersheds, aquatic ecosystems and wetlands.	• High	• Increased stresses to water bodies and water quality would make it more challenging to protect and restore the chemical, biological, and physical integrity of Waters of the U.S, and water quality standards. • Snowmelt runoff shift to earlier in the spring, could result in increased floods in spring and reduced stream flow later in summer, altering aquatic environments and increasing impairments. • Geographic shifts in aquatic habitat and species may threaten water quality and the economic and cultural practices of tribal, and other indigenous, communities. • Increased temperatures, drought, wildfires, and invasive species may accelerate landscape change and make certain aquatic ecosystems (e.g., mountain wet meadows, vernal pools, desert springs, and playa lakes) more vulnerable to loss.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 9 PROGRAMMATIC IMPACTS [c]		
	Type of Climate Change Impact [d]	**Likelihood of Climate Change Impact [e]**	**Focus of Associated Region 9 Program**	**Likelihood Region 9 Program will be Affected by Impact [f]**	**Example of Risks to Public Health and Environment if Region 9 Program were Impacted**
	• Increasing heavy precipitation events • Increasing intensity of hurricanes and typhoons • Sea-level rise • Increasing flood risk • Increased frequency and intensity of wildfires • Earlier timing of spring snowmelt events • Decreasing precipitation days and increasing drought intensity	• Likely[3,6] • Likely[3] • Very likely[7] • Likely[6] • Likely[2] • Very Likely[10] • Likely[6]	• Drinking water, wastewater and stormwater infrastructure	• High	• Increase in inland precipitation , storm intensity and snowmelt flooding could overwhelm or damage water infrastructure (i.e., intakes, outfalls, treatment plants, and associated pipes and pumps) resulting in an increase in pathogens and an increased incidence of waterborne diseases • Sea level rise in combination with Intensifying coastal storms and flooding would impact coastal and tide-water infrastructure; which could result in an increase in pathogens, an increased incidence of waterborne diseases, and reduced access to freshwater • In addition to earthquake response plans and other hazard response plans, drinking water and wastewater utilities will need to consider extreme weather, wildfire, and sea level events in their emergency response plans, as appropriate (an "all hazards" approach) • Problems of safety as well as access to clean and safe drinking water will be exacerbated for vulnerable and economically deprived communities.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 9 PROGRAMMATIC IMPACTS [c]		
	Type of Climate Change Impact [d]	**Likelihood of Climate Change Impact [e]**	**Focus of Associated Region 9 Program**	**Likelihood Region 9 Program will be Affected by Impact [f]**	**Example of Risks to Public Health and Environment if Region 9 Program were Impacted**
	• Increased water temperatures • Increasing heavy precipitation events • Decreasing precipitation days and increasing drought intensity • Reduction in snowpack • Increased frequency and intensity of wildfires • Earlier timing of spring snowmelt events • Sea Level Rise	• Very likely[8] • Likely[3] • Likely[6] • Very likely[10] • Likely[2] • Very Likely[10] • Very Likely[7]	• The quality and availability of safe drinking water	• High	• High water temperatures and increased storm-water runoff may increase the need for drinking water treatment, raising drinking water system costs and costs for customers. • Decrease in precipitation or changes in precipitation seasons could impact water availability, forcing communities to seek alternative sources. • Changes in precipitation or an increased need for water supplies may increase pressure to use other water supplies (e.g., surface reservoirs, or naturally occurring or injected groundwater requiring EPA to ensure safety. • Problems of access to clean and safe drinking water will be exacerbated for vulnerable and economically deprived communities. • Sea Level Rise could lead to salt water inundation or intrusion into coastal freshwater groundwater sources.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 9 PROGRAMMATIC IMPACTS [c]		
	Type of Climate Change Impact [d]	**Likelihood of Climate Change Impact [e]**	**Focus of Associated Region 9 Program**	**Likelihood Region 9 Program will be Affected by Impact [f]**	**Example of Risks to Public Health and Environment if Region 9 Program were Impacted**
Goal 3: Cleaning Up America's Communities & Advancing Sustainable Development	• Increasing heavy precipitation events • Increasing risk of floods • Sea level rise • Changes in temperature • Increased frequency and intensity of wildfires	• Likely[3,6] • Likely[6] • Very likely[7] • Very likely[3] • Likely[2]	• Cleaning up Contaminated Sites and Waste Management	• Med.	• Increasingly frequent or intense inland and coastal flooding, as well as increasingly frequent or intense wildfires, could increase the risk of contaminant releases from EPA hazardous waste sites • EPA may need to alter selected remedies to ensure protection.
	• Increasing heavy precipitation events • Increasing intensity of hurricanes and typhoons • Increasing risk of floods • Increased frequency and intensity of wildfires	• Likely[3,6] • Likely[3] • Likely [6] • Likely[2]	• Emergency Response	• High for islands and Med. for main-land.	• Increase in frequency and/or intensity of coastal and inland flood events, storm events and wildfires could increase the risk of contaminant releases from regulated sites and non-regulated sites, which would increase the need for emergency response. • A rapid increase in level and frequency of emergency events could overwhelm EPA's emergency response resources and limit our ability to respond quickly and effectively, which could result in more risk to communities and the environment.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 9 PROGRAMMATIC IMPACTS [c]		
	Type of Climate Change Impact [d]	**Likelihood of Climate Change Impact [e]**	**Focus of Associated Region 9 Program**	**Likelihood Region 9 Program will be Affected by Impact [f]**	**Example of Risks to Public Health and Environment if Region 9 Program were Impacted**
Goal 4: Ensuring Safety of Chemicals & Preventing Pollution	• Decreasing precipitation days and increasing drought intensity • Increasing extreme temperatures • Increasing heavy precipitation events • Earlier timing of spring events • Increase in, and a changing mix of, pests* (* includes weeds, insects, molds, fungi, and diseases)	• Likely[6] • Very likely[3] • Likely[3,6] • Very likely[10] • Very likely[12]	• Protecting human health and ecosystems from chemical risks	• Med.	• Changes in planting timing or location may affect the volume and timing of agricultural chemical use, which could impact water quality and pesticide exposures to people and the environment. • Many weeds, diseases, and insect pests would benefit from warming, and many weeds would also benefit from a higher carbon dioxide concentration, increasing stress on crop plants and requiring more attention to pest and weed control. • Emergency exemptions for unregistered pesticides, state/local special need registrations, as well as requests to approve additional or new end uses of registered products, may increase.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 9 PROGRAMMATIC IMPACTS [c]		
	Type of Climate Change Impact [d]	**Likelihood of Climate Change Impact [e]**	**Focus of Associated Region 9 Program**	**Likelihood Region 9 Program will be Affected by Impact [f]**	**Example of Risks to Public Health and Environment if Region 9 Program were Impacted**
Goal 5: Enforcing Environmental Laws	• Earlier timing of spring events • Increasing risk of floods • Increased frequency and intensity of wildfires • Increasing heavy precipitation events • Increased water temperatures	• Very Likely[10] • Likely [6] • Likely[2] • Likely[3,6] • Very likely[7]	• Conducting environmental sampling of water, air and soils and of materials to determine exposure and risk	• Med.	• Increase in frequency and/or intensity of coastal and inland flood events, storm events and wildfires, as well as sea level rise, may require a change in sampling methods and strategies for EPA and its partners. • Increase in frequency or intensity of flood events, storm events and wildfires, as well as sea level rise may impact EPA's and partners' long-term sampling locations, which may require EPA and partners to set up new sampling sites and analyze data from different sites over the long term.
Facilities and Operations	• Decreasing precipitation days and increasing drought intensity • Increasing extreme temperatures	• Likely [6] • Very likely[3]	• Water and energy usage at EPA facilities	• Low	• Region 9 facilities are in areas that could experience water shortages, requiring even more water conservation. • Region 9 facilities are in locations that could experience extreme heat events, requiring even more energy conservation; and in cases of resulting region-wide power failure, could require additional accommodations.

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA REGION 9 PROGRAMMATIC IMPACTS [c]		
	Type of Climate Change Impact [d]	**Likelihood of Climate Change Impact [e]**	**Focus of Associated Region 9 Program**	**Likelihood Region 9 Program will be Affected by Impact [f]**	**Example of Risks to Public Health and Environment if Region 9 Program were Impacted**
	• Increasing risk of floods • Increasing intensity of hurricanes and typhoons • Sea level rise • Increasing extreme temperatures • Increased frequency and intensity of wildfire	• Likely [6] • Likely[3] • Very likely[7] • Very likely[3] • Likely[2]	• Operations of Agency facilities, personnel safety, physical security, and emergency communications • Emergency management mission support (protective gear and acquisition)	• Med.	• Facilities in coastal or inland flood-prone areas may be flooded or their access cut off. • Personnel engaged in field work may be vulnerable to extreme temperatures or weather events. • During an emergency extreme weather, flooding, or wildfire event; power may be cut off, which could impact security, lighting, temperature control, and communication systems. • Personnel and real property that support emergency response and management may be impacted directly or indirectly by flood events, storm events and wildfires; and EPA's ability to respond in an emergency could be compromised.

Footnotes for Summary Table of Potential Challenges that Climate Change Poses to the Functioning of EPA Region 9 Programs

Appendix A Table - Heading Footnotes:

[a] This table summarizes vulnerabilities by the five goals in EPA's Strategic Plan http://www.epa.gov/planandbudget/strategicplan.html. Please note that the table also summarizes vulnerabilities to EPA facilities and operations; this is not part of the EPA Strategic Plan goal structure but is an important element of EPA's vulnerability assessment. Please see Section 2 of this document for a fuller discussion of impacts.

[b] Climate Change Impacts are based upon peer-reviewed scientific literature.

[c] Programmatic Impacts are based upon EPA best professional judgment at this time.

[d] Impacts can vary by season and location.

[e] In general, the sources cited in this section use Intergovernmental Panel on Climate Change (IPCC) likelihood of outcome terminology where the term 'very likely' means 90-100% probability and the term 'likely' means 66-100% probability. For some impacts in the table, additional discussion on the likelihood term is provided in the associated footnote.

[f] **High** assumes the program will be affected by the impact; **Medium** assumes the program could be affected under some conditions by the impact; **Low** assumes that there is a potential for the program to be impacted or uncertainty currently exists as to the potential nature and extent of the impact. This assessment is based on best professional judgment within EPA at this time. Please note, this column does not reflect several important considerations. For example it does not distinguish timeframes (current, near-term, long-term). It does not account for regional and local variations. And it does not reflect the priority of actions the agency may undertake now or in the future.

Appendix A Table Text Footnotes:

[1] Denman, K.L., et al. (2007). Couplings Between Changes in the Climate System and Biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[2] C.B. Field et al., "North America," Chapter 14 in Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2007).

[3] IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

[4] World Meteorological Organization, Scientific Assessment of Ozone Depletion: 2010, Global Ozone Research and Monitoring Project—Report No. 52 (Geneva, Switzerland, 2011). Note: the word "expected" is used in the report to characterize projected climate change impacts on the stratospheric ozone layer. For purposes of this table the word "likely" has been used as a proxy for "expected."

[5] Burns, D.A., Lynch, J.A., Cosby, B.J., Fenn, M.E., Baron, J.S., US EPA Clean Air Markets Div., 2011,National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment, National Science and Technology Council, Washington, DC, p. 114.

[6] USGCRP, 2009: *Global Climate Change Impacts in the United States*. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

[7] IPCC, 2012: "it is very likely that mean sea level rise will contribute to upward trends in extreme coastal high water levels in the future."

[8] NRC, 2010: National Research Council of the National Academies, America's Climate Choices: Panel on Advancing the Science of Climate Change, 2010. p 41. "One of the most certain outcomes from increasing CO2 concentrations in the atmosphere is the acidification of the world's oceans." For purposes of this table, the term "certain" is used.

[9] USGCRP, 2009: p. 46. [In the case of freshwater] "Increased air temperatures lead to higher water temperatures, which have already been detected in many streams, especially during low-flow periods." For the purposes of this table "very likely" is used.

[10] USGCRP, 2009: p. 45. [In the case of timing of snow melt] "In areas where snowpack dominates, the timing of runoff will continue to shift to earlier in the spring and flows will be lower in late summer." Based upon EPA best professional judgment at the time, the likelihood of this impact was determined to be "very likely."

Lettenmaier, D., D. Major, L. Poff, and S. Running, 2008: Water Resources. In: The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States. Synthesis and Assessment Product 4.3. U.S. Department of Agriculture, Washington, DC, p.130. Based upon EPA best professional judgment at the time, the likelihood of this impact was determined to be "very likely."

USGCRP, 2009: p. 80. [In the case of onset of spring and length of the growing season] "In the United States, spring now arrives an average of 10 days to two weeks earlier than it did 20 years ago. The growing season is lengthening over much of the continental United States." Based upon EPA best professional judgment at the time, the likelihood of this impact was determined to be "very likely."

[11] Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 2008: Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, p. 130

[12] USGCRP, 2009. Agriculture: p. 75. [In the case of weeds, diseases, and pests] "Weeds, diseases, and insect pests benefit from warming, and weeds also benefit from a higher carbon dioxide concentration, increasing stress on crop plants and requiring more attention to pest and weed control." Based upon EPA best professional judgment at the time, the likelihood of this impact was determined to be "very likely."

Hatfield, J., K. Boote, P. Fay, L. Hahn, C. Izaurralde, B.A. Kimball, T. Mader, J. Morgan, D. Ort, W. Polley, A. Thomson, and D. Wolfe, 2008: Agriculture. In: The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States. Synthesis and Assessment Product 4.3. U.S. Department of Agriculture, Washington, DC, pp. 59-60. Based upon EPA best professional judgment at the time, the likelihood of this impact was determined to be "very likely."

Appendix B. Summaries of Selected Documents on Climate Change Vulnerabilities in EPA Region 9

Climate Change Vulnerabilities – Generally in EPA Region 9

A report by the U.S. Global Change Research program entitled**, "*Global Climate Change Impacts in the United States*"[1]** pointed to upcoming likely vulnerabilities in the Southwest**.**

- Water supplies will be subject to more competition (between communities, ecosystems, agriculture and power generation) as precipitation decreases and temperatures increase.
- The southwest ecosystem will be more vulnerable to large-scale change given reduced precipitation, increased temperatures and the resulting increase in wildfires.

In a National Park Service 2010 report entitled**, "*Understanding the Science for Climate Change: Talking Points – Impacts to Arid Lands*"[2],** vulnerabilities are identified:

- Under current conditions and if no changes in Colorado River allocations are made, there is a 50% chance that live storage reservoir levels will be zero by 2021 and a 50% chance that minimum power pool levels will be reached in 2017.
- River and riparian habitats will suffer from decreased flows and increased water removal.
- Decreased late dry season runoff will likely reduce water quality through concentration of pollutants in shrinking water bodies and decrease in dissolved oxygen.
- Increases in wildfires, due to increased temperatures and changes in precipitation, will set up a self-reinforcing increase in fire frequencies, due to proliferation of exotic fire-prone grasses. The Great Basin fire season could increase by 2 or more weeks.
- Increased water demands and a decreased water supply will result in over-allocation of water resources that are already oversubscribed in many areas.

Climate Change Vulnerabilities in the Southwest

Climate change issues for the Southwest are described in the 2013 document entitled, "Assessment of Climate Change in the Southwest United States. A Report Prepared for the National Climate Assessment"[3]. The report covers Arizona, California, Colorado, Nevada, New Mexico, and Utah, as well as Southwest Native Nations lands and the United States-Mexico border region.

The report includes a discussion of vulnerabilities for communities and habitats, for example:

- Stationarity (assumption that future climate variations will be the same as past climate variations) no longer holds in the Southwest. It is likely that temperatures will increase substantially in some parts of the Southwest, leading to even more arid conditions.
- Tribal communities are likely to be affected more than non-tribal communities, due to limited water supplies and water rights, and impacts on livelihood and traditional lifeways.
- Disadvantaged populations are likely to be most at risk for health issues from heat and particulate matter increases and other climate change effects.

- An increase in temperatures will increase health effects due to heat-related illness; and are likely to cause an increase in air-borne particulates (from wildfires and dust storms), and associated illnesses.
- Changes in species life cycles and distribution may impact public health (e.g., timing of vegetation blooms and associated allergic reactions, presence of mosquitoes and rodents carrying pathogens).
- Changes in land cover will be significant, and is related to an increase in wildfires and pest outbreaks.
- Coastal erosion, flooding and storm surges are likely to increase. The intensity of coastal storms may increase. Sea-level rise is occurring. These combine to put coastal communities and habitats at more risk.
- Streamflow reduction is expected across the region, which would limit water availability for communities and habitats.
- Surface water quality is expected to be reduced in some parts of the Southwest due to reduced streamflows, increased evaporation, and increased nonpoint source pollution from more intense storm events and wildfire events.
- Energy supplies may become less reliable as demand for cooling and water pumping increases and transmission lines are impacted by high temperatures or wildfires.

Climate Change Vulnerabilities in California

The State of California issued, **"Our Changing Climate 2012: Vulnerability & Adaptation to the Increasing Risks from Climate Change in California. A Summary Report on the Third Assessment form the California Climate Change Center"**[4]. The report discussed California climate change vulnerabilities.

- Rising temperatures will be more noticeable in spring than in other seasons.
- Heat events will increase in intensity, length and frequency; which will lead to increased impacts to public health (especially for low income populations) and ecosystems.
- Precipitation may decrease and temperatures are likely to grow warmer which will make conditions dryer, especially in Southern California. This would also make the spring snowpack melt sooner in the year.
- Increased temperatures will lead to an increased demand for water supplies.
- Soil moisture levels are likely to decline during longer dryer summer conditions.
- Dryer and hotter conditions will lead to a higher risk of wildfire.
- Increased wildfires will increase particulate matter and ozone levels, leading to decreased public health.
- Sea level rise, combined with high waves and strong winds will impact coastal communities (and their infrastructure), habitats and coastlines.
- Sea level rise and more intense storm events will put added pressure on aging Bay Delta levees

The July 2012 report, "***Climate Change and Water Supply Security: Reconfiguring Groundwater Management to Reduce Drought Vulnerability***"[5] was prepared by the University of California at Santa Cruz for the California Energy Commission. This report identified key community vulnerabilities:

- Communities in California that already experience water shortages during droughts are likely to have more water supply vulnerability.

- Coastal communities that do not have an inter-tie to larger water projects and that rely on local groundwater supplies and storage systems are at significant risk for water supply shortages.
- Communities that subject their groundwater basins to overdraft can permanently lose groundwater storage capacity and put their community at greater risk for water shortages.
- Increasing recharge of groundwater basins with treated water requires more care to not introduce pollutants into the basin and maintain groundwater quality.
- Increase in large storm events will put communities and their infrastructure at greater risk.
- Communities in the southwest at the urban-forest border will be more vulnerable to damage by wildfire as temperatures increase and precipitation decreases.

The report, "***The Future is Now: An Update on Climate Change Science Impacts and Response Options for California***"[6], prepared for the California Energy Commission in May 2009, found that:

- The American West is heating faster than the United States as a whole.
- Warming and precipitation changes are not occurring uniformly throughout the state. Two examples relating to temperature are the effect of intensive crop irrigation in the Central Valley, which has historically decreased the amount of warming in this region, and the increased warming effect observed in urban areas. Changes in snowpack and the timing of spring runoff have already been observed in the Sierra Nevada Mountains over the past century.
- Agricultural productivity, forest composition, timing of ecological events (for example, migration), and wildfire frequency have all experienced measurable changes resulting from a changing climate.
- Factors that can aggravate problems caused by climate change include population growth, the presence of poor or vulnerable social groups, and seismic risks in the Sacramento-San Joaquin Delta. In addition, some climate change impacts will overlap and combine in challenging ways.

"***Preparing for Climate Change: A Perspective from Local Public Health Officers in California***"[7], by Louise Bedsworth of the Public Policy Institute of California (Published in *Environmental Health Perspectives*, April 2009) summarized climate change impacts on air pollution:

- Climate change is likely to lead to an increase in the severity and duration of air pollution episodes.[8, 9]
- Air pollution levels can be affected by a number of direct and indirect effects of climate change. These include increased temperature, changes in biogenic emissions (e.g., emissions from vegetation), changes in chemical reaction rates, changes in atmospheric conditions that affect pollutant mixing, and changes in the atmospheric flows that affect pollutant transport.[10]
- Behavioral responses to climate change could result in an increase in emissions, such as through the increased energy demand with higher temperatures.[11, 12]
- There is feedback between local air pollution and climate change, because some local air pollutants also have an effect on the climate.

Climate Change Vulnerabilities in Nevada

The Nevada Climate Change Advisory Committee, under then-Governor Jim Gibbons, issued the ***"Nevada Climate Change Advisory Committee Final Report"*** in 2008[17]. Note that this is not a peer-reviewed document. The report highlighted the following potential climate change impacts:

- Increases in ozone pollution, air-borne particulate matter and air temperatures could impact public health.
- If more of the Sierra Nevada precipitation falls as rain, rather than as snow, then
    - Flooding may increase in the Truckee, Walker and Carson River watersheds in the winter and spring, and
    - Less water may be available in the summer for water supplies, habitat and recreation.
- If Colorado River Basin precipitation decreases, then the Las Vegas Valley may see more pressure on its water supplies.
- Decreased precipitation could reduce summer water supplies, increase wild land fires (and developed land fire risk), reduce native plant species cover and increase in invasive plant species cover.

Climate Change Vulnerabilities in Hawaii and other Pacific Island Communities

Climate change issues for the Hawaii and the US-Affiliated Pacific Islands are described in the document entitled, "***Climate Change and Pacific Islands: Indicators and Impacts. Report for the 2012 Pacific Islands Regional Climate Assessment***"[14]. The report covers the State of Hawai'i, the territories of American Samoa and Guam, the Commonwealth of the Northern Mariana Islands, as well as other US-Affiliated Pacific Islands. The report includes discussions on island community and habitat vulnerabilities:

- Freshwater supplies, particularly on low-elevation islands, may decrease if temperatures increase and precipitation decreases. Air temperatures on Hawaiian islands have increased over 100 years with a more marked increase over the most recent 30 years. Future trends in precipitation are difficult to predict for the Pacific islands. Low-elevation freshwater aquifers are vulnerable to inundation from sea level rise combined with storms or other big wave events. A reduction in freshwater supplies could raise concerns for island food security.
- Sea level rise will make islands' coastal infrastructure more vulnerable to the flooding and erosion from storm events. Low-elevation islands are especially vulnerable as their entire infrastructure, communities and habitats are close to the present-day sea level, and are more subject to wave over wash.
- Coral reefs are vulnerable to sea-surface temperature rise (which can cause coral bleaching) and ocean water acidification (which can impact the coral-forming process). An increase in storm events could cause more sediment deposition on coral reefs which harms the coral.
- Coastal wetlands (e.g., mangrove forests, sea grass beds) are vulnerable to direct impact from increased wave events and tropical cyclone strength, as well as increased sediment pollution from eroding watersheds.

Appendix B Footnotes:

[1] USGCRP (2009). *Global Climate Change Impacts in the United States* . Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA. http://globalchange.gov/what-we-do/assessment/previous-assessments/global-climate-change-impacts-in-the-us-2009

[2] Loehman, R. 2010. *Understanding the science of climate change: talking points - impacts to Arid Lands.* Natural Resource Report NPS/NRPC/NRR—2010/209. National Park Service, Fort Collins, Colorado. http://www.fs.fed.us/rm/pubs_other/rmrs_2010_loehman_r002.pdf

[3] Garfin, G., A. Jardine, R. Merideth, M. Black, and S. LeRoy, eds. 2013. *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*. A report by the Southwest Climate Alliance. Washington, DC: Island Press. http://swccar.org/sites/all/themes/files/SW-NCA-color-FINALweb.pdf

[4] Moser, S., Ekstrom, J., and Franco, G. "*Our Changing Climate 2012: Vulnerability & Adaptation to the Increasing Risks from Climate Change in California. A Summary Report on the Third Assessment form the California Climate Change Center*". (2012). California Energy Commission (CEC-500-2012-007). http://www.energy.ca.gov/2012publications/CEC-500-2012-007/CEC-500-2012-007.pdf

[5] Langridge, Ruth, Andrew Fisher, Andrew Racz, Bruce Daniels, Kirsten Rudestam, and Blake Hihara. 2012. *Climate Change and Water Supply Security: Reconfiguring Groundwater Management to Reduce Drought Vulnerability*. California Energy Commission. Publication Number: CEC-500-2012-017. http://www.energy.ca.gov/2012publications/CEC-500-2012-017/CEC-500-2012-017.pdf

[6] Moser, Susie, Guido Franco, Sarah Pittiglio, Wendy Chou, Dan Cayan. 2009. *The Future Is Now: An Update on Climate Change Science Impacts and Response Options for California*. California Energy Commission, PIER Energy-Related Environmental Research Program. CEC-500-2008-071. http://www.energy.ca.gov/2008publications/CEC-500-2008-071/CEC-500-2008-071.PDF

[7] Bedsworth L. *Preparing for climate change: a perspective form local public health officers in California*. Environ Health Perspectives. 2009 Apr; 117(4):617-23. doi: 10.1289/ehp.0800114. Epub 2008 Dec 8.

[8] Mickley LJ. *A future short of breath? Possible effects of climate change on smog*. Environment. 2007; 49(6):34–43.

[9] Mickley LJ, Jacob DJ, Field BD, Rind D. *Effects of future climate change on regional air pollution episodes in the United States*. Geophys Res Lett. 2004; 31(24):L24103. doi: 10.1029/2004GL02126.

[10] Hogrefe C, Lynn B, Civerolo K, Ku JY, Rosenthal J, Rosenzweig C, et al. J Geophys Res Atmos. Vol. 109. 2004. *Simulating changes in regional air pollution over the eastern United States due to changes in global and regional climate and emissions*; p. D22301.

[11] Franco G, Sanstad AH. *Climate change and electricity demand in California*. Clim Change. 2008; 87:S139–S151

[12] Miller NL, Hayhoe K, Jin J, Auffhammer M. *Climate, extreme heat, and electricity demand in California*. J Appl Meteorol Climatol. 2008; 47(June):1834–1844.
[13] Gibbons, J. "*Governor Jim Gibbons' Nevada Climate Change Advisory Committee Final Report*". (2008). www.epa.statelocalclimate/documents/pdf/nevada_final_report.pdf

[14] Keener, V. W., Marra, J.J., Finucane, M. L., Spooner, D., & Smith, M. H. (Eds.). (2012). *Climate Change and Pacific Islands: Indicators and Impacts*. *Report for the 2012 Pacific Islands Regional Climate Assessment* (PIRCA). Washington, DC: Island Press. http://www.pacificrisa.org/projects/pirca/

Appendix C: Acknowledgements

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Superfund Division

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Waste Management Division

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Water Division

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Robert Hall, Standards and TMDL Office
Bruce Macler, Drinking Water Office
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EPA Region 10 Climate Change Adaptation Implementation Plan

June 2014

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Preface

The U.S. Environmental Protection Agency (EPA) is committed to identifying and responding to the challenges that a changing climate poses to human health and the environment.

Scientific evidence demonstrates that the climate is changing at an increasingly rapid rate, outside the range to which society has adapted in the past. These changes can pose significant challenges to the EPA's ability to fulfill its mission. The EPA must adapt to climate change if it is to continue fulfilling its statutory, regulatory and programmatic requirements. The Agency is therefore anticipating and planning for future changes in climate to ensure it continues to fulfill its mission of protecting human health and the environment even as the climate changes.

In February 2013, the EPA released its draft *Climate Change Adaptation Plan* to the public for review and comment. The plan relies on peer-reviewed scientific information and expert judgment to identify vulnerabilities to EPA's mission and goals from climate change. The plan also presents 10 priority actions that EPA will take to ensure that its programs, policies, rules, and operations will remain effective under future climatic conditions. The priority placed on mainstreaming climate adaptation within EPA complements efforts to encourage and mainstream adaptation planning across the entire federal government.

Following completion of the draft *Climate Change Adaptation Plan*, each EPA National Environmental Program Office, all 10 Regional Offices, and several National Support Offices developed a *Climate Adaptation Implementation Plan* to provide more detail on how it will carry out the work called for in the agency-wide plan. Each *Implementation Plan* articulates how the office will integrate climate adaptation into its planning and work in a manner consistent and compatible with its goals and objectives.

Taken together, the *Implementation Plans* demonstrate how the EPA will attain the 10 agency-wide priorities presented in the *Climate Change Adaptation Plan*. A central element of all of EPA's plans is to build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. EPA will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

Each Program and Regional Office's *Implementation Plan* contains an initial assessment of the implications of climate change for the organization's goals and objectives. These "program vulnerability assessments" are living documents that will be updated as needed to account for new knowledge, data, and scientific evidence about the impacts of climate change on EPA's mission. The plan then identifies specific priority actions that the office will take to begin addressing its vulnerabilities and mainstreaming climate change adaptation into its activities. Criteria for the selection of priorities are discussed. An emphasis is placed on protecting the most vulnerable people and places, on supporting the development of adaptive capacity in the tribes, and on identifying clear steps for ongoing collaboration with tribal governments.

Because EPA's Programs and Regions and partners will be learning by experience as they mainstream climate adaptation planning into their activities, it will be essential to evaluate their efforts in order to understand how well different approaches work and how they can be improved. Each *Implementation Plan* therefore includes a discussion of how the organization will regularly evaluate the effectiveness of its adaptation efforts and make adjustments where necessary.

The set of *Implementation Plans* are a sign of EPA's leadership and commitment to help build the nation's adaptive capacity that is so vital to the goal of protecting human health and the environment. Working with its partners, the Agency will help promote a healthy and prosperous nation that is resilient to a changing climate.

Bob Perciasepe
Deputy Administrator

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The U.S. Environmental Protection Agency (EPA) Region 10 serves Alaska, Idaho, Oregon, Washington, and 271 federally-recognized tribes.

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Section 1: Introduction

Executive Order EO13514 directed the U.S. Government to address the impacts of climate change, and form an Interagency Climate Change Adaptation Task Force. This task force is co-chaired by the White House Council on Environmental Quality (CEQ), the White House Office of Science and Technology Policy, and the National Oceanic and Atmospheric Administration. There are over 20 federal agencies represented on the task force, including the Environmental Protection Agency (EPA). The task force developed recommendations to the President regarding the integration of climate adaptation into planning, operations, policies, and programs, and each agency was required to develop a climate change adaptation plan.

> "Adaptation" refers to efforts by society or ecosystems to prepare for or adjust to future climate change. These adjustments can be protective (i.e., guarding against negative impacts of climate change), or opportunistic (i.e., taking advantage of any beneficial effects of climate change).

In response, EPA issued a climate change adaptation policy statement in June 2011, and completed an agency-wide Climate Adaptation Plan in June 2012. These documents directed every Program and Regional office within EPA to develop an Implementation Plan detailing how they will integrate climate adaptation into their work, and address the priorities identified in the agency-wide plan.

To promote consistency, these Implementation Plans have common areas of focus, as outlined below.

Common Areas of Focus for Implementation Plans

1. Vulnerability assessments
2. Priority actions on climate adaptation
3. Agency-wide strategic measures on climate adaptation
4. Legal and enforcement issues
5. Training and outreach
6. Partnerships with tribes
7. Evaluation and cross-office pilot projects

The Implementation Plans are complementary and are meant to work in conjunction with the Agency's Strategic Plan and Sustainability Plan, and the climate change plans developed by the individual EPA Program Offices. The Implementation Plan for Region 10 will be a living document to be updated over time.

I. Regional Overview

Region 10 serves Washington, Oregon, Idaho, Alaska and 271 Federally Recognized Tribes. In this report, Washington, Oregon, and Idaho are often referred to as the Pacific Northwest. EPA Region 10 represents a diverse geographic region with varying climate, geographic features, social, and ecological

conditions. Region 10 is composed of eight landscape conservation cooperative[1] areas (five in Alaska and 3 in the Pacific Northwest) out of twenty-two Nationwide. This attests to the wide diversity of geographic regions within Region 10. The Pacific Northwest is bordered by the Pacific Ocean to the west and Canada to the north. The region includes the cities of Seattle, Portland, Spokane, Boise, and Tacoma with susceptible populations that are particularly vulnerable to a changing climate.

The Cascade Mountain Range runs north-south through Washington and Oregon, splitting the region. The climate on each side of the mountain range is very different. West of the mountains, temperatures are mild year-round (days below freezing or above 90°F are relatively rare), winters are wet, and summers are dry. East of the mountains, it is typically sunnier and drier over the course of the year, winters are colder, and summers can be significantly hotter. The Pacific Northwest contains many miles of coast line, contains high sage deserts, is composed of large tracks of forest, and consists of several mountain ranges that are critical to maintaining the water resources in the Region.

Alaska presents unique challenges given its geographic location, and that it is the only arctic region in United States. Issues related to permafrost thawing and sea ice melting are unique to Alaska and climate change impacts are being seen in many areas of Alaska and threatening coastal communities, habitats, and infrastructure. Alaska contains more coastline than the other 49 states combined. Alaska contains almost 40% (229 tribes) of the federally recognized tribes in the United States that are particularly vulnerable to climate change given their proximity to coastal areas.

II. Overview of Climate Change Impacts in Region 10

The climate of the Northwest is changing. According to the United States Global Change Research Program (USGCRP) the following changes have or are anticipated to occur in the region.[2] Over the last century, the average annual temperature rose by 1.5°F, with increases in some areas up to 4°F. Changes in snowpack, streamflows, and forest cover are already occurring. Future climate change will likely continue to influence these changes. Average annual temperature in the region is projected to increase by 3-10°F by the end of the century. Winter precipitation is projected to increase while summer precipitation is projected to decrease, though precipitation projections are less certain than those related to temperature. Future climate change impacts would be compounded by pressures related to the region's rapidly growing population.

[1] Landscape Conservation Cooperatives are public-private partnerships composed of states, tribes, federal agencies, non-governmental organizations, universities and others.
[2] U.S. Global Change Research Program (USGCRP). 2009. *Global Climate Change Impacts in the United States* . Karl, T.R., J. M. Melillo, and T. C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

Impacts from climate change are being observed in Alaska. According to the Alaska Climate Change Strategy[3] recent decades of warmer temperature have produced extensive thawing of permafrost, which has resulted in increased coastal erosion, landslides, and sinking of the ground surface, as well as consequent disruption and damage to forests, buildings, infrastructure, and coastal communities. Sea ice off the Alaskan Coast is retreating and thinning, with widespread effects on marine ecosystems, coastal climate, human settlements, and subsistence activities. The Arctic Region, particularly Alaska, is already experiencing major ecological impacts such as the northward expansion of boreal forest in some areas, significant increases in fire frequency and intensity, and unprecedented insect outbreaks.

Section 2: Region 10 Vulnerability Assessment

This section contains an assessment of the vulnerabilities of Region 10 programs to the impacts of climate change. It builds on the work presented in Part 2 of EPA's Agency-Wide Implementation Plan, as well as the individual assessments completed by various Program Offices in Region 10. It also draws heavily from existing efforts from the four states in Region 10, as well as the work from the Landscape Conservation Cooperatives in Region 10 and from Tribal assessments. A summary of those efforts is provided below and a more detailed discussion can be found in Appendix A. The vulnerability assessment is structured by the goals in EPA's FY 2011-2015 Strategic Plan and includes a vulnerability assessment of EPA Region 10 facilities and Tribes. A more detailed discussion of the vulnerabilities and impacts is included in Appendix B. Appendix D provides a comparison of the vulnerabilities identified below with existing Region 10 actions. This information could be used to help focus future actions.

> Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

It is important to note that EPA Region 10 did not conduct a quantitative vulnerability assessment, but has qualitatively evaluated the nature and magnitude of risks associated with climate change impacts. The vulnerability assessment is based on the best available information, state and tribal vulnerability assessments, and our own best professional judgment. The assessment does not specifically distinguish timeframes (current, near-term, long-term) for impacts, although it mentions where impacts are already occurring, and it does provide judgments on the likelihood of the impact occurring in the Region. The assessment will need to be updated as our understanding of climate science evolves, and the Region will need to identify the important gaps in our scientific knowledge and technical analyses that are needed to assist in decision-making.

[3] Alaska's Climate Change Strategy: Addressing Impacts in Alaska. http://www.climatechange.alaska/aag/docs/aag_ES_27Jan10.pdf.

The overall goal of the Region 10 vulnerability assessment and the detailed discussion of specific vulnerabilities contained in Appendix B and the comparison with vulnerabilities and existing actions in Appendix D are to:

1. Inform staff and managers in Region 10 about the most critical impacts from climate change for their programs;

2. Motivate staff and managers to continue with existing climate change and sustainability work and integrate climate change adaptation into their program work;

3. Serve as a starting point to engage in conversations with EPA partners, especially Tribes, on future actions that are needed to adapt to climate change; and

4. Serve as a qualitative assessment of the baseline set of vulnerabilities, which can be refined as new regional information on climate science and adaptation alternatives become available.

Vulnerable populations are mentioned throughout the document. Certain parts of the population, such as children, the elderly, minorities and the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Tribes may be more vulnerable to climate change impacts because of dependence upon a specific geographical area for their livelihood; and their unique cultural, economic, or political characteristics and contexts.[4]

Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society.

I. Region 10 General Vulnerabilities

All four States in Region 10 have identified vulnerabilities specific to their State. A summary of what is included in each State assessment is included below with a more detailed discussion in Appendix A.

[4] Cutter, S.L. and C. Finch. 2008. Temporal and spatial changes in social vulnerability to natural hazards. Proceedings of the National Academy of Science 105(7): 2301-2306.

- The State of Oregon has developed a framework that condenses specific vulnerabilities and risks from climate change into 11 overarching categories. They then ranked these into three groups: very likely, likely, and more likely than not.[5]

- The Washington State Department of Ecology has summarized climate impacts in their response strategy.[6] Washington examined projected impacts for sector groupings – e.g., built infrastructure, wildlife & habitat, etc.

- Climate change planning in Idaho is conducted by the Idaho Experimental Program to Stimulate Competitive Research (EPSCoR).[7] The EPSCoR work addresses concerns about how the hydrology in Idaho will change as climate changes in the western U.S.

- The State of Alaska Adaptation Advisory Group describes vulnerabilities including effects that are already occurring in their document *Alaska's Climate Change Strategy: Addressing Impacts in Alaska*.[8]

- In an effort to understand Tribal cultural resource vulnerabilities, Region 10 reviewed the Swinomish Climate Change Initiative Impact Assessment Technical Report.[9]

- The Tribal Climate Change Adaptation Plan Template provides a summary of the Arctic vulnerabilities and those related to Alaskan Tribes.[10]

The following suite of climate change vulnerabilities and impacts, and their effects on Region 10 Programs is discussed in the sections below. They are discussed individually, or in combinations based on the focus of the Strategic Plan Goal under consideration. A more detailed discussion of the vulnerabilities is in Appendix B.

Based on the assessments described above we developed the following list of the most significant regional vulnerabilities.

1. Increase in average annual air temperature.
2. Decreased/loss of snowpack.
3. Sea level rise.
4. Permafrost thawing.

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[5] http://www.oregon.gov/LCD/docs/ClimateChange/Framework_Final.pdf
[6] http://www.ecy.wa.gov/climatechange/ipa_responsestrategy.htm
[7] http://www.idahoclimatechange.org/DrawOnePage.aspx?PageID=135
[8] http://www.climatechange.alaska.gov/aag/docs/aag_ES_27Jan10.pdf
[9] http://www.swinomish.org/departments/planning/climate_change/climate_main.html
[10] http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

5. Sea ice melting.
6. Increase in wildfire frequency and intensity.
7. Increase in ocean temperatures.
8. Increase in ocean acidification.
9. Increase frequency of extreme precipitation events and flooding.
10. Increase in and changing mix of pests.
11. More frequent and severe drought.
12. Increase health impacts.

In addition to the vulnerabilities above, several cultural vulnerabilities were identified in the Swinomish Impact Assessment that may be relevant to other Tribes including:

- Shrinking land base (sea level rise).
- Inundation of coastal sites/artifacts.
- Exposure of burial sites and human remains from strong storm events.
- Loss of cultural use plants.
- Impacts within traditional use areas.
- Historic subsistent natural resources used by indigenous tribes such as fishery resources, wildlife, traditional foods, native plants, and holistic medicines are vulnerable.

These vulnerabilities are discussed when evaluating potential impacts on Regional Office programmatic areas of responsibility. The five goals discussed below are taken from the National Goals to facilitate comparisons across regions. The relationships to Region 10 Goals[11] are also given. Two additional areas of responsibility beyond the five National Goals that are addressed under vulnerabilities are facilities and operations and Tribes and vulnerable populations.

Cross Walk between National and Region 10 Goals	
National Goal	**Regional Goal**
Goal 1: Taking Action on Climate Change and Improving Air Quality	Goal 1: .Taking Action on Climate Change and Goal 2: Improving Air Quality
Goal 2: Protecting America's Waters	Goal 5: Protecting America's Waters
Goal 3: Cleaning Up Communities and Advancing Sustainable Development	Goal 4: Cleaning Up Our Communities
Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution	Goal 3: Assuring the Safety of Chemicals
Goal 5: Enforcing Environmental Laws	Goal 3: Assuring the Safety of Chemicals
Facilities and Operations	No specific goal.

[11] http://www.epa.gov/region10/pdf/regional_priorities_2011-2015.pdf

Vulnerable populations	Goals 6: Expanding the Conversation on Environmentalism and Working for Environmental Justice Goal 7: Building Strong State and Tribal Partnerships.

1. Goal 1: Taking Action on Climate Change and Improving Air Quality

Many of the impacts from climate change including increased summer temperatures, increased wildfires, changes in precipitation, and severe weather events are likely to impact both ambient and indoor air quality in the Pacific Northwest and Alaska. These impacts will present new challenges to EPA Region 10 and its partners to ensure the continued protection of public health and the environment.

A. Increase in tropospheric ozone pollution may occur in certain areas due to increased average summertime temperature

There is the possibility that higher summertime temperatures would increase ozone productivity as well as emissions of volatile organic contaminant (VOC) precursors and, there is scientific consensus that climate change will decrease the background ozone in the lower troposphere where the water vapor effect is dominant.[12] However, from the available academic literature that includes results for the Pacific Northwest, there is no consistent finding about whether climate change will increase, decrease, or have no change on ozone in this region.[13,14] Potential ozone increases are more likely to occur in the larger metropolitan areas including Spokane, Tacoma, Portland, and Boise. Whether or not these increases will result in violations of the NAAQS health standards however is unknown.

B. Increase in air toxics from anthropogenic sources is uncertain due to variability in effects of temperature increase on individual air toxics.

Many hazardous air pollutants volatilize at higher temperatures, creating the potential for higher emission rates and higher concentrations in ambient air.[15] The higher concentrations could increase

[12] Jacob, DJ., and D.A. Winner. 2009. Effect of climate change on air quality. Atmos. Environ., 43 (56).
[13] Ibid Jacob and Winner 43 (51-63).
[14] USGCRP. 2009. Assessment of the impacts of global change on regional U.S. Air quality: a synthesis of climate change impacts on ground-level ozone, *EPA/600/R-07/094F*, Office of Research and Development, Washington, D.C.
[15] IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (Field, C.B., V. Barros, T.F. Stocker, D.Qin, D.J. Dokken, K.L. Ebi, M.D., Mastrandrea, K.J. Mach, G.K. Plattner, SlK. Allen, M. Tignor, and P.M. Midgley (eds.). A Special Report of Working Groups I & II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA pp. 1-19.

public health risks, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations. There is uncertainty however as to actual impacts on hazardous air pollutants (HAPs) concentrations since the boundary layer height will also likely be higher, adding more volume of air for the HAPs to mix into. It is also possible for pollutant removal mechanisms to increase as a result of climate change.

C. Particulate matter levels are likely to increase due to increased frequency or intensity of wildfires due to increased summertime temperatures, prolonged droughts, and decreased soil moisture.

Larger and more frequent wildfires are predicted throughout the region as a result of warmer summertime temperatures, decreased soil and fuel moisture, and increased pest infestations.[16] For example, in the Columbia Basin, the acres of forest burned are projected to double by the 2020s, and triple by the 2040s compared to average burned from 1916 to 2006.[17] This could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter pollution in areas affected by more frequent wildfires. All four Region 10 States have a high percent of forested areas (about 50% for Washington and Oregon) and would all be adversely affected by an increase in wildfires.

D. Indoor air quality is very likely to be impacted, especially in Alaska, due to changes in precipitation, extreme temperatures, more frequent wildfires, and severe weather events.

Deterioration in indoor air quality will increase public health risks including those from respiratory illnesses such as asthma.[18] Public health risks from poor indoor air quality may also increase for susceptible populations - the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations across the region. Alaska's native and rural populations are very vulnerable to worsening indoor air quality with more insulated housing reducing air circulation - thereby increasing levels of both indoor and ambient pollution. [19] Increased flooding and melting permafrost also worsen indoor air

[16] Mote, P. K. Snover, S. Capalbo, S.D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder, 2014: Ch. 21: Northwest. Climate Change Impacts on the United States: The Third National Climate Assessment, J.M. Melilo, Terese (T.C.) Richmond and G.W Yohe, Eds., U.S. Global Change Research Program, 487-513. doi:10.7930/J04Q7RWX. http://nca2014.globalchange.gov/report/regions/northwest#statement-1700.
[17] Littell, J.S. et. al. 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. Climatic Change 102(1-2): 129-158.
[18] Reid, Colleen and Gamble, Janet. 2009. Aeroallergens, Allergic Disease, and Climate Change: Impacts and Adaptation, Ecohealth Vol 6(3):458-470, September, 2009.
[19] Institute of Medicine, *Climate Change, the Indoor Environment, and Health* (Washington, DC: The National Academies Press, 2011).

quality by supporting mold growth.[20] This is an issue across the Region, but particularly important in environmental justice (EJ) areas and areas with a high density of more susceptible populations such as in Alaska's native villages[21] and on tribal reservations in Washington, Oregon and Idaho.

E. Stratospheric ozone layer is likely to be impacted in Alaska due to climate change effects.

This issue is important in the Arctic (Alaska) where severe depletion of stratospheric ozone has been observed during winter and spring months.[22] While there currently are no EPA Region 10 programs that directly deal with monitoring or restoring the stratospheric ozone layer, there is enforcement activity against violators related to use and disposal of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) and their substitutes.

F. Increased rate and deposition of sulfates, nitrates, and mercury is uncertain due to changes in precipitation patterns.

Increased concentrations of sulfates, nitrates, and mercury could cause adverse effects on ecosystems throughout the region, particularly mountain ecosystems and freshwater ecosystems, and could contribute to accumulation of mercury in fish tissue. [23] However, overall effects are uncertain because higher temperatures drive increased chemical reactions and possibly more secondary organic carbon. [24] At the same time, there might be changes to the boundary layer height, airmass ventilation rate, and precipitation. We do not know the relative importance of these effects in Region 10 states.

2. Goal 2: Protecting America's Waters

There are many impacts that climate change may have on our water resources including drinking water and wastewater infrastructure, freshwater fisheries, terrestrial and marine ecosystems, water quality and water quantity, and agricultural and forestry production. These impacts will present challenges as there will be competing demands in some areas for water resources for agriculture, energy production, drinking water, and maintaining streamflows for fish. The section below highlights the main vulnerabilities and impacts identified in Region 10.

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[20] Kovesi, Thomas MD et al. 2007. Indoor Air Quality and the Risk of lower respiratory tract infections in young Canadian Inuit children, Canadian Medical Association, 2007

[21] Bulkow, Lisa, et al. 2010. Risk Factors for Severe Respiratory Synctial Virus Infection Among Alaska Native Children, Pediatrics. 109 (2) 2010.

[22] Manney, G.L., et al., Unprecedented Arctic Ozone Loss in 2011. 2011. Nature 478, 469-475, October 27, 2011.

[23] Dawson, J.P., B.J. Bloomer, D.A. Winner, C.P. Weaver, 2013. Understanding the meteorological drivers of U.S. particulate matter concentrations in a changing climate, Bulletin of the American Meteorological Society, doi:10.1175/BAMS-D-12-00181.1, in press.

[24] Ibid. Dawson 2013.

A. Drinking water, wastewater, stormwater, and agricultural infrastructure is likely to be impacted by increased heavy precipitation, more frequent flood events, storm surge, coastal erosion, and drought.

Impacts on water infrastructure may result in flooded facilities, an increased number of sewer overflows and wastewater bypasses, as well as increased pollutant loads in runoff, increased pollution of streams and threats to public health.[25] Climate change impacts drinking water by heightening risk of contamination of surface water sources due to higher temperatures, lower flows, and increased erosion/sedimentation.[26] Problems of safety as well as access to clean and safe water will be exacerbated for Tribal communities, and other vulnerable and economically depressed communities who have limited access to clean water supplies.[27] Agricultural productivity may be impacted in areas with inadequate water storage capacity and limited agricultural irrigation systems. Adequate summertime water supply for irrigation of crops is essential to agricultural communities east of the Cascades in Oregon, Washington, and Idaho. For tribes, who lack irrigation infrastructure and rely primarily on lakes and streams as water sources, availability of water for agriculture may be more severely impacted by climate change.

B. Impacts to freshwater fisheries is occurring now and is likely to increase due to earlier stream runoff and scouring of streambeds due to earlier snow melt, decreased summer stream flows and increased steam temperatures, and longer periods of low stream flow.

Impacts include loss of salmon habitat and increased stress on salmon reproduction throughout their entire lifecycle.[28] Salmon and other cold water fish constitute a large part of the marine fishery business in the Pacific Northwest, and loss of these fish would have a substantial impact on the Pacific Northwest economy. Coastal Native Americans depend on salmon as an essential part of their diets. There will be secondary impacts on other species in the ecosystem that benefit from salmon – e.g., forests that rely on decaying salmon for nutrients, and bears, eagles, others that feed on salmon. This also applies to other fresh cold water fish. Water resource decision-makers will need to modify watershed planning efforts to include projected impacts of altered stream flows and increased temperatures due to climate change.[29, 30]

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[25] USGCRP. 2009. Regional Impacts: Northwest. *EPA/600/R-07/094F*, Office of Research and Development, Washington, D.C.
[26] Ibid. USGCRP.
[27] http://www.climatechange.alaska.gov/aag/docs/aag_ES_27Jan10.pdf
[28] USGCRP. 2009. Regional Impacts: Northwest. *EPA/600/R-07/094F*, Office of Research and Development, Washington, D.C.
[29] Wenger, S.J., et al. 2011. Role of climate and invasive species in structuring trout distributions in the Interior Columbia Basin 2011, USA: Canadian Journal of Fisheries and Aquatic Sciences, v. 68, p. 988-1008. Catalog No: 2508.
[30] Wenger, S.J., et al. 2011. Flow regime, temperature and biotic interactions drive differential declines of trout species under climate change. Proceedings of the National Academy of Sciences, online. Catalog No: 2652.

C. Estuarine watersheds, aquatic ecosystems, and wetlands are likely to be impacted by sea-level rise, sea surface temperature and increasing heavy precipitation events during the winter months, and decreasing precipitation days and increasing drought intensity during the summer months.

Changes in precipitation patterns, and increased drought intensity will cause stress on wetlands, and forest and mountain ecosystems, and pose challenges to migration of species in these ecosystems to more suitable habitats. Warmer sea surface temperature contributes to sea level rise, increased storm intensity, and greater stratification of the water column.[31] For the Washington, Oregon, and California coasts north of Cape Mendocino, sea level is projected to change between -4 cm (sea-level fall) and +23 cm by 2030, -3 cm and +48 cm by 2050, and 10–143 cm by 2100.[32]

D. Forest ecosystems will likely be impacted by warming temperatures and more frequent and intense drought conditions.

Forest tree species are expected to shift their ranges northward and upslope in response to climate change and existing ecosystems will breakup as different species shift at different rates, resulting in the formation of new ecosystems, with unknown consequences.[33] Breakup of existing ecosystems and loss of biodiversity, in combination with increased drought conditions, can make forests more susceptible to destruction by wildfires and insect infestation. In the western United States, both the frequency of large wildfires, and the length of the fire season have increased substantially in recent decades, due primarily to earlier spring snowmelt and higher spring and summer temperatures.[34] Adverse effects are likely in forests across the region, but more immediately in low elevation forests, and forests in drier parts of the region, such as in Idaho eastern Washington and Oregon, and the interior of Alaska.[35]

E. Loss of sea ice is occurring now and will very likely increase in Alaska due to warming air and water temperatures.

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[31] Hoegh-Guldberg, Ove and Bruno, John F. 2010. The impact of climate change on the world's ecosystems. Science 328(1523-1528.

[32] National Research Council. 2012. Sea-level rise for the coasts of Washington, Oregon and California: Past, Present, and Future. Division on Earth and Life Studies Board on Earth Sciences and Resources and Ocean Studies Board. Committee on Sea Level Rise in California, Oregon, and Washington.

[33] ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, UK, and New York, 139 pp.

[34] Westerling A.L., et. al. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. Science, 313(5789), 940-943.

[35] USGCRP. 2009. Regional Impacts: Pacific Northwest and Alaska. EPA/600/R-07/094F, Office of Research and Development, Washington, D.C.

Loss of arctic ice in the Bering Sea is adversely affecting Arctic sea ice ecosystems. The Bering Sea fishery is a very important source of seafood and an important factor to Alaska's economy. The earlier ice melt resulting from warming, however, leads to later phytoplankton blooms that are largely consumed by microscopic animals near the sea surface, vastly decreasing the amount of food reaching the living organisms on the ocean floor.[36] This will radically change the species composition of the fish and other creatures, with significant repercussions for both subsistence and commercial fishing.[37] Sea ice is forming later in the fall in Alaska, making the coastal communities more vulnerable to extreme storms causing coastal erosion in villages.[38]

F. Ocean acidification is occurring now and is very likely to increase due to increasing concentrations of CO_2 in the atmosphere.

Ocean acidification can lead to substantial decline of marine organisms that form their shells and skeletons from calcium carbonate in ocean waters.[39] Adverse effects of ocean acidification on marine organisms have already been documented.[40] Specifically, adverse effects of ocean acidification have been documented in pteropods (sea snails),[41] a primary food source for salmon in the Pacific Ocean, and in oyster larvae in estuaries on the coast of OR.[42] This is an important issue in coastal areas of the Pacific Northwest and Alaska.

G. Change in vegetation is likely in eastern Washington and Oregon and Idaho due to pest outbreaks, invasive species, increased fire, shifts in species ranges and increased erosion, drier soils, and depletion of water.

Climate warming is likely to increase the severity of West Nile Virus (WNv) outbreaks and to expand the area susceptible to outbreaks into areas that are now too cold for the WNv vector.[43] Observed and projected decreases in the frequency of freezing temperatures, lengthening of the frost-free season, and

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[36] USGCRP. 2009. Regional Impacts: Alaska. EPA/600/R-07/094F, Office of Research and Development, Washington, D.C.
[37] Janetos, A., et. al. 2008. Biodiversity. In: The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States. Synthesis and Assessment Product 4.3. U.S. Department of Agriculture, Washington, DC, pp. 151-181.
[38] http://www.stormsurge.noaa.gov/event_history.html
[39] Orr, J.C., et. al. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature, 437(7059), 681-686. 2005
[40] Feely, R.A., et. al. 2008. Evidence for upwelling of corrosive “acidified” water onto the continental shelf. Science, 320(5882), 1490-1492.
[41] Bednaršek, N., et. al. 2012. Extensive dissolution of live pteropods in the Southern Ocean, Nature Geoscience, 5 (881–885).
[42] Barton, Alan, et. al. 2012. The Pacific oyster, Crassostrea gigas, shows negative correlation to naturally elevated carbon dioxide levels: Implications for near-term ocean acidification effects. Limnology and Oceanography. 57(3).
[43] Ibid Washington State Department of Fish and Wildlife. 2011.

increased minimum temperatures can alter plant species ranges and shift the geographic and elevational boundaries of many arid lands. These changes are particularly relevant to the intermountain regions in western North America, the Palouse grassland bioregion, southeastern Washington, and northeastern Oregon.

3. Goal 3: Cleaning Up Communities and Advancing Sustainable Development

Contaminated site cleanup and waste/petroleum management occur under a variety of EPA programs, most commonly Superfund (i.e., remedial, time-critical and non-time critical removals, and emergency response), Resource Conservation and Recovery Act (RCRA), Toxic Substance Control Act (TSCA) (e.g., polychlorinated biphenyls – PCBs), Clean Air Act (CAA) (e.g., asbestos), and the Oil Pollution Act (OPA).

There are over 100 hazardous waste sites listed on the National Priority List, and many RCRA permitted and corrective action sites in Region 10. Many of these sites are especially vulnerable to impacts from climate change and the potential impacts to infrastructure and in place remedies at corrective action, remedial, removal, and brownfield sites. Also, there may be an increased need for Emergency Response as part of FEMA response.

Region 10 recognizes the importance of sustainable development, and the overlap and intersection with climate change issues. The Region is focusing on coordinating its sustainability efforts internally as well as with our external partners with a specific consideration of climate change.

A. Remedial, removal, brownfield, corrective action or permitted sites may be impacted due to flooding, sea level risk, storm surges, extreme events, and landslides.

There could be an increased risk of contaminant release from hazardous waste sites. Remedial project managers and corrective action project managers may need to alter selected remedies to ensure hazardous substances are not released. In situ remedies (e.g., stabilization, reactive barriers) and on-site above ground treatment systems (e.g., pump & treat, air sparging) could be compromised or overwhelmed if they are not designed to withstand the climate-related events. The net result could be release of contaminants.

Groundwater and subsurface contamination could be impacted by drought and flood conditions. There may be an increased risk of migration of contaminants from flooded containment facilities. Remedies such as caps in contaminated industrial waterways in Washington and Oregon could be subject to (and not designed to withstand) unanticipated scour events.

Possible issues of nuclear waste disposal related to climate change (e.g., locations of storage facilities, appropriate containment, and risk management issues) would also be important at the DOE Hanford facility in Washington State, and the DOE Idaho National Lab facility in Idaho.

B. Increase in work for Alaska's Tribal and emergency response programs is occurring now and likely to increase due to thawing permafrost and changes in sea ice that leads to damage of roads, runways, water and sewer systems, and other infrastructure.

Melting sea ice and late formation in the fall is causing storms to move in close to shore as the natural buffering system disappears. That is causing rapid coastal erosion, with houses and infrastructure falling into the ocean in several communities. That, along with higher storm, tidal surges flood communities, is requiring more immediate evacuation needs. Open dumps are also impacted by storm surges, and flooding, which increases contamination risk. Permafrost temperatures have increased throughout Alaska since the late 1970s.[44] Land subsidence (sinking) associated with the thawing of permafrost presents substantial challenges to engineers attempting to preserve infrastructure in Alaska.[45]

C. EPA Region 10, Tribal and state partners will have increasing workloads in many aspects of site and waste management as well as work related to the formation and implementation of sustainable development and materials management programs, partnerships and initiatives.

Existing trends will exacerbate the challenges of climate adaptation. For example, accelerating development (sustainable or otherwise) and the expected migration of people to Region 10 are issues of concern. It is projected that the population of the States in Region 10 will increase from 11.2 million in 2010 to 13.1 million in 2025.[46] Communities are struggling with how to manage the new people while protecting the environment and providing basic services like energy, water and waste management. In support of the increased sustainability of our communities, our investments in partnerships related to more sustainable materials management play an increasing role in preventing waste, conserving energy and reducing emissions of toxics as well as greenhouse gases. Waste management can be especially challenging in remote tribal communities in Alaska.[47]

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[44] Lettenmaier, D., et. al. 2008. The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States, Synthesis and Assessment Product 4.3. U.S. Department of Agriculture, Washington,DC, pp. 121-150.

[45] Instanes, A., et. al. 2005. Infrastructure: buildings, support systems, and industrial facilities. In: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, UK, and New York, pp. 907-944

[46] U.S. Census Bureau. 2013. Current Population Report: Population Projections: States 1995-2025. Economics Statistical Administration. Department of Commerce. Website:http://www.census.gov/prod/2/pop/p25/p25-1131.pdf. Accessed May 23, 2013.

[47] U.S. EPA. 2011. National Priorities with a Local Focus – Region 10's Approach for Implementing Administrator Jackson's Seven Priorities – FY 2011-2015 November 2011. www.epa.gov.

D. Availability of raw materials may decrease and the cost of mining and refining raw materials, producing products, transporting products, and disposing products may increase due to impacts of climate change.

EPA Region 10 will need to put more effort into advocating for sustainable materials management and pollution prevention with States, industry, communities and tribes as climate change affects the availability and cost of raw materials and products. This issue will impact the entire region but may have a greater impact on remote cities and villages in Alaska where transportation and disposal of products is more difficult and costly. For example, increasing pest infestations and forest fires can result in millions of acres of dead, dying, and burned trees in the Pacific Northwest and Alaska. This decreases the availability and drives up the costs of wood products. Thawing permafrost in Alaska results in infrastructure damage in the form of compromised or impassible haul roads for timber and ore, reducing the availability of these natural resources and driving up transportation costs.

4. Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution

EPA and the states (usually the State Department of Agriculture) register or license pesticides for use in the United States. In addition, EPA must be notified of the importation of pesticides for use in the U.S. EPA receives its authority to register pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Climate change may lead to an increase in pesticide use, due to an increase in pests and diseases which favor warm and humid climates. Also, a changing climate can affect exposures to a wide range of chemicals not just pesticide. Exposures may change because of changing environmental conditions or changing use patterns.

A. Increased exposure and risk to hazardous chemicals may occur due to increasing extreme temperatures and heavy precipitation events, changes in storm intensities, and increasing frequency of floods.

The increased exposures and risk may require adjustments to the relevant risk assessment framework to determine public risk due to modified exposure scenarios and modified toxicity of chemicals due to climate change. Altered weather and severe climate events could also affect the interpretations of risk at RCRA/TSCA and Superfund sites. This is very relevant for permitting and planning activities, where facilities may not have previously required an awareness of risk management for water/flooding, or other climate change impacts. In particular, Puget Sound is vulnerable to these potential impacts of chemical pollution; restoration of Puget Sound is a key ecosystem-level activity in EPA Region 10.[48] This

[48] http://www.psp.wa.gov/downloads/AA2011/083012_final/Action%20Agenda%20Book%202_Aug%2029%202012.pdf

is more relevant near sites with large densities of chemical manufacturers, processors and formulators, and RCRA and Superfund sites.

5. Goal 5: Enforcing Environmental Laws

EPA Region 10's Office of Compliance and Enforcement (OCE) is charged with ensuring compliance with environmental requirements and enforcing against violations to those requirements in the Pacific Northwest and Alaska. In that capacity, OCE's vulnerabilities are uniquely tied to interactions with the regulated community. Some types of vulnerabilities (e.g., difficulties with maintaining staff functionality due to power outages and physical damage to facilities due to extreme weather) would be similar to those experienced by all EPA programs and regions.

Other vulnerabilities are more specific to OCE, such as those which impact the ability of regulated entities to comply with environmental requirements and with our ability to determine such compliance and take appropriate action. The vulnerabilities of greatest importance for OCE are conditions/events which would compromise our ability to ensure compliance with environmental requirements by regulated entities and, where necessary, to take effective enforcement action in case of violations. The activities impacted would include: compliance assistance; compliance monitoring and civil enforcement.

A. Non-compliance at regulated entities may increase due to extreme weather events and changing weather patterns.

Compliance and enforcement programs under the Clean Water Act (CWA) have the potential to see an increase in violations from many situations including sanitary sewer and combined sewer overflows, violations of percent removal at wastewater treatment plants (due to limited water flow as a result of drought), violations in bypasses due to the inability of wastewater treatment plants to treat a flow in excess of the design capacity, and increased violations in numerous programs due to failure of existing infrastructure protecting against extreme weather events. In addition, CWA section 311 (Spill Prevention Control Countermeasures) may see an increase in non-compliance along Alaskan coastal areas that have oil storage containers, as a result of sea ice melting (thereby increasing storm surges along those coastal areas) and increased flooding.

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) compliance and enforcement programs may see violations at Pesticides Producing Establishments as there is a shift toward increasing pesticide usage, productions and imports. As weather patterns change in the Region, the habitats of insects and pests may also change, bringing different pests and diseases to areas.

The RCRA program may see increased non-compliance at landfills due to changes in precipitation patterns (including more precipitation in some cases and more extreme precipitation events in other

cases). Landfills may generate excessive hazardous leachate, see unexpected mobilization of contaminants in the waste column, and/or experience failure of the liner or leachate collection systems.

B. Shift in regional enforcement priorities due to changes in compliance (both increased compliance and non-compliance in different sectors) and increased number of inquiries from industry about maintaining compliance due to extreme weather events and changing weather patterns.

If an increase in violations in various programs and industry are identified, OCE may shift the enforcement focus to address those violations. Conversely, OCE may use discretion to refocus enforcement priorities when localized extreme weather events (e.g., flooding) greatly impact the regulated community or when a change in weather patterns decreases the potential for non-compliance (e.g., less precipitation could decrease surface runoff). This will be most important in states where EPA has direct implementation of an enforcement program (e.g., Idaho for NPDES program), on Tribal lands, and non-delegable programs (e.g., Chlorofluorocarbons, CWA 311 (SPCC), and PCBs). In states with authorized program implementation, OCE's work share could change as a result of climate change shifting states' priorities.

OCE may need to make adjustments to normal workload to address an increase in industry's compliance inquiries. There may need to be reassignment or delay of normal work duties as staff provides response support to those inquiries in a timely manner. Requests may also be received from Regional state counterparts regarding guidance to address unique enforcement issues as a result of extreme weather events or changing weather patterns.

C. Increased permitting of Class VI Underground Injection Control (UIC) wells for Carbon Dioxide sequestration and Class V UIC wells for stormwater management.

EPA has developed criteria for Class VI wells, used specifically for the injection of carbon dioxide into underground subsurface rock formations for long-term storage. As the need to reduce carbon dioxide emissions into the atmosphere increases, various technologies including Class VI wells will be deployed. OCE may need to reassign or delay other UIC permitting and enforcement work, as permit requests for Class VI wells increase. This will be seen across the Region, until permitting and enforcement of the Class VI well program is delegated to the states.

As the amount of stormwater increases with increased precipitation levels, industries regulated to manage stormwater and associated discharges may be faced with challenges surrounding the volume of stormwater to manage. Class V wells are designed to receive stormwater, as a substitution for or in addition to discharging stormwater through more traditional means. OCE may see an increase in permitting Class V wells, as challenges managing high volumes of stormwater increase. Permitting will

be focused on Class V wells in Alaska and Tribal lands, as the Region implements this program in these areas.

D. An increase in regulated industrial activities in Alaska may result as the melting of sea ice opens new areas for activities.

Sea ice off the Alaskan Coast is retreating and thinning. This reduction of sea ice is very likely to increase the navigation season and create a seasonal opening of the Northern Sea Route to likely make trans-arctic shipping and transport feasible during summer months. As areas and routes become more accessible, there is a potential for industrial activity (e.g., oil and gas extraction) to become more active in these areas. As a result, OCE may see an increase in regulated entities.

6. EPA Facilities and Operations

The main EPA Region 10 building is in Seattle with field offices in Olympia, Portland, Boise, Anchorage, and Juneau. The Region also maintains an environmental laboratory in Manchester, Washington. The Region has a Continuity of Operations Plan (COOP) that describes efforts to prepare and react to issues affecting the operation of our facilities and a Regional Incident Command Team (RICT) who is responsible for responding to any emergency situation. In general, the EPA Region 10 facilities are not uniquely vulnerable to climate change impacts. The Manchester Lab is located on the shoreline and could be more susceptible. They have an emergency operation plans in the event of extreme weather events or other possible impacts from climatic change.

A. Drinking water may be limited and an increase in demand for air conditioning is possible due to increasing drought frequency and intensity.

Facilities could be located in areas with water shortages, requiring water rationing. There is likely to be a greater demand for electricity for air conditioning during the summer months. Increased extreme temperature at any Region 10 office would put higher demand on drinking water and electricity for cooling. This could impact the regional office and all the operations office.

B. Operations of Region 10 facilities may be impacted by increasing risk of floods and increasing intensity of storms.

Facilities in flood-prone areas may have to temporarily close. Personnel engaged in field work may be more vulnerable to extreme temperatures or storm events. Personnel and real property supporting emergency response and management may be at risk during flooding or extreme weather events. Ongoing work at the Manchester Environmental Laboratory may be disrupted with effects on many different programs. Closure of regional offices due to climate change related damage could prevent

staff from carrying out important functions. The Regional Office in Seattle is located in an area with low probability for flooding or sea level rise. Region 10 has flexiplace options available to staff and a COOP in place in case any Region 10 office is damaged by flooding or storms or transportation to/from offices are affected (e.g., flooded roadways; landslides on commuter train tracks).

7. Tribal and other Vulnerable Populations

As part of the EPA's direct federal implementation and oversight responsibilities, EPA Region 10 has a trust responsibility to each of the 271 federally recognized Indian tribes within the Region. Many Tribes are especially vulnerable to climate change impacts due to their reliance on traditional hunting and fishing and their connections to the land and sea. Climate change is threatening access to traditional foods such as salmon, marine mammals, shellfish, and terrestrial and aquatic plants which are used for cultural, medicinal, and economic purposes as well as a primary food source. Tribes have already experienced many climate-related changes including changes in salmon habitat, drought, declining water tables, increased wildfires that impact crops, wildlife, traditional foods and medicines, earlier spring snow melt, a decrease in sea ice, and permafrost thawing. EPA Region 10 is committed to work with the Tribes to adapt to these changing conditions.

The impacts of climate change can have unique effects on the health of children. Children are different from adults in how they interact with their environment and how their health may be affected. Because of their unique physical, biological, and social characteristics they are likely to suffer disproportionally from both the direct and indirect adverse health effects of climate change.[49]
The impacts of climate change raise environmental justice issues. Climate change is likely to exacerbate existing and introduce new environmental burdens and associated health impacts in communities dealing with environmental justice challenges across the nation.[50]

A. Food security for native Alaskans and Tribal people in the Pacific Northwest who live a subsistence lifestyle may be at risk due to warming associated with climate change.

Warming due to climate change reduces the availability and accessibility of many traditional food sources for Native Americans. People face losing their healthiest foods, their communities, and in some cases, their culture, since each of these depends on traditional ways of collecting and sharing food.[51]

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[49] Pediatrics, Global Climate Change and Children's Health, Committee on Environmental Health. 2007. Available at http://pediatrics.aappublications.org/content/120/5/1149.full.pdf
[50] USGCRP. 2009. *Global Climate Change Impacts in the United States* . Karl, T.R., J. M. Melillo, and T. C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA. 89–106.
[51] ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, UK, and New York, 139 pp.

Climate change will continue to impact and put stress on salmon in the Pacific Northwest along with other traditional foods such as wildlife, berries, and roots. In Alaska, climate change will reduce the availability and access to ice seals, walrus and caribou and access to shellfish and plants used for medicinal and cultural ceremonies.[52]

B. Increased erosion of shorelines is likely to increase risk to coastal native communities due to increased intensity of coastal storms and rising sea levels.

Coastlines and shorelines throughout the Pacific Northwest and Alaska are increasingly threatened by a combination of increasing storm activity, loss of its protective sea ice buffer, declining habitat, and thawing coastal permafrost.[53] In Alaska, over 100 villages on the coast and in low-lying areas along rivers are subject to increased flooding and erosion due to warming. Federal, state, and tribal officials have identified 31 villages that face imminent threats.[54] At least 12 of the 31 threatened villages have decided to relocate--in part or entirely--or to explore relocation options. Federal programs to assist threatened villages prepare for and recover from disasters and to protect and relocate them are limited and unavailable to the majority of villages. At least one Pacific Northwest Tribe, the Hoh Tribe is planning to relocate due to erosion and storm security.

C. Decreased access to clean drinking water is very likely due to loss of permafrost and reduced snowpack.

In many rural Alaskan tribal communities, the loss of permafrost can cause many problems including the loss of drinking water sources because tundra lakes, from which drinking water is drawn, are disappearing with the permafrost.[55] Also, melting permafrost destabilizes foundations, endangering the sewer and water infrastructure in these communities and without permafrost, the untreated leachate from open dumps may be a contamination risk for their water supply. Pacific Northwest Tribes may also experience water scarcity, due to failing aquifers and less rainfall. With the reduced snow pack and increased seasonal drought, many traditional drinking water sources are not being replenished.

D. Reduced availability of fish and shellfish resources is occurring now and is likely to increase due to changing water conditions.

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[52] Ibid ACIA. 2004.
[53] USGCRP. 2009. Regional Impacts: Pacific Northwest and Alaska. *EPA/600/R-07/094F*, Office of Research and Development, Washington, D.C.
[54] Alaska's Climate Change Strategy: Addressing Impacts in Alaska. http://www.climatechange.alaska/aag/docs/aag_ES_27Jan10.pdf.
[55] Alaska's Climate Change Strategy: Addressing Impacts in Alaska. http://www.climatechange.alaska/aag/docs/aag_ES_27Jan10.pdf.

Climate change is bringing rapid and adverse habitat challenges, from changing stream flows to warming waters that are having an impact on the viability of juvenile salmon to the impacts of ocean acidification on salmon, crustacean, and shellfish food sources. Seafood is central to diet, physical, and cultural well-being of Tribal lifeways. Increasing ocean acidification threatens shellfish beds that Tribes have harvested for millennia. Ocean acidification may reduce rates of shellfish larval survival and weaken the shells of the adults, thus making them more vulnerable as well.[56]

E. Vulnerable population such as children, the elderly, poor, and the infirm may be at increased health risk due to increased temperatures, failing infrastructure, and extreme weather events.

Children playing in areas with higher ozone levels resulting from increased temperature will be at higher risk for experiencing asthma symptoms, although in Region 10 the impacts from higher ozone levels are not anticipated to be significant. The elderly are more vulnerable to heat stress because they are often in poorer health and are less able to regulate their body temperature during periods of extreme heat. Economic constraints can also place low-income households at disproportionate risk to extreme heat events due to lack of air condition or failure to use air-conditioning to cut down on associated energy costs.

Section 3: Region 10 Priority Existing Actions

The sections below present the existing actions EPA Region 10 is taking to address the identified vulnerabilities and their associated impacts. These existing actions are from commitments in the EPA Region 10 Strategic Alignment Plan and existing actions identified by the program offices in EPA Region 10. The actions are summarized below for each EPA Region 10 office. A more complete description of the actions can be found in Appendix C. Also, Appendix D compares the vulnerabilities identified in Section 2 with the existing Regional actions by National or Regional goals.

Appendix D indicates that there are Regional vulnerabilities where there are no existing actions. Since this documents focus is existing actions, EPA Region 10 will evaluate how to address critical vulnerabilities in the future. In addition, Region 10 will evaluate how to better integrate climate change into its existing core programs along with engaging states, Tribes and other partners to adapt to changing environmental conditions.

EPA Region 10 has developed the following criteria that can be used for evaluating priority actions in the future.

- Actions that address an identified vulnerability in Region 10.

[56] Orr, J.C., et. al. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature, 437(7059), 681-686.

- Actions that align with EPA national or regional priorities for climate change.
- Actions that will assist tribes in adapting to climate change.
- Actions that are linked to sustainability and environmental justice.
- Actions that increase awareness of climate change for EPA Region 10 staff.
- Actions that promote integration of climate change into EPA Region 10 program operations.
- Actions that increase awareness and collaboration with outside partners including tribes.
- Actions where EPA has a unique role or capacity to address the issue.

1. Office of Air, Waste, and Toxics (OAWT)

EPA Region 10's Office of Air, Waste, and Toxics (OAWT) carries out air, waste and chemicals management programs under statutory authorities such as the Clean Air Act (CAA), Resource Conservation and Recovery Act (RCRA), the Toxic Substances Control Act (TSCA), the Pollution Prevention (P2) Act, and the Diesel Emission Reduction Act (DERA), and carries out TSCA enforcement actions dealing with lead-based paint and asbestos. Many of OAWT activities reduce greenhouse gas emissions. OAWT is currently also involved in the following Region-specific actions that address the climate change vulnerabilities identified in the previous section for Goals 1, 3 and 4.

Indoor Air (Goal 1)

- Develop and host training for professionals (housing, medical, schools) on making indoor environments healthier for the most vulnerable.

Materials Management and Pollution Prevention (Goals 3 and 4)

- Work with our partners through the West Coast Climate and Materials Management Forum and our pollution prevention technical assistance providers and grants to assist in the transition to sustainable materials management processes and source reduction.
- Recruiting and retaining participants for the Federal Green Challenge and for the Food Recovery Challenge in support of the EPA's Sustainable Materials Management (SMM) Program.

Tribal Waste Management (Goal 3)

- Work with federally recognized tribes in Region 10 to address landfills and unconfined open dumps which are impacted by climate change and help develop appropriate responses to these threats.

RCRA Corrective Action and Permitting (Goal 4)

- Ensuring that Climate Change guidance and policy capture RCRA issues.
- Incorporating green remediation in corrective action decision-making.

2. Office of Water and Watersheds (OWW)

EPA Region 10's Office of Water and Watersheds (OWW) implements programs under the CWA, Safe Drinking Water Act (SDWA), and parts of the National Environmental Policy Act (NEPA). Also, OWW provides funds for Puget Sound via the National Estuary Program to support climate change adaptation projects. OWW's current focus is on increasing awareness for Regional staff and partners on the science of climate change and strategies for adaptation to meet this goal. Many of these actions will benefit from the development and implementation of appropriate national guidance to promote consistency across the states. The Region will implement these actions in coordination with any related national guidance. The actions mainly focus on addressing the vulnerabilities for Goal 2.

Drinking water, wastewater, and stormwater infrastructure (Goal 2)

- Work with the State of Alaska to identify alternative technologies for providing first time service to unserved homes in a more sustainable way compared to a traditional piped system.
- Work with the Water Sense program to encourage water efficiency in homes, landscaping and commercial buildings with a focus on new homes.
- Continue implementing the Sustainable Energy Management Program with a Western Washington cohort of drinking water and wastewater utilities.

Freshwater fisheries (Goal 2)

- Continue with pilot program examining how to integrate climate change in an ongoing total maximum daily load (TMDL) by examining how temperature can be improved in the Nooksack watershed in order to support salmon restoration.

Puget Sound (Goal 2)

- Continue to support projects in Puget Sound related to climate change. There are several on-going projects that are highlighted in Appendix C.
- Work with the University of Washington to develop a system for visualizing and analyzing a variety of climate change-related features that are shifting with time and probability across the Region.

Training and Outreach (Goal 2)

- Inform and educate water program managers in the public and private sectors on climate change and water issues and EPA related activities such as the National and Regional climate change adaptation strategies.
- Work with States, Tribal governments, municipalities, non-profit organizations and businesses to promote the Climate Ready Water Utilities (CRWU) and Climate Ready Estuaries (CRE) Programs and new Climate Ready Resilience and Awareness (CREAT) Version 2.0.
- Support Development of a Climate Change Section in the "Green" Paper for the State Revolving Loan Funds and Annual Review Checklists.

3. Office of Ecosystems, Tribal, and Public Affairs (ETPA)

EPA Region 10's Office of Ecosystems, Tribal, and Public Affairs (ETPA) implements cross-program efforts to protect the environment and engage communities and leads Regional efforts related to Freedom of Information Act requests, environmental justice, and sustainable agriculture. ETPA's focus is to ensure consideration of climate change on projects via NEPA review process, incorporating climate change science in wetlands management, providing assistance to Region 10 Tribes for climate change activities, and supporting activities that address children's health and other vulnerable populations.

NEPA Review (Goal 2)

- Through the NEPA review process ensure consideration of climate change in review of all federal projects and incorporate climate change adaptation into land management planning and other projects as appropriate.
- Include ocean acidification language in NEPA review comment letters as appropriate and develop template language in letters and example NEPA analyses that include ocean acidification information.

Wetlands (Goal 2)

- Coordinate a *Wetlands and Climate Change Research Meeting* focused on new approaches and tools to better understand, manage, and conserve wetlands in a changing climate.
- Incorporate climate change considerations into the CWA 404 regulatory program as they relate to permit reviews and compensatory mitigation.
- As resources allow, improve baseline information on wetland extent, condition and performance to inform effective adaptation to climate change.
- Integrate climate adaptation in the FFY14/15 Region 10 Wetland Program Development Grants RFP by considering how the design and installation of demonstration projects would take relevant potential impacts from climate change into account when considering long-term viability.[57]

Ocean Programs (Goal 2)

- Participate in interagency development and implementation of federal strategies through the National Ocean Council (NOC) and the National Ocean Policy Implementation Plan

Tribes (Multiple Goals)

- Support Tribes to develop adaptation actions (plans), to document impacts from climate change and to engage in the collaboration with local, state and federal agencies working on broad based adaptation plans.

[57] http://www.epa.gov/region10/pdf/wetlands/FY13_Wetland_Program_Development_Grants_Request_for_Proposals.pdf

- Provide Indian General Assistance Program (IGAP) funding as appropriate to Tribes with climate change in their IGAP workplans to do baseline environmental assessments and support adaptation planning.
- Raise awareness by providing educational outreach, training, and webinars to Tribes and work with the Institute for Tribal Environmental Professionals on tribal climate change adaptation models and resources.
- Support Tribal projects on climate change in Puget Sound through the National Estuary Program. A listing of those projects is included in Appendix C.
- Assist Tribes to build capacity and knowledge and assess and address air quality concerns including those related to climate change through the Regional Clean Air Act Grants.
- Support the Rural Alaska Children's Health Initiative which works to protect children from harmful environmental exposures in rural Alaska, including factors related to climate change.

Community Health (Regional Goal 7)

- Through work on children's health, develop and host training for professionals in the housing, health and educational fields on making indoor environments healthier for the most vulnerable populations.
- Provide technical assistance and training to affected communities on risks associated with poor outdoor air quality (e.g., work with Tribal Air Program and convene Rural Alaska Children's Environmental Initiative).
- Outreach/risk communication to vulnerable and economically deprived communities.
- Work with Department of Housing and Urban Development, Department of Transportation, and Urban Sustainability Directors Network on promoting sustainable communities via housing, transportation, and transit.

4. Office of Environmental Clean-Up (ECL)

EPA Region 10's Office of Environmental Clean-Up (ECL) is responsible for investigating contaminated properties; cleaning up contaminated land, sediment, and water for appropriate uses; emergency response; emergency planning and spill prevention; and Homeland Security and counter terrorism preparedness. ECL works closely with communities and interested stakeholders, providing funding in some cases to facilitate meaningful engagement in the Superfund process. ECL has focused on green remediation strategies for specific sites, and the reduction of carbon and toxic emissions and reducing overall environmental footprint of clean-up activities. There are no specific adaptation activities currently underway in ECL.

5. Office of Compliance and Enforcement (OCE)

EPA Region 10's Office of Compliance and Enforcement (OCE) provides enforcement, compliance monitoring, and compliance assistance for ground water, pesticides and toxics, wastewater (NPDES), air, and solid and hazardous waste (RCRA) programs. Regional and national enforcement priorities change. OCE is positioned to be flexible and use discretion when deciding those enforcement priorities, even as those priorities are influenced by climate change. OCE has several ongoing activities all of which fall under Goal 5.

- Continue to use an Environmental Justice Screening tool to identify regulated facilities located in overburdened communities.
- The UIC program will continue to permit several Class I wells for underground injection of wastes to reduce the need to establish waste retention ponds on the increasingly vulnerable permafrost.
- Continuing to support the Regional Support Corps by deploying staff for varying emergency response efforts.
- Continue to look for opportunities to encompass green infrastructure as part of settlement agreements.

6. Office of Regional Counsel (ORC)

The Region has broad legal mandates to protect human health and the environment and therefore, broad legal authority to support adaptation work. In the course of adaptation planning, specific questions will likely arise that will need legal review. As there is variation among the statutes EPA administers, as well as the regulatory programs EPA designs, implements, and enforces under those laws, the best way for ORC to support adaptation efforts is to provide legal analysis on a case by case basis. ORC will also support each of the regional program offices by coordinating with the Office of General Counsel, offices of Regional Counsel in other regions, and the Office of Enforcement and Compliance Assurance, as necessary to provide legal advice to the regional program offices.

7. Office of Environmental Assessment (OEA)

EPA Region 10's Office of Environmental Assessment (OEA) provides scientific and technical expertise in assessing the condition of the environment to support program decision-making and scientific initiatives. OEA collects and analyze data to characterize the environment, investigate environmental problems, and evaluate proposed solutions. A major emphasis of the OEA's activities are related to raising awareness on the science of climate change to staff in the Regional office, to integrate climate

change into the core program work, and to work with external partners to better coordinate the work and increase collaboration. OEA has several ongoing activities that address of the goals.

- Provide outreach/trainings to increase awareness of climate science to regional staff and partners.
- Work with individual programs and cross-office projects to integrate climate science into core program work.
- Communicate with the public about hazards posed by climate change and actions being taken by the EPA to address climate change.
- Coordinate with other federal agencies by participating on the Climate Change Cooperative and supporting the Regional Landscape Conservation Cooperatives.
- Participate on the National Tribal Science Council, and support actions related to climate change and tribes.

Section 4: Developing Measures, Monitoring and Evaluating Performance

Evaluating progress is important because there will be "learning by doing" over time as we mainstream climate adaptation planning into our programs. We will monitor the outputs and outcomes of our actions so we can learn what works – and why, and what doesn't work – and why not. This will allow us to continually improve the effectiveness of our mainstreaming efforts and share our lessons learned with other regions and our national programs. An evaluation process will be developed during the first year of implementation to learn how to best capture desired outcomes, some of which will come as staff integrates climate science into programmatic work. Appendix C provides more details on the Region 10 approach to develop and measure specific metrics.

Section 5: Legal and Enforcement Issues

The legal and enforcement issues were discussed in Sections 2 under Goal 5: Enforcing Environmental Laws and in Section 3 under the Office of Compliance and Enforcement and Office of Regional Counsel.

Section 6: Training and Outreach

The specific actions related to training and outreach is discussed in Section 3. Training and outreach is a critical part of Region 10's Implementation Plan. One of the primary tasks of the Regional Climate Change Advisor is to provide training and outreach for both Regional staff and partners. The goal of the training and outreach is to provide the foundation for programs to integrate climate science into their core program work.

Section 7: Partnerships with Tribes

As part of the EPA's direct federal implementation and oversight responsibilities, EPA Region 10 has a trust responsibility to each of the 271 federally recognized Indian tribes within the Region. EPA values its unique government-to-government relationship with Indian tribes in planning and decision making. This trust responsibility has developed over time and is further expressed in the *1984 EPA Policy for the Administration of Environmental Programs on Indian Reservations* and the *2011 Policy on Consultation and Coordination with Indian Tribes*. These policies recognize and support the sovereign decision-making authority of tribal governments.

Supporting the development of adaptive capacity among tribes is a priority for the EPA. Indigenous peoples 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 to develop adaptation strategies that promote sustainability and reduce the impact of climate change on Tribes and tribal members.

EPA engaged tribes through a formal consultation process in the development of the Agency's *Climate Change Adaptation Plan*. Tribes identified some of the most pressing issues as erosion, temperature change, drought and various changes in access to and quality of water. Tribes recommended a number of tools and strategies to address these issues, including improving access to data and information; supporting baseline research to better track the effects of climate change; developing community-level education and awareness materials; and providing financial and technical support. At the same time, tribes challenged EPA to coordinate climate change activities among federal agencies so that resources are better leveraged and administrative burdens are reduced.

EPA Region 10 plans to partner with tribal governments, in collaboration with other Federal agencies, on an ongoing basis to increase their adaptive capacity and address their adaptation-related priorities. These collaborative efforts will benefit from the expertise provide by our tribal partners and the Traditional Ecological Knowledge (TEK) they possess. TEK is a valuable body of knowledge in assessing the current and future impacts of climate change and has been used by tribes for millennia as a valuable tool to adapt to changing surroundings. Consistent with the principles in the 1984 Indian Policy, TEK is viewed as a complementary resource that can inform planning and decision-making.

Networks and partnerships already in place will be used to assist tribes with climate change issues, including Regional Tribal Operations Committees, the Institute for Tribal Environmental Professionals and IGAP. Additionally, efforts will be made to coordinate with other Regional and Program Offices in EPA and other partners such as other federal agencies, since climate change has many impacts that transcend media and regional boundaries. Transparency and information sharing will be a focus, in order to leverage activities already taking place within EPA Offices and tribal governments.

Section 8: Vulnerable Population and Places

As mentioned in Sections 1, 2 and 3, certain parts of the population, such as children, the elderly, minorities, the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal communities, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. One of the principles guiding EPA's efforts to integrate climate adaptation into its programs, policies and rules calls for its adaptation plans to prioritize helping people, places and infrastructure that are most vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society.

This Implementation 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 Plan is conducted, the communities and demographic groups most vulnerable to the impacts of climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events (*e.g.,* Hurricane Katrina and Superstorm Sandy) and the subsequent recovery efforts.

Section 9: Cross-Office Pilot Projects

Developing cross-office pilot projects is a vital role for the Region 10 Climate Change Advisor. Region 10 has a TMDL pilot project described in Appendix C on the Southfork of the Nooksack River. We anticipate building on that success using the same approach of outreach at the unit or office/program level to increase awareness of vulnerabilities and available science. At the same time, we will collect input on climate science needs and ideas on how the science might be incorporated into day-to-day decisions. To keep the process sustainable, OEA provides some initial assistance and looks for partners to provide some further assistance.

APPENDICIES

Appendix A: Vulnerabilities Identified by Region 10 States and Tribes

Appendix B: Detailed Description of EPA Region 10 Program Vulnerabilities

Appendix C: Detailed Description of EPA Region 10 Existing Actions

Appendix D: Comparison of Vulnerabilities and EPA Region 10 Existing Actions

Appendix E: EPA Region 10 Approach for Measuring Success

Appendix A: Vulnerabilities Identified by Region 10 States and Tribes

Oregon

The State of Oregon has developed a framework[58] that condenses specific vulnerabilities and risks from climate change into 11 overarching categories. They then ranked these into three groups: very likely, likely, and more likely than not. While the framework does not indicate a formal peer review was conducted, the Oregon Climate Change Research Institute (OCCRI) assisted in the development of the framework and the risks are fully documented with extensive citations. The categories and ranked risks are:

Very Likely Risks:

- Increase in average annual air temperatures and likelihood of extreme heat events that also increase water temperatures
- Changes in hydrology and water supply; reduced snowpack and water availability in some basins; changes in water quality and timing of water availability

Likely Risks:

- Increase in wildfire frequency and intensity
- Increase ocean temperatures, with potential for changes in ocean chemistry and increased ocean acidification
- Increased incidence of drought
- Increased coastal erosion and risk of inundation from increasing sea levels and increasing wave heights and storm surges
- Changes in abundance and geographical distributions of plant species and habitats for aquatic and terrestrial wildlife
- Increase in diseases, invasive species, and insect, animal, and plant pests
- Loss of wetland ecosystems and services

More likely than not Risks:

- Increased frequency of extreme precipitation events and incidence and magnitude of damaging floods
- Increased incidence of landslides

Washington

Similarly, Washington State Department of Ecology has summarized climate impacts in Preparing for a Changing Climate: Washington States' Integrated Climate Response Strategy.[59] The information below is a summary of the Ecology document and the references are included in their document and they are not repeated here. Washington examined projected impacts for sector groupings – e.g., Built Infrastructure, Wildlife & Habitat, etc. They also worked with University of Washington's Climate Impacts Group to understand how the impacts might affect the different sector groups, with the goal of prioritizing actions within those groups and developing coordinated strategies. The impacts include the scientific evidence and are summarized into the following groups:

Warmer temperatures and more severe heat waves: In the Pacific Northwest, average annual temperature rose 1.5 °F between 1920 and 2003. Climate scientists' project average annual temperatures in the Pacific Northwest will rise 2°F by the 2020s and 3.2°F by the 2040s, compared with 1970-1999 averages. Heat waves are projected to occur more often and last longer.

Larger and more intense wildfires: Researchers project that the area burned by fire each year in the Columbia Basin will double or triple by the 2080s, compared to the 1916-2006 average. Costs of fighting wildfires are expected to rise and risks to communities, the environment, and wildlife are expected to increase.

[58] http://www.oregon.gov/LCD/docs/ClimateChange/Framework_Final.pdf

[59] http://www.ecy.wa.gov/climatechange/ipa_responsestrategy.htm

Drier summers and wetter autumns and winters: Downscaled climate models project that summer precipitation will decrease and autumn and winter precipitation will increase. Washington could experience more intense rainfall events more often.

Decreased snowpack and loss of natural water storage: In Washington's Cascades, average snowpack declined about 25 percent between 1950 and 2006. Spring snowpack across Washington State is projected to decrease 28 percent by the 2020s and 40 percent by the 2040s relative to the 1916-2006 average, and snowmelt is expected to occur earlier in the spring.

More frequent and severe drought: Increasing temperature, declining snowpack and earlier snowmelt will increase the risk of summer water shortages and increase the demand for water. The amount of water available for communities, irrigation, fish, hydropower generation, recreation, and other uses will be affected and competition for water will increase.

More severe winter flooding: Although the risks vary by location, Washington is expected to experience more severe winter flooding during the winter due to more precipitation falling as rain instead of snow in the mountains. More severe winter flooding poses challenges for managing reservoirs for flood control, fish, and hydropower production. Damages and repair costs for vulnerable homes, roads, and other infrastructure could increase. Extreme rainfall may place more stress on our stormwater infrastructure.

Sea level rise: Global sea level has risen about 7 inches during the 20th century and is projected to rise at a higher rate in the future. For the Washington, Oregon, and California coasts north of Cape Mendocino, sea level is projected to rise 24 inches over the next century. In addition, an earthquake magnitude of 8 or greater along the Cascadia Subduction Zone would suddenly raise sea level along the coast of Washington and Oregon by an additional 3-7 feet, exacerbating the effects of sea level rise due to climate change.

Idaho

Climate change planning in Idaho is mainly led by the Idaho Experimental Program to Stimulate Competitive Research (EPSCoR). Two major river basins of national significance are in Idaho, the Snake River Plain (Snake) and the Salmon River Basin (Salmon). The EPSCoR work addresses concerns about how the hydrology in Idaho will change as climate changes in the western U.S. Of particular interest to EPSCoR is how the connection between surface water and groundwater in the Snake River Plain may change.[60]

According to EPSCoR, the National Ground Water Association has stressed that groundwater supplies might be used in the future to balance large swings in water supplies caused by drought and climate change. Despite this, the connections between climate change and groundwater is largely unexplored and poorly understood. The projected changes in the timing and magnitude of stream flows will affect ecosystems in sensitive areas. In addition, because Idaho's economy is strongly coupled to water and snowmelt, the proposed research has direct application to Idaho's citizens and implications for decision makers.

Concerns in Idaho center on:

Hydroclimatology and the connections between surface water and groundwater; understand how projected climate change might affect the timing and magnitude of mountain snow packs and snowmelt.

Hydro-economics/policy and changes in the timing and variability of water supply on land use, economic production, urban growth, and water management, and water rights.

Hydroecology and effects of climate change on natural ecosystems such as species shifts, and integrated relationships between climate, hydrology, fire, insects, ecology, and changing landscapes.

Alaska

The State of Alaska Adaptation Advisory Group describes vulnerabilities including impacts that are already occurring in their document, Alaska's Climate Change Strategy: Addressing Impacts in Alaska.[61] The information

[60] http://www.idahoclimatechange.org/DrawOnePage.aspx?PageID=135

[61] http://www.climatechange.alaska.gov/aag/docs/aag_ES_27Jan10.pdf

below is from the executive summary of the document. The references are included in the document and are not repeated in this document.

Permafrost Thawing and Sea Ice Melting

Permafrost underlies most of Alaska. Air temperature, snow cover, and vegetation affect the temperature of the frozen ground and the depth of seasonal thawing. Recent decades of warmer temperatures have produced extensive thawing, which has resulted in increased coastal erosion, landslides, and sinking of the ground surface, as well as consequent disruption and damage to forests, buildings, infrastructure, and coastal communities. In addition, many industrial activities depend on frozen ground surfaces, and many northern communities rely on ice roads for transport of groceries and other materials. Continued warming will further impair transport by shortening the seasonal use of ice roads. Thawing is projected to accelerate under future warming, with as much as the top 10 to 30 feet of discontinuous permafrost thawing by 2100.

Sea ice off the Alaskan Coast is retreating and thinning, with widespread effects on marine ecosystems, coastal climate, human settlements, and subsistence activities. Recent studies estimate arctic-wide reductions in annual average sea-ice extent of about 5-10% and a reduction in average thickness of about 10-15% over the past few decades. Retreat of sea ice allows larger storm surges to develop, increasing the risk of inundation and increasing erosion on coasts already made vulnerable by permafrost thawing. Loss of sea ice also causes large scale changes in marine ecosystems, and threatens populations of marine mammals and polar bears that depend on ice. At the same time, the continued reduction of sea ice is very likely to increase the navigation season, and within several decades a seasonal opening of the Northern Sea Route is likely to make trans-arctic shipping feasible during summer months, although increasing ice movement will initially make shipping more difficult in some channels of the Northwest Passage.

Threats to Coastal Communities, Habitats, and Infrastructure

Alaska has more coastline than the other 49 states combined. Increases in the frequency and intensity of storm surges have triggered increased coastal erosion that is threatening a number of coastal villages. A recent report from the Government Accountability Office (GAO) indicated that 31 villages face imminent threats. Storm surges have also reduced the protection that barrier islands and spits provide to coastal habitats. Both coastal and inland infrastructure face threats due to the climate change. Thawing permafrost threatens water and sanitation infrastructure, and roads, buildings, pipelines, power lines and other infrastructure are threatened by coastal erosion and degrading permafrost.

Forest and Vegetation Changes

The Arctic region, particularly Alaska, is already experiencing major ecological impacts as a consequence of warming. Rising temperatures have caused northward expansion of boreal forest in some areas, significant increases in fire frequency and intensity, and unprecedented insect outbreaks. Current projections suggest that, due to increases in burn area per decade, the tundra-dominated landscape on Seward Peninsula will eventually be replaced by deciduous forest. In other areas, forested areas are likely to convert to bogs as permafrost thaws. Growing-degree days have increased by 20%, with benefits for agriculture and forest productivity on some sites, and reduced growth on others.

Sensitivity of Marine Ecosystems and Fisheries

The Gulf of Alaska and Bering Sea support marine ecosystems of great diversity and productivity as well as the nation's largest commercial fishery. Perhaps one of the most daunting threats lies in increasing acidification of the cold Alaskan waters. This would affect all organisms that possess calcifying shells, and these organisms play an integral role in the food web. Recent climate-related impacts observed in the Bering Sea include significant reductions in seabird and marine mammal populations, unusual algal blooms, abnormally high water temperatures, and low harvests of salmon on their return to spawning areas. Future projections for the Bering Sea suggest productivity increases at the base of the food chain, poleward shifts of some cold-water species, and negative effects on ice-dwelling species. Warmer temperatures will also affect commercial fisheries by inducing

large northward shifts of fish and shellfish species. This would result in decreased harvesting of cold-water species such as salmon and pollock, and increased harvesting of other species.

Changes in the Diversity, Ranges, and Distributions of Species

The Arctic sub-region that includes Alaska, Chukotka, and the Western Canadian Arctic is home to over 70 percent of the rare plant species that occur only in the Arctic and a number of plant and animal species already classified as "threatened." Species concentrated in small areas, such as Wrangell Island, are particularly vulnerable to the direct effects of climate change combined with competition from migrating non-native species.

Increased Stress on Subsistence Livelihoods and Lifestyles

Subsistence makes an important contribution to livelihood in many isolated rural communities, especially but not exclusively for native peoples. Livelihoods that sustain indigenous communities include hunting, trapping, gathering, and fishing. These activities not only make significant contributions to the diet and health of many indigenous populations, but also play large and important social and cultural roles. Reduced or displaced populations of marine mammals, seabirds, and other wildlife, together with continuing thinning of sea-ice, have affected the safety and the dietary and economic well-being of subsistence communities.

Tribes

Among other effects of climate change, Tribes are concerned about declining stocks, changes in migration patterns, and other impacts on natural resources including endangered species.[62] In an effort to begin an understanding of Tribal cultural resource vulnerabilities, Region 10 reviewed the Swinomish Climate Change Initiative Impact Assessment Technical Report as a very useful resource.[63] Although peer review was not described, this report represents the work of a multidisciplinary team led by staff of the Swinomish Office of Planning & Community Development, in partnership with the University of Washington Climate Impacts Group (CIG), and with further scientific assistance from Skagit River System Cooperative (SRSC). CIG staff played a crucial role in reviewing scientific data, reports, and project documents, advising on the use of scientific data and information in the project, and in identifying probable local impacts and climate change scenarios. Scientific expertise was also provided by Skagit River System Cooperative, which partnered with Western Washington University and Battelle Northwest to model hydrologic impacts at the local level.

The cultural vulnerabilities identified in the Swinomish Impact Assessment included:

- Shrinking land base (sea level rise);
- Inundation of coastal sites/artifacts;
- Exposure of burial sites and human remains from strong storm events;
- Loss of cultural use plants; and
- Ecological Impacts on resources within the Swinomish traditional use areas.

In addition, Region 10 has funded two Indian General Assistant Program (IGAP) grants for the Jamestown and Port Gamble S'Klallam Tribes to develop a climate change vulnerability assessment template that other tribes could use. The work began in January 2012. The Jamestown Tribe Tribal Advisory committee was formed and identified four areas of concern for which they developed subcommittees: facilities/roads; economics; natural resources; and human health. The Tribe's process will be reported in a short stand-alone document that may be used by other Tribal Governments.

[62] James Woods, Region 10 Senior Tribal Policy Advisor

[63] http://www.swinomish.org/departments/planning/climate_change/climate_main.html

Another useful description of vulnerabilities related to Alaskan Tribes, in particular, is the Tribal Climate Change Adaptation Plan Template[64] which references three sources.[65,66,67] A summary of the findings from the Template are included below. The specific references are included in the Template and are not repeated here.

Alaska has already experienced many climate-related changes including earlier spring snow melt, a decrease in sea ice, thawing permafrost, glacier retreat, changes in precipitation levels, and an increase in drought and wild fires. The annual average temperature has increased by 3.4°F, while winter temperatures have increased by 6.3°F during the last half century. The snow-free season lengthened by an average of 10 days throughout the state between 1970 and 2000; this continues to impact Alaska's soil moisture and consequently vegetation that is not accustomed to drought-like conditions.

Rising temperatures are creating a more hospitable habitat for spruce beetles resulting in a severe infestation in spruce forests in the south-central portion of Alaska; there has also been an increase in catastrophic wildfires throughout the state due to the warmer and drier conditions. Additionally Alaska is beginning to witness a thaw in permafrost which is affecting not only human-made infrastructure, but also forest health and lake area in wetland ecosystems.

Continued future warming in this region is inevitable, even if all greenhouse gas emissions were halted today. Temperatures are projected to increase anywhere between 5°F and 13°F by the end of the 21st century, depending on different emission scenarios. These increasing temperatures are expected to have major consequences on the different ecosystems in Alaska. This includes the warming of sea surface temperatures, further reductions in sea ice (impacting not only marine mammals but also eliminating a natural buffer to coastal storms), increased coastal erosion and flooding, an increase in catastrophic wildfires (models suggest that the yearly average area that burns may double by the middle of the century), and the warming and thawing of permafrost (Karl *et al.*, 2009).

The changes that are already occurring in Alaska, and that will continue to occur, have the potential to alter the landscape considerably and may have immeasurable implications for Alaska's plants, animals and people.

Alaska has already experienced many climate-related changes including: earlier spring snow melt; decrease in sea ice (important to marine mammals and a natural buffer to coastal storms); thawing permafrost, which makes tribal infrastructure (water, sewer, and foundations) designed for permafrost conditions extremely vulnerable to failure; glacier retreat; changes in precipitation levels; increase in drought, vegetation stress, and wild fires; severe infestation of spruce beetles in the south-central portion of Alaska; and increased coastal erosion and flooding.

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[64] http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts

[65] USGCRP. 2009. *Global Climate Change Impacts in the United States* . Karl, T.R., J. M. Melillo, and T. C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.Karl, T. R., Melillo, J. M., & Peterson, T. (2009). Global Climate Change Impacts in the United States. New York, NY: Cambridge University Press.

[66] U.S. Department of Interior, Bureau of Indian Affairs website accessed on January 20, 2011 at: www.bia.gov/WhoWeAre/RegionalOffices/Alaska/index.htm

[67] U.S. Fish and Wildlife Service website accessed on January 20, 2011 at: http://alaska.fws.gov/climate/index.htm.

Appendix B: Detailed Description of EPA Region 10 Program Vulnerabilities

In general, where possible, the sources cited by Region 10 use the Intergovernmental Panel on Climate Change (IPCC) likelihood of outcome terminology where 'very likely' means 90-100% probability, and the term 'likely' means 66-100% probability. Some likelihoods are noted as "Occurring now" where appropriate.

In addition, the use of terms are as follows: "High" assumes the program will be affected by the impact; "Medium" assumes the program could be affected under some conditions by the impact; "Low" assumes that there is a potential for the program to be impacted or uncertainty currently exists as to the potential nature and extent of the impact.

Goal 1: Taking Action on Climate Change and Improving Air Quality

1.A. <u>Increased tropospheric ozone pollution</u> in certain areas due to increased average summertime temperatures

Likelihood of Impact: Likely. Projections of future tropospheric ozone levels in the literature for the Pacific Northwest and Alaska are inconclusive at this time but the level of impact could change as new information becomes available. See further discussion below.

Focus of Associated EPA Program: Protecting public health and the environment by attaining the National Ambient Air Quality Standards (NAAQS) by implementing programs in States and Indian Country to help meet the standards

Likelihood of EPA Program Affected: High in large urban areas in the Pacific Northwest – Washington, Oregon, and Idaho, and Low in remaining rural areas and in Alaska.

Example of Risks if Program were Impacted: Could become more difficult to attain NAAQS for ozone in metropolitan areas where ozone design values are close to the NAAQS.

Regional Importance of Vulnerabilities: Washington, Idaho, and Oregon each have at least 1 metropolitan area that has ozone design values close to the ozone NAAQS. There is the possibility that higher summertime temperatures would increase ozone productivity as well as emissions of VOC precursors and, there is scientific consensus that climate change will decrease the background ozone in the lower troposphere where the water vapor effect is dominant.[68] Ozone in NOx-limited areas is projected to decrease as well as a result of climate change. From the available academic literature that included results for the Pacific Northwest, there is no consistent finding about whether climate change will increase, decrease, or have no change on ozone in this region.[69,70] Of potential greater concern for the Pacific Northwest and Alaska over the next several decades is the increase in transported ozone precursors from Asia. Asian transport of ozone will decrease with an increase in water vapor over the Pacific, but hydroxyl radicals will increase, potentially increasing ozone formation in PNW urban areas.[71]

Variation in importance across the Region: Ozone is more likely to increase with climate change in inland Idaho rather than Washington and Oregon due to coastal airflow. It is not an issue for Alaska since ozone formation is

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[68] Jacob, DJ., and D.A. Winner. 2009. Effect of climate change on air quality, Atmos. Environ., *43,* 56.

[69] Ibid Jacob and Winter 51-63. Jacob, D.J., and D. A. Winner. 2009. Effect of climate change on air quality, *Atmos. Environ., 43*, 51-63.

[70] U.S. Global Change Research Program. 2009., Assessment of the impacts of global change on regional U.S. air quality: a synthesis of climate change impacts on ground-level ozone, *EPA/600/R-07/094F*, Office of Research and Development, Washington, D.C.

[71] Task Force on the Hemispheric Transport of Air Pollution. 2010. Hemispheric transport of air pollution 2010, Part A: ozone and particulate matter, *Air Pollution Studies No. 17*, United Nations, New York, USA and Geneva, Switzerland.

limited by relatively low summertime temperatures. Potential ozone increases are more likely to occur in the larger metropolitan areas including Spokane, Tacoma, Portland, and Boise. Whether or not these increases will result in violations of the NAAQS health standards however is unknown.

1.B. Increase in summertime temperatures and extreme temperature events can potentially affect concentrations of air toxics from anthropogenic sources.
Likelihood of Impact: Impact uncertain due to variability in effects of temperature increase on individual air toxics in Region 10.
Focus of Associated EPA Program: Reducing risk from emissions of air toxics through Maximum Achievable Control Technology (MACT), National Emission Standards for Hazardous Air Pollutants (NESHAPS) and residual risk programs
Likelihood of EPA Program Affected: There is insufficient literature available on air toxics and climate change to project this likelihood for Region 10.
Example of Risks if Program were Impacted: Could increase public health risks, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations
Regional Importance of Vulnerabilities: Many HAP chemicals volatilize at higher temperatures, creating the potential for higher emission rates and higher concentrations in ambient air.[72] There is uncertainty however as to actual impacts on HAP concentrations since the boundary layer height will also likely be higher, adding more volume of air for the HAPs to mix into. It is also possible for pollutant removal mechanisms to increase as a result of climate change. There is still considerable uncertainty about the effect of climate change on air toxics in Region 10. **Variation in importance across the Region:** Although we would expect air toxics to be most important in urban areas near large sources or a high density of sources, we cannot say that this will be the norm in Region 10. Potential variations by individual air toxic, location, and season were indicated in a continuous monitoring of atmospheric mercury study comparing high arctic, sub-Arctic, and temperate sites. While background mercury levels were shown to be decreasing at sub-Arctic and temperate sites, the levels at Alert (Nunavut, Canada – locationally and climatically comparable to arctic Alaska) indicated increases in both RGM (reactive gaseous mercury) and TPM (total particulate mercury) from 2002 – 2009 in the spring when concentrations are the highest. Background mercury had decreased at all other locations.[73]

1.C. Increased frequency or intensity of wildfires due to increased summertime temperatures, prolonged droughts, and decreased soil moisture may impact <u>Particulate Matter levels</u>.[74]
Likelihood of Impact: Likely
Focus of Associated EPA Program: Protecting public health and the environment by assuring that the National Ambient Air Quality Standards (NAAQS) are attained and assisting States and Tribes in the implementation of programs to help meet these standards.
Likelihood of EPA Program Affected: High.
Example of Risks if Program were Impacted: Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) pollution in areas affected by more frequent wildfires.

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[72] IPCC. 2012. Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (Field, C.B., V. Barros, T.F. Stocker, D.Qin, D.J. Dokken, K.L. Ebi, M.D., Mastrandrea, K.J. Mach, G.K. Plattner, SlK. Allen, M. Tignor, and P.M. Midgley (eds.). A Special Report of Working Groups I & II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA pp. 1-19.
[73] Cole, A.S., et. al. 2013. Ten year trends of atmospheric mercury in the high Arctic compared to Canadian sub-Arctic and mid-latitude sites, Atmospheric Chemistry and Physics, 13, 3, 1535-45.
[74] Mote, P. K. Snover, S. Capalbo, S.D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder, 2014: Ch. 21: Northwest. Climate Change Impacts on the United States: The Third National Climate Assessment, J.M. Melilo, Terese (T.C.) Richmond and G.W Yohe, Eds., U.S. Global Change Research Program, 487-513. doi:10.7930/J04Q7RWX. http://nca2014.globalchange.gov/report/regions/northwest#statement-1700.

Implications: increased concentrations of PM resulting in public health impacts and increasing responsibility of public agencies to protect public health.

Regional Importance of Vulnerabilities: Larger and more frequent wildfires are predicted throughout the region as a result of warmer summertime temperatures, decreased soil and fuel moisture, and increased pest infestations. For example, in the Columbia Basin, the acres of forest burned are projected to double by the 2020s, and triple by the 2040s compared to average burned from 1916 to 2006.[75] These large increases in annual acres burned will increase the number of airsheds and communities impacted by high summertime concentrations of Pm10 and PM2.5 from wildfires, impacting the health of more individuals who have preexisting respiratory conditions such as asthma, and preexisting heart conditions. State, local, and Tribal air agencies will also be impacted by these events and Region 10 will be obligated to assist them. More frequent and larger wildfires could result in agricultural and forestry slash burning permits not being issued at all, or issued later into the winter, where permitted burning would more likely overlap with home heating season and add to emissions from woodburning stoves. Although increased wildfire will have little impact on the attainment of the National Ambient Air Quality Standards (NAAQS) or the SIP State Implementation Plan (SIP) program, the Region 10 impact would be in workload to process Exceptional Event documentation and potentially in assisting States, local communities, and land managers in minimizing the impact of increased wildfire smoke on human health.

Variation in importance across the Region: All four R10 States have a high percent of forested areas (about 50% for States of WA and OR) and would all be adversely affected by an increase in wildfires

1.D. Changes in precipitation, extreme temperatures, more frequent wildfires, and severe weather events will impact <u>indoor air quality.</u>

Likelihood of Impact: Very Likely

Focus of Associated EPA Program: Protection of public health from exposure to indoor air pollutants which are concentrated in indoor environments many times above ambient air levels. Potential for increased mold growth, particularly among buildings without access to air conditioning. Indoor Air Quality, Children's Health and outreach programs will be impacted due to increased need for public education and guidance on reducing exposures to both indoor and ambient air pollutants.

Likelihood of EPA Program Affected: High.

Example of Risks if Program were Impacted: Will increase public health risks including those from respiratory illnesses including asthma[76], and risks for susceptible populations - the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations across the region. Alaska's native and rural populations are very vulnerable to worsening indoor air quality with more insulated housing reducing air circulation- thereby increasing levels of both indoor and ambient pollution - and increasing flood risk and melting permafrost that will support more mold growth[77]. Also, though not directly related to climate change, increasing use of wood combustion as an indoor heat source (due to rising cost of home heating oil) further impairs indoor air quality.

Regional Importance of Vulnerabilities: Important across the Region. Susceptible individuals will be impacted by elevated temperatures, increasing pollutant levels, and therefore increasing exposures to both indoor and ambient air pollution.

Variation in importance across the Region: Particularly important in environmental justice (EJ) areas and areas with a high density of more susceptible populations such as in Alaska's native villages[78] and on tribal reservations in Washington, Oregon and Idaho.

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[75] J.S. Littell, et. al. 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. Climatic Change 102(1-2): 129-158.

[76] Reid, Colleen and Gamble, Janet. 2009. Aeroallergens, Allergic Disease, and Climate Change: Impacts and Adaptation, Ecohealth Vol 6(3):458-470.

[77] Kovesi, Thomas MD et al. 2007. Indoor Air Quality and the Risk of lower respiratory tract infections in young Canadian Inuit children, Canadian Medical Association.

[78] Lisa Bulkow et al., 2010. Risk Factors for Severe Respiratory Synctial Virus Infection Among Alaska Native Children, Pediatrics. 109 (2).

1.E. Depletion of the stratospheric ozone layer due to climate change effects on the atmosphere
Likelihood of Impact: Likely – changes continue over the Arctic.
Focus of Associated EPA Program: Restoring the stratospheric ozone layer, preventing UV-related disease, and providing a smooth transition to safer alternatives to CFCs and HCFCs
Likelihood of EPA Program Affected: Low – there is no stratospheric ozone monitoring or restoration program in R10.
Example of Risks if Program were Impacted: May be unable to restore ozone concentrations to benchmark levels as quickly at some latitudes.
Regional Importance of Vulnerabilities: Not uniformly important across the region. Important in the Arctic (Alaska) where severe depletion of stratospheric ozone has been observed during winter and spring months.[79] While there currently are no EPA Region 10 programs that directly deal with monitoring or restoring the stratospheric ozone layer, there is enforcement activity against violators related to use and disposal of CFCs and HCFCs and their substitutes.
Variation in importance across the Region: Most important in Alaska, particularly in Arctic regions.

1.F. Changes in the rate and distribution of deposition of sulfates, nitrates, and mercury as a result of changes in precipitation patterns.[80]
Likelihood of Impact: Impact potentially ranges from Unlikely to Likely. Much uncertainty exists re: the overall impacts of changes in precipitation on sulfates, nitrates and mercury deposition in Region 10. We assume that there would be increased deposition of available sulfates, nitrates, and mercury with increased precipitation, but the availability of these pollutants in the atmosphere may be decreasing due to control measures.
Focus of Associated EPA Program: Agency programs to protect ecosystems from atmospheric deposition of pollutants such as sulfates, nitrates, and mercury. Deposition of pollutants may also impact compliance with water quality standards and Total Maximum Daily Loads (TMDLs).
Likelihood of EPA Program Affected: There is insufficient research on sulfate, nitrate, and mercury deposition and climate change to project this likelihood for Region 10, particularly in light of increasing wildfires and transport from Asia.
Example of Risks if Program were Impacted: Could cause adverse effects on ecosystems throughout the region, particularly mountain ecosystems and freshwater ecosystems, and could contribute to accumulation of mercury in fish tissue. This would disproportionally effect populations of people whose diet consists of a high percent of fish. Water quality impacted during summer due to lower stream flows. TMDLs may be more difficult to attain. An accurate assessment of impacts is difficult to determine at this time.
Regional Importance of Vulnerabilities: Accumulation of sulfates and nitrates may kill sensitive plant species and alter richness of species in sensitive ecosystems through the region. Mercury deposition in freshwater habitats could contribute to bioaccumulation of mercury in fish tissue, posing risks to humans who consume these freshwater fish. Lower stream flows during the summer months could make attainment of TMDLs associated with release of pollutants from point sources more difficult to attain, negatively impacting ecosystem health. Atmospheric deposition of sulfates, nitrates and mercury from Region 10 sources are expected to decrease over time due to compliance with the new air toxics rules (i.e. the Mercury Air Toxics Standard – MATS), the attainment of additional reductions through the residual risk and technology review program, and mobile source controls. Additional compliance activities resulting in decreases over time include sources meeting permit requirements or closing down. There is some uncertainty in this expected downward trend however due to potential increased mercury releases due to wildfires and transport from Asia. Global emissions of mercury continue to change at the same time as the Arctic is experiencing ongoing climatic changes. Multi-year trends analysis in reactive gaseous

[79] G.L. Manney et. al., 2011. Unprecedented Arctic Ozone Loss in 2011, Nature 478, 469-475. October 27, 2011.
[80] Dawson, J.P., B.J. Bloomer, D.A. Winner, C.P. Weaver, 2013. Understanding the meteorological drivers of U.S. particulate matter concentrations in a changing climate, Bulletin of the American Meteorological Society, doi:10.1175/BAMS-D-12-00181.1, in press.

mercury (RGM) and total particulate mercury (TPM) at a Canadian Arctic site indicated increases from 2002 to 2009 in both RGM and TPM in the spring when concentrations are highest.[81]

Variation in importance across the Region: Sulfate and nitrate deposition is important across the region. Mercury deposition is highest close to mercury sources, such as mining operations. The issue is more important for parts of the Region containing mountain ecosystems and freshwater ecosystems and for parts of the Region where people's diets consist of a high percent of fish. While studies have shown that on the East Coast, sulfate concentrations increase with temperature due to faster SO2 oxidation (higher rate constants and higher oxidant concentrations)[82,83] no studies are available to indicate that the same is true for the Pacific Northwest and Alaska. In contrast, nitrate and organic semi-volatile components shift from the particle phase to the gas phase with increasing temperature.[84] Overall effects are uncertain however because higher temperatures drive increased chemical reactions and possibly more secondary organic carbon. At the same time there might be changes to the boundary layer height, airmass ventilation rate, and precipitation. We do not know the relative importance of these effects in R10 states.

[81] Cole, A.S., et. al. 2013. Ten-year trends of atmospheric mercury in the high Arctic compared to Canadian sub-Arctic and mid-latitude sites, Atmospheric Chemistry and Physics, Vol 13, Issue 3, pp. 1535-45.

[82] Aw, J., and Kleeman, M.J. 2003. Evaluating the first-order effect of intra-annual temperature variability on urban air pollution. J. Geophys. Res. 108, 4365.

[83] Dawson, J.P., et. al. 2007. Sensitivity of PM2.5 to climate in the Eastern US: a modeling case study. Atmos. Chem. Phys. 74,295–4,309

[84] Tsigaridis, K., and Kanakidou, M. 2007. Secondary organic aerosol importance in the future atmosphere. Atmos. Environ. 41, 4682–4692.

Goal 2: Protecting America's Waters

2.A. Regional focus: Increasing heavy precipitation events and more frequent flood events may impact water systems and infrastructure.
Likelihood of Impact: Very Likely
Focus of Associated EPA Program: Protecting Water infrastructure: drinking water, wastewater, stormwater, and agricultural irrigation systems and infrastructure.
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: Water infrastructure could be overwhelmed or damaged. Impacts on water infrastructure may result in an increased number of sewer overflows and wastewater bypasses, as well as increased pollutant loads in runoff, increased pollution of streams and threats to public health.[85] Drinking water and wastewater utilities will need an integrated approach to planning for emergencies and extreme weather events.[86] Problems of safety as well as access to clean and safe water will be exacerbated for Tribal communities, and other vulnerable and economically depressed communities who have limited access to clean water supplies.[87] Agricultural productivity may be impacted in areas with inadequate water storage capacity and limited agricultural irrigation systems.
Regional Importance of Vulnerabilities: The Region will work with the Tribes and States to assist in water planning by sharing information on available downscaled models and tools and provide technical assistance, outreach, and education to further assist in the implement of state and tribal voluntary programs. Climate change impacts drinking water by heightening risk of contamination of surface water sources due to higher temperatures, lower flows, and increased erosion/sedimentation. For example, in Alaska, melting permafrost is causing sources of drinking water for rural communities to disappear altogether, plus increased erosion is causing more sediment.[88] Also road and bridge failures from more storms, erosion, etc. will result in more accidents and spills that threaten drinking water supplies. Groundwater sources could be impacted by changes in hydrology, also impacting changes in transport of potential contaminants.
Variation in importance across the Region: Important across the region, but especially in areas with ageing or inadequate water infrastructure. Adequate summertime water supply for irrigation of crops is essential to agricultural communities east of the Cascades in OR, WA, and ID. For tribes, who lack irrigation infrastructure and rely primarily on lakes and streams as water sources, availability of water for agriculture may be more severely impacted by climate change.

2.B. Regional focus: Earlier stream runoff and scouring of streambeds due to earlier snow melt, and decrease summer stream flows and increased steam temperatures will adversely impact fresh water fisheries
Likelihood of Impact: Occurring Now and very likely to increase
Focus of Associated EPA Program: Protection of Fresh water Fisheries: Loss and extinction of salmon species and other cold water fisheries due to seasonal changes in stream flows and increasing surface water temperatures. Important to the TMDL program, and salmon recovery programs
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: Loss of salmon habitat and increased stress on salmon reproduction throughout their entire lifecycle. This also applies to other fresh cold water fish. Watershed planning efforts will

[85] USGCRP. 2009. Regional Impacts: Northwest. EPA/600/R-07/094F, Office of Research and Development, Washington, D.C.
[86] Ibid. UGCRP. 2009.
[87] http://www.climatechange.alaska.gov/aag/docs/aag_ES_27Jan10.pdf.
[88] Lettenmaier, D. et. al. 2008. Water resources. In: The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States, Synthesis and Assessment Product 4.3. U.S. Department of Agriculture, Washington, DC, pp. 121-150.

need to be modified to include projected impacts of altered stream flows and increased temperatures due to climate change.[89,90]

Regional Importance of Vulnerabilities: Salmon and other cold water fish are a large part of the marine fishery business in the Pacific Northwest (PNW), and loss of these fish would have a substantial impact on the economy of the (PNW). Coastal Native Americans depend on salmon as an essential part of their diets. There will be secondary impacts on other species in the ecosystem that benefit from salmon – e.g., forests that rely on decaying salmon for nutrients, and bears, eagles, others that feed on salmon.

Variation in importance across the Region: Important across the region.

2.C. Regional focus: Sea-level rise, sea surface temperature and increasing heavy precipitation events during the winter months, and decreasing precipitation days and increasing drought intensity during the summer months, may have adverse impacts on estuarine watersheds, aquatic ecosystems, and wetlands.

Likelihood of Impact: Very Likely

Focus of Associated EPA Program: Restoring and protecting watersheds, aquatic ecosystems, and wetlands

Likelihood of EPA Program Affected: High

Example of Risks if Program were Impacted: Changes in precipitation patterns, and increased drought intensity will cause stress on wetlands, and forest and mountain ecosystems, and pose challenges to migration of species in these ecosystems to more suitable habitats. Sedimentation rates and organic matter (vegetative) accumulation rates also need to be taken into account for inland marine influenced ecosystems such as estuaries. Nyman et al[91] found that the vegetative component is the most significant of the two factors for the coasts of Oregon and Washington—i.e., accretion varied with organic accumulation rather than mineral sedimentation. Warmer sea surface temperature contributes to sea level rise, increased storm intensity, and greater stratification of the water column.

Regional Importance of Vulnerabilities: EPA may need to examine the use of more sophisticated models, and training to use the models, so that impacts to ecosystems due to Climate Change are addressed. Impact to states/tribes. Climate change impacts would make it more difficult for EPA to protect these ecosystems.

Variation in importance across the Region: Especially important in coastal areas of WA, OR, and Alaska due to increased extreme storm events and rising ocean levels and their impacts on coastal ecosystems. For the Washington, Oregon, and California coasts north of Cape Mendocino, sea level is projected to change between -4 cm (sea-level fall) and +23 cm by 2030, -3 cm and +48 cm by 2050, and 10–143 cm by 2100.[92] The effects will also be important to all non-coastal watersheds, aquatic ecosystems, and wetlands across the region.

2.D. Regional focus: Warming temperatures and more frequent and intense drought conditions will have adverse impacts on Forest Ecosystems

Likelihood of Impact: Very Likely

Focus of Associated EPA Program: Protecting Forest Ecosystems

Likelihood of EPA Program Affected: High

Example of Risks if Program were Impacted: Forest tree species are expected to shift their ranges northward and upslope in response to climate change and existing ecosystems will break up as different species shift at different

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[89] Wenger, S.J. et al. 2011. Role of climate and invasive species in structuring trout distributions in the Interior Columbia Basin 2011, USA: Canadian Journal of Fisheries and Aquatic Sciences, v. 68, p. 988-1008. Catalog No: 2508.

[90] Wenger, S.J., et. al.. 2011. Flow regime, temperature and biotic interactions drive differential declines of trout species under climate change. Proceedings of the National Academy of Sciences, online. Catalog No: 2652.

[91] Nyman, J.A et. al. 2006. Marsh vertical accretion via vegetative growth. Estuarine Coastal and Shelf Science 69:370-380. DOI: 10.1016/j.ecss.2006.05.041.

[92] National Research Council. 2012. Sea-level rise for the coasts of Washington, Oregon and California: Past, Present, and Future. Division on Earth and Life Studies Board on Earth Sciences and Resources and Ocean Studies Board. Committee on Sea Level Rise in California, Oregon, and Washington. .

rates, resulting in the formation of new ecosystems, with unknown consequences.[93] Interactions among impacts of climate change and other stressors can increase the risk of species extinction.[94] Breakup of existing ecosystems and loss of biodiversity, in combination to increased drought conditions, can make forests more susceptible to destruction by wildfires and insect infestation.

Regional Importance of Vulnerabilities: In the western United States, both the frequency of large wildfires and the length of the fire season have increased substantially in recent decades, due primarily to earlier spring snowmelt and higher spring and summer temperatures.[95] Simulations of the impact of Climate Change on forest production in North America indicate that North American producers of lumber may suffer losses averaging $1 billion to $2 billion/yr over the 21st century[96].

Variation in importance across the Region: Adverse effects are likely in forests across the region, but more immediately in low elevation forests, and forests in drier parts of the region, such as in ID, eastern WA and OR, and the interior of AK

2.E. Regional focus: Loss of sea ice in Alaska due to warming air and water temperatures associated with Climate Change

Likelihood of Impact: Occurring Now and very likely to increase

Focus of Associated EPA Program: Protecting Marine Ecosystems and shorelines

Likelihood of EPA Program Affected: High

Example of Risks if Program were Impacted: Loss of arctic ice in the Bering Sea is adversely affecting Arctic sea ice ecosystems. Algae that bloom on the underside of the sea ice form the base of a food web linking microscopic animals and fish to seals, whales, polar bears, and people. The earlier ice melt resulting from warming, however, leads to later phytoplankton blooms that are largely consumed by microscopic animals near the sea surface, vastly decreasing the amount of food reaching the living organisms on the ocean floor.[97] This will radically change the species composition of the fish and other creatures, with significant repercussions for both subsistence and commercial fishing.[98] Sea ice is forming later in the fall in Alaska, making the coastal communities more vulnerable to extreme storms (e.g., the storm in 2011 that was a record low atmospheric pressure and caused winds up to 90 mph).[99]

Regional Importance of Vulnerabilities: Adverse impacts to the Bering Sea marine ecosystem would have profound effects on mammals and birds that migrate to feed in this area during the summer months. The Bering Sea fishery is a very important source of seafood and an important factor to Alaska's economy. Species composition in the Bering Sea ecosystem could be radically changed.

Variation in importance across the Region: This impact is specific to Alaskan ecosystems and shorelines, but could also have adverse effects on associated terrestrial ecosystems in Alaska.

2.F. Regional focus: Acidification of ocean water due to increasing concentrations of CO2 in the atmosphere

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[93] ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, UK, and New York, 139 pp.

[94] Millennium Ecosystem Assessment, 2005: Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC, 86 pp.

[95] Westerling A.L., et. al. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. Science, 313(5789), 940-943.

[96] IPCC, 2007, chapter 14

[97] USGCRB. 2009. Regional Impacts: Alaska. EPA/600/R-07/094F, Office of Research and Development, Washington, D.C.

[98] Janetos, A., et. al. 2008. Biodiversity. In: The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States. Synthesis and Assessment Product 4.3. U.S. Department of Agriculture, Washington, DC, pp. 151-181)

[99] http://www.stormsurge.noaa.gov/event_history.html

Likelihood of Impact: Occurring Now and very likely to increase
Focus of Associated EPA Program: Protecting Marine Ecosystems
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: Substantial decline of marine organisms that form their shells and skeletons from calcium carbonate in ocean waters.[100] Adverse effects of ocean acidification on marine organisms have already been documented.[101]
Regional Importance of Vulnerabilities: Specifically, adverse effects of ocean acidification have been documented in pteropods (sea snails)[102], a primary food source for salmon in the Pacific Ocean, and in oyster larvae in estuaries in Washington State and on the coast of OR.[103]
Variation in importance across the Region: Important in coastal areas of WA, OR and AK.

2.G. Regional focus: Pest outbreaks, invasive species, increased fire, shifts in species ranges and increased erosion, depletion of water and changes in riparian vegetation in Columbia basin Shrubsteppe/grassland eastern WA, OR, and ID.
Likelihood of Impact: Likely
Focus of Associated EPA Program: Protecting watershed ecosystems.
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: Under projected future temperature conditions, the cover of sagebrush within the distribution of sage-grouse is anticipated to be reduced due to non-native grass invasions making the areas prone to destructive fires. Observed and projected decreases in the frequency of freezing temperatures, lengthening of the frost-free season, and increased minimum temperatures can alter plant species ranges and shift the geographic and elevational boundaries of many arid lands. The extent of these changes will also depend on changes in precipitation and fire. Increased drought frequency could also cause major changes in vegetation cover. Losses of vegetative cover coupled with increases in precipitation intensity and climate-induced reductions in soil aggregate stability will dramatically increase potential erosion rates. Transport of eroded sediment to streams coupled with changes in the timing and magnitude of minimum and maximum flows can affect water quality, riparian vegetation, and aquatic fauna. In particular, the climate-driven dynamic of the fire cycle is likely to remain the single most important feature controlling future plant distribution in U.S. arid lands. Riparian vegetation in arid lands can occur at scales from isolated springs to ephemeral and intermittent watercourses and perennial rivers.[104] This habitat is tightly associated with stream dynamics and hydrology.[105] The net result of climate warming is greater depletion of water along the riverine corridor.[106]

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[100] Orr, J. C. et. al., 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature, 437(7059), 681-686.
[101] Feely, R.A., et. al. 2008. Evidence for upwelling of corrosive "acidified" water onto the continental shelf. Science, 320(5882), 1490-1492.
[102] Bednaršek, N. et. al. 2012. Extensive dissolution of live pteropods in the Southern Ocean, Nature Geoscience, Volume:5, Pages:881–885.
[103] Barton, A. et al. 2012. The Pacific oyster, Crassostrea gigas, shows negative correlation to naturally elevated carbon dioxide levels: Implications for near-term ocean acidification effects. Limnology and Oceanography, 2012; 57 (3).
[104] Ryan, M. et al. 2008. Land Resources. In: The effects of climate change on agriculture, land resources, water resources, and biodiversity. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC., USA, 362 pp.
[105] Chappell et al. 2001. Wildlife Habitats: Description, Status, Trends, and System Dynamics. Chapter 2 in: Wildlife-Habitat Relationships in Oregon and Washington.
[106] Ryan, M. et al. 2008. Land Resources. In: The effects of climate change on agriculture, land resources, water resources, and biodiversity. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC., USA, 362 pp.

Regional Importance of Vulnerabilities: Note that the direct climate change effects of CO2 fertilization and increasing average temperatures may have contrasting influences on dominant functional types. Trees and C3 grasses may benefit from rising CO_2 but not from warming, whereas C4 grasses may benefit from warming but not from CO_2 fertilization. This may mean that uncertain, non-linear, and rapid changes in ecosystem structure and carbon stocks could occur.[107] The changes in the cycling of Nitrogen and to some extent Carbon due to climate change could alter the microbial and plant community structure and function of this ecosystem and cause it to move in the direction of desertification.[108] Large-scale conversion of grasslands to shrublands, coupled with anticipated changes in climate in the coming decades, and increases in wind speed, temperature, drought frequency, and precipitation intensity, contribute to greater wind erosion and dust emission from arid lands. In arid regions, erosion has been shown to increase sediment delivery to large rivers (e.g., the Rio Grande), and can change the flow conditions of those rivers. Transport of eroded sediment to streams can change conditions in waterways, impacting water quality, riparian vegetation, and water fauna.[109]

Variation in importance across the Region: specific to the shrubsteppe and grassland ecosystems which include (1) intermountain regions in western North America (well-vegetated semi desert scrub in lower elevations in basins, valleys, and lower plateaus foothills and lower mountain slopes and (2) the Palouse grassland bioregion covers approximately 6,200 mi^2 in west central Idaho, southeastern Washington, and northeastern Oregon between the western edge of the Rocky Mountains and the Columbia River basin. It encompasses the hills of the Palouse Prairie, the southerly Camas Prairie, and the forested hills and canyonlands of the area's rivers.[110]

[107] Parry et al. 2007, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC Fourth Assessment Report, section 4.4.3.

[108] Smith et al. 2002. Soil properties and microbial activity across a 500m elevation gradient in a semi-arid environment. Soil, Biology, and Biochemistry. 34(1749-1757).

[109] Ryan, M. et al. 2008. Land Resources. In: The effects of climate change on agriculture, land resources, water resources, and biodiversity. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC., USA, 362 pp.

[110] McWethy et al. 2010. Climate and Terrestrial Ecosystem Change in the U.S. Rocky Mountains and Upper Columbia Basin: Historical and Future Perspectives for Natural Resource Management. (NPS report).

Goal 3: Cleaning Up Communities and Advancing Sustainable Development

3.A. Regional focus: Flooding, sea-level rise, storm surges, extreme events and landslides could mean site characterizations, risk assessments and selection of remedies are not protective or that existing remedies may be vulnerable
Likelihood of Impact: Likely
Focus of Associated EPA Program: Removal program, corrective action or permitted sites, cleanup of hazardous waste sites (Superfund), and management of waste containment facilities (RCRA).
Likelihood of EPA Program Affected: Medium
Example of Risks if Program were Impacted: Increased risk of contaminate release from hazardous waste Sites. RPMs and corrective action RPMs may need to alter selected remedies to ensure containment of hazardous substances. In situ remedies (e.g., stabilization, reactive barriers) and on-site above ground treatment systems (e.g., pump & treat, air sparging) could be compromised or overwhelmed if they are not designed to withstand the climate-related events. The net result could be release of contaminants.
Regional Importance of Vulnerabilities: Groundwater and subsurface contamination could be impacted by drought and flood conditions. There may be an increased risk of migration of contaminants from flooded containment facilities. Remedies such as caps in contaminated industrial waterways in WA and OR could be subject to (and not designed to withstand) unanticipated scour events. Any infrastructure whether for treatment or, say, green stormwater management such as pump and treat systems protecting drinking water wells have a potential to be at risk. Areas where permafrost has been assumed to work as a containment barrier would also be at risk.
Variation in importance across the Region: A high potential for impact could occur in the industrial waterways of WA and OR where industrial wastes have been capped in place, however could be a potential concern anywhere contaminants have been left in place. Possible issues of nuclear waste disposal related to climate change (e.g., locations of storage facilities, appropriate containment, and risk management issues) would also be important at the DOE Hanford facility in WA, and the DOE Idaho National Lab facility in ID.

3.B. Regional focus: Thawing permafrost and changes in sea ice leads to damage of roads, runways, water and sewer systems, and other infrastructure in Alaska affecting Tribal and Emergency Response
Likelihood of Impact: Occurring Now
Focus of Associated EPA Program: Emergency Response and Tribal Programs, Village Safe Water Program
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: Melting sea ice and late formation in the fall is causing storms to move in close to shore as the natural buffering system disappears. That is causing rapid coastal erosion, with houses and infrastructure falling into the ocean in several communities. That, along with higher storm, tidal surges flood communities, is requiring more immediate evacuation needs. Open dumps are also impacted by storm surges, flooding, which increases contamination risk. Permafrost temperatures have increased throughout Alaska since the late 1970s.[111] Land subsidence (sinking) associated with the thawing of permafrost presents substantial challenges to engineers attempting to preserve infrastructure in Alaska.[112]
Regional Importance of Vulnerabilities: Substantial infrastructure damage in areas of Alaska built on permafrost. Release of methane contained in permafrost into the atmosphere would accelerate global warming since methane is a GHG.
Variation in importance across the Region: Important only in Alaska.

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[111] Lettenmaier, D., et. al. 2008. Water resources. In: The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States, Synthesis and Assessment Product 4.3. U.S. Department of Agriculture, Washington,DC, pp. 121-150.
[112] Instanes, A., et. al. 2005. Infrastructure: buildings, support systems, and industrial facilities. In: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, UK, and New York, pp. 907-944

3C. Regional focus: Region 10, Tribal and state partners will have increasing workloads in many aspects of site and waste management as well as work related to the formation and implementation of sustainable development and materials management programs, partnerships and initiatives.
Likelihood of Impact: Likely
Focus of Associated EPA Program: Sustainability and Materials Management
Likelihood of EPA Program Affected: Medium
Example of Risks if Program were Impacted: Accelerating development (sustainable or otherwise) and the expected migration of people to Region 10 are issues of concern. It is projected that the population of the States in Region 10 will increase from 11.2 million in 2010 to 13.1 million in 2025.[113] Communities are struggling with how to manage the new people while protecting the environment and providing basic services like energy, water and waste management.
Variation in importance across the Region: In support of the increased sustainability of our communities, our investments in partnerships related to more sustainable materials management play an increasing role in preventing waste, conserving energy and reducing emissions of toxics as well as greenhouse gases. Waste management can be especially challenging in remote tribal communities in Alaska.[114]

3D. Regional focus: Climate change impacts on the availability of raw materials and the cost of mining and refining raw materials, producing products, transporting products, and disposing products.
Likelihood of Impact: Likely
Focus of Associated EPA Program: Sustainability and Materials Management
Likelihood of EPA Program Affected: Medium
Example of Risks if Program were Impacted: EPA Region 10 will need to put more effort into advocating for sustainable materials management and pollution prevention with States, industry, communities and tribes as climate change affects the availability and cost of raw materials and products. Climate Change increasing temperature-related pest infestations and forest fires result in millions of acres of dead, dying, and burned trees in the Pacific NW and Alaska which decreases the availability and drives up the costs of wood products. Thawing permafrost in Alaska results in infrastructure damage in the form of compromised or impassible haul roads for timber and ore, reducing the availability of these natural resources and driving up transportation costs. Transportation of raw materials and products also becomes more costly and risky as thawing permafrost damages remote Alaskan airfields, and coastal erosion from storm surges and increased springtime flooding of river valleys damages coastal and inland river valley rail transport lines. Finally, damage to landfill infrastructure from thawing permafrost in Alaska makes disposal more costly due to the need for clean-up and fortification.
Variation in importance across the Region: This issue will impact the entire region but may have a greater impact on remote cities and villages in Alaska where transportation and disposal of products is more difficult and costly.

[113] U.S. Census Bureau. 2013. Current Population Report: Population Projections: States 1995-2025. Economics Statistical Administration. Department of Commerce. Website:http://www.census.gov/prod/2/pop/p25/p25-1131.pdf. Accessed May 23, 2013.
[114] U.S. EPA. 2011. National Priorities with a Local Focus – Region 10's Approach for Implementing Administrator Jackson's Seven Priorities – FY 2011-2015 November 2011. www.epa.gov.

Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution
There are concerns for which we do not have sufficient scientific or programmatic information at this time to evaluate in our vulnerability analysis, some examples are:
(1) increased use of pesticides in response to increase in pests and vector borne diseases (see 2.G. which mentions invasive species, West Nile virus) and requests for emergency waivers.
(2) movement of volatile contaminants (pesticides, PCBs, mercury, etc.) into Alaska via global distillation.

4.A. Regional focus: Increasing extreme temperatures, increasing heavy precipitation events, changes in storm intensities, and increasing frequency of floods may increase the exposure to and risk associated with hazardous chemicals regulated by certain EPA programs
Likelihood of Impact: Likely
Focus of Associated EPA Program: Protecting human health and ecosystems from chemical releases regulated by the Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (TSCA), and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) programs
Likelihood of EPA Program Affected: Medium
Example of Risks if Program were Impacted: Adjustments to the relevant risk assessment framework to determine public risk due to modified exposure scenarios and modified toxicity of chemicals due to climate change.
Regional Importance of Vulnerabilities: Altered weather and severe climate events could also affect the interpretations of risk at RCRA/TSCA and Superfund sites. Very relevant for permitting and planning activities, where facilities may not have previously required an awareness of risk management for water/flooding, or other climate change impacts. In particular, Puget Sound is vulnerable to these potential impacts of chemical pollution; restoration of Puget Sound is a key ecosystem-level activity in R10.[115]
Variation in importance across the Region: More relevant near sites with large densities of chemical Manufacturers, Processors and Formulators (MPFs), and RCRA and Superfund sites

[115] (see the 2012/2013 Action Agenda for Puget Sound) http://www.psp.wa.gov/downloads/AA2011/083012_final/Action%20Agenda%20Book%202_Aug%2029%202012.pdf

Goal 5: Enforcing Environmental Laws
EPA Region 10's Office of Compliance and Enforcement (OCE) is charged with ensuring compliance with environmental requirements and enforcing against violations to those requirements. In that capacity, OCE's vulnerabilities are uniquely tied to interactions with the regulated community. Some types of vulnerabilities (e.g., difficulties with maintaining staff functionality due to power outages, physical damage to facilities due to extreme weather) would be similar to those experienced by all EPA programs and regions. Other vulnerabilities are more specific to OCE such as those which impact the ability of sources to comply with environmental requirements and with our ability to determine such compliance and take appropriate action.

The vulnerabilities of greatest importance for OCE are conditions/events which would compromise our ability to ensure compliance with environmental requirements by regulated entities and, where necessary, to take effective enforcement action in case of violations. The programs impacted would include: compliance assistance; compliance monitoring and civil enforcement.

5.A. Regional focus: Increased non-compliance at regulated entities as a result of extreme weather events and changing weather patterns
Likelihood of Impact: Likely
Focus of Associated EPA Program: All regulatory programs
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: Compliance and enforcement programs under the Clean Water Act (CWA) have the potential to see an increase in violations from many situations including sanitary sewer and combined sewer overflows, violations of percent removal at wastewater treatment plants (due to limited water flow as a result of drought), violations in bypasses due to the inability of wastewater treatment plants to treat a flow in excess of the design capacity, and increased violations in numerous programs due to failure of existing infrastructure protecting against extreme weather events. In addition, CWA section 311 (Spill Prevention Control Countermeasures) may see an increase in non-compliance along Alaskan coastal areas that have oil storage containers, as a result of sea ice melting (thereby increasing storm surges along those coastal areas) and increased flooding.

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) compliance and enforcement programs may see violations at Pesticides Producing Establishments if there is a shift toward increasing pesticide usage, productions and imports. As weather patterns change in the Region, the habitats of insects and pests may also change, bringing different pests and diseases to areas.

The Resource Conservation and Recovery Act (RCRA) programs may see increased non-compliance at landfills due to changes in precipitation patterns (including more precipitation in some cases and more extreme precipitation events in other cases). Where more precipitation is seen in traditionally arid climates and little rainfall is assumed during landfill design, landfills may generate excessive hazardous leachate, see unexpected mobilization of contaminants in the waste column and/or experience failure of the liner or leachate collection systems.
Regional Importance of Vulnerabilities: May be most important in states where EPA has direct implementation of an enforcement program, on Tribal lands, and non-delegable programs.
Variation in importance across the Region: Relevant across the Region.

5.B. Regional focus: Shift in regional enforcement priorities due to changes in compliance (both increased compliance and non-compliance in different sectors) and increased number of inquiries from industry about maintaining compliance
Likelihood of Impact: Likely
Focus of Associated EPA Program: All regulatory programs.
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: If an increase in violations in various programs and industry are identified, OCE may shift the enforcement focus to address those violations. Conversely, OCE may use discretion

to refocus enforcement priorities when localized extreme weather events (e.g., flooding) greatly impact the regulated community or when a change in weather patterns decrease the potential for non-compliance (e.g., less precipitation could decrease surface runoff). This will be most important in states where EPA has direct implementation of an enforcement program (e.g., Idaho for NPDES program), on Tribal lands, and non-delegable programs (e.g., Chlorofluorocarbons, CWA 311 (SPCC), PCBs). OCE may need to make adjustments to normal workload to address an increase in industry's compliance inquiries. There may need to be reassignment or delay of normal work duties as staff provides response support to those inquiries in a timely manner. Requests may also be received from Regional state counterparts regarding guidance to unique enforcement issues as a result of extreme weather events or changing weather patterns.
Regional Importance of Vulnerabilities: May be most important in states where EPA has direct implementation of an enforcement program, on Tribal lands and non-delegable programs.
Variation in importance across the Region: Relevant across the Region

5.C. Regional focus: Increased permitting of Class VI Underground Injection Control (UIC) wells for Carbon Dioxide sequestration and Class V UIC wells for stormwater management.
Likelihood of Impact: Likely
Focus of Associated EPA Program: UIC permitting and enforcement programs
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: EPA has developed criteria for Class VI wells, used specifically for the injection of carbon dioxide into underground subsurface rock formations for long-term storage. As the need to reduce carbon dioxide emissions into the atmosphere increases, various technologies including Class VI wells will be deployed. OCE may need to reassign or delay other UIC permitting and enforcement work, as permit requests for Class VI wells increase. This will be seen across the Region, until permitting and enforcement of the Class VI well program is delegated to the states. As the amount of stormwater increases with increased precipitation levels, industries regulated to manage stormwater and associated discharges may be faced with challenges surrounding the volume of stormwater to manage. Class V wells are designed to receive stormwater, as a substitution for or in addition to discharging stormwater. OCE may see an increase in permitting Class V wells, as challenges managing high volumes of stormwater increase. Permitting will be focused on Class V wells in Alaska and Tribal lands, as the Region implements this program in these areas.
Regional Importance of Vulnerabilities: Across the Region, until permitting and enforcement of the Class VI well program is delegated to the states.
Variation in importance across the Region: Relevant across the Region.

5.D. Regional focus: Increase in regulated industrial activities in Alaska may result as the melting of sea ice opens new areas for activities.
Likelihood of Impact: Likely
Focus of Associated EPA Program: Oil and gas extraction.
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: Sea ice off the Alaskan Coast is retreating and thinning. This reduction of sea ice is very likely to increase the navigation season and create a seasonal opening of the Northern Sea Route to likely make trans-arctic shipping and transport feasible during summer months. As areas and routes become more accessible, there is a potential for industrial activity (e.g., oil and gas extraction) to become more active in these areas. As a result, OCE may see an increase in regulated entities.
Regional Importance of Vulnerabilities: Relevant in Alaska.
Variation in importance across the Region: Relevant in Alaska.

EPA Facilities and Operations

6.A. Regional focus: Increasing drought frequency and intensity may limit drinking water at EPA facilities. Increased demand for air conditioning.
Likelihood of Impact: Likely
Focus of Associated EPA Program: Personnel Safety and security. Operations of Agency facilities, and ability to carry out emergency response actions
Likelihood of EPA Program Affected: Low
Example of Risks if Program were Impacted: Facilities could be located in areas with water shortages, requiring water rationing. There is likely to be a greater demand for electricity for air conditioning during the summer months. Increased extreme temperature at any R10 office would put higher demand on drinking water and electricity for cooling.
Regional Importance of Vulnerabilities: Could affect the regional office and all the operations offices
Variation in importance across the Region: Operation offices may not be as vulnerable as the regional office due to a smaller staff and less demand for cooling water, drinking water, and water for other personal uses.

6.B. Regional focus: Increasing risk of floods and increasing intensity of storms may adversely affect operations of agency facilities
Likelihood of Impact: Unlikely
Focus of Associated EPA Program: Operations of Agency facilities, personnel safety, physical security, and ability to carry out emergency response actions. In particular, Region 10 operates the Manchester Environmental Laboratory in Port Orchard. The lab is adjacent to Puget Sound.
Likelihood of EPA Program Affected: Low
Example of Risks if Program were Impacted: Facilities in flood-prone areas may have to temporarily close. Personnel engaged in field work may be more vulnerable to extreme temperatures or storm events. Personnel and real property supporting emergency response and management may be at risk during flooding or extreme weather events. Ongoing work at the Manchester Environmental Laboratory may be disrupted with effects on many different programs.
Regional Importance of Vulnerabilities: Closure of regional offices due to climate change related damage could prevent staff from carrying out important functions. The Regional Office in Seattle is located in an area with low probability for flooding or sea level rise.
Variation in importance across the Region: R10 has flexiplace options available to staff and a Continuity of Operations Plan in place in case any R10 office is damaged by flooding or storms or transportation to/from offices are affected (e.g., flooded roadways; landslides on commuter train tracks).

Tribal and other vulnerable populations

7.A. Regional focus: Food security for Tribal communities that live a subsistence lifestyle may be at risk due to warming associated with climate change
Likelihood of Impact: Likely
Focus of Associated EPA Program: All R10 Programs working on issues that affect Tribal populations, potential link to permitting programs and actions
Likelihood of EPA Program Affected: Medium
Example of Risks if Program were Impacted: Warming due to climate change reduces the availability and accessibility of many traditional food sources such as ice seals, walrus and caribou.[116] For example, climate change decreases the amount and quality of food that grows in the summer months, preventing caribou from storing enough fat to survive the winter. People face losing their healthiest foods, their communities, and in some cases, their culture, since each of these depends on traditional ways of collecting and sharing food.[117]
Regional Importance of Vulnerabilities: The most vulnerable population would be the native Alaskan people. They face losing their current livelihoods, their communities, and in some cases, their culture.
Variation in importance across the Region: To some degree, this is also relevant to all the tribes in the rest of Region 10 (WA, OR, and ID).

7.B. Regional focus: An increase in intensity of coastal storms and rising sea levels would increase erosion of shorelines and pose risks to coastal native villages.
Likelihood of Impact: Occurring Now
Focus of Associated EPA Program: Tribal Programs, emergency response
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: Alaska's coastline, much of which is close to sea level, is increasingly threatened by a combination of the loss of its protective sea ice buffer, increasing storm activity, and thawing coastal permafrost.[118] In Alaska, over 100 villages on the coast and in low-lying areas along rivers are subject to increased flooding and erosion due to warming. Federal, state, and tribal officials have identified 31 villages that face imminent threats.[119] At least 12 of the 31 threatened villages have decided to relocate--in part or entirely--or to explore relocation options. Federal programs to assist threatened villages prepare for and recover from disasters and to protect and relocate them are limited and unavailable to the majority of villages. The Federal Emergency Management Agency has several disaster preparedness and recovery programs, but villages often fail to qualify for them, generally because they may lack approved disaster mitigation plans or have not been declared federal disaster areas.[120]
Regional Importance of Vulnerabilities: Erosion of shorelines may require relocation of native villages. Loss of water infrastructure would require emergency water supplies. Flooding and storm events will require emergency management plans
Variation in importance across the Region: Greatest risks are to the shorelines in Alaska, but shorelines in WA and OR are also at a moderate risk

7.C. Regional focus: Loss of permafrost and reduced snowpack threatens access to clean water

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[116] ACIA. 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge, UK, and New York, 139 pp.
[117] Ibid ACIA. 2004.
[118] USGCRB. 2009. Regional Impacts: Alaska. EPA/600/R-07/094F, Office of Research and Development, Washington, D.C.
[119] Alaska's Climate Change Strategy: Addressing Impacts in Alaska. http://www.climatechange.alaska/aag/docs/aag_ES_27Jan10.pdf.
[120] U.S. General Accounting Office. 2003. Alaska Native Villages: Most Are Affected by Flooding and Erosion, but Few Qualify for Federal Assistance. GAO-04-142. U.S. General Accounting Office, Washington, DC, 82 pp.

Likelihood of Impact: High
Focus of Associated EPA Program: Tribal Programs, Clean Water Indian set-aside program
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: In many Alaskan rural tribal communities, their water is drawn from tundra lakes and these are disappearing with the permafrost.[121] Another impact of melting permafrost is the loss of a stable foundation, endangering the sewer and water infrastructure that EPA, and the American taxpayer, has invested billions of dollars in.[122] Tribes in other parts of Region 10 may experience water scarcity, due to failing aquifers. With reduced snow pack and increased seasonal drought, traditional drinking water sources are not being replenished. This can affect individuals: a small well fails, or communities: a large aquifer does not recharge. In general, without access to clean water, tribal communities across Region 10 have greatly increased respiratory and gastrointestinal infections and skin diseases including methicillin-resistant Staphylococcus aureus (MRSA). These risks are increased by the open dumps that exist in close proximity to most rural communities. There is often human waste and solid waste comingled and when there are floods or storm surges from the loss of protective ice, viable bacteria and contaminants are carried through the community and into people's homes. Often times running water is not available for sanitation so these contaminants are making significant and dangerous impacts to both the environment and human health of rural Alaska communities. Most dumps are unlined, but permafrost has partially contained their toxic materials. Without permafrost, the untreated leachate may be a contamination risk for their water supply.
Regional Importance of Vulnerabilities: High. Costs to repair or replace water/sewer infrastructure damaged by thawing permafrost has been estimated at well over 6 billion dollars.[123]
Variation in importance across the Region: Permafrost thawing affects Alaskan tribes, some of whom already do not have access to clean water.

7.D. <u>Regional focus</u>: Changing water conditions <u>reduce availability of fish & shellfish resources</u>.
Likelihood of Impact: Occurring Now
Focus of Associated EPA Program: Tribal Programs, Ecosystems and public affairs.
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: Salmon of the PNW are central to the lives of all native peoples, they bring spiritual, physical and cultural well-being. Climate change is bringing rapid habitat challenges, from rapidly changing stream flows to warming waters that can no longer protect salmon fry. Agricultural runoff and clear-cut forests further degrade water quality. It is a mystery what is happening to the salmon in the ocean and scientists are concerned about the threat of ocean acidification to salmon food sources. Addressing these issues will require large scale cooperative restoration and enhancement projects between many partners.

The R10 Tribes' traditional shellfish use areas are on reserves, in ceded customary and traditional use areas. Increasing ocean acidification threatens shellfish beds that Tribes have harvested for millennia. Ocean acidification may reduce rates of shellfish larval survival and weaken the shells of the adults, thus making them more vulnerable as well.
Regional Importance of Vulnerabilities: High (Ocean acidification was a high priority in discussion groups at the 2012 Tribal Leaders Summit and was presented by both Makah and Tulalip tribes)
Variation in importance across the Region: high priority to all coastal tribes.

7.E. <u>Regional focus</u>: Vulnerable population such as children, the elderly, poor, and the infirm may be at increased health risk due to increased temperatures, failing infrastructure, and extreme weather events.

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[121] Alaska's Climate Change Strategy: Addressing Impacts in Alaska. http://www.climatechange.alaska/aag/docs/aag_ES_27Jan10.pdf.
[122] Alaska's Climate Change Strategy: Addressing Impacts in Alaska. http://www.climatechange.alaska/aag/docs/aag_ES_27Jan10.pdf.
[123] Institute of Social and Economic Research, University of Alaska. 2008. http://www.iser.uaa.alaska.edu/Publications/webnote/Web_Note4a.pdf

Likelihood of Impact: Occurring Now
Focus of Associated EPA Program: Tribal Programs, Ecosystems and public affairs.
Likelihood of EPA Program Affected: High
Example of Risks if Program were Impacted: Children playing in areas with higher ozone levels resulting from increased temperature will be at higher risk for experiencing asthma symptoms and exacerbations. The elderly are more vulnerable to heat stress because they are often in poorer health and are less able to regulate their body temperature during periods or extreme health. Economic constraints can also place low-income households at disproportionate risk to extreme heat events due to lack of air condition or failure to use air-conditioning to cut down on associated energy costs.
Regional Importance of Vulnerabilities: Across the region.
Variation in importance across the Region: Across the region.

Appendix C: Detailed Description of EPA Region 10 Existing Actions

The tables below include detailed information on existing actions in Region 10. It is organized by Office and includes the following columns

- Vulnerability: This identifies the vulnerability associated with each action. Many actions have multiple vulnerabilities.
- Relevant Agency Direction: This includes the EPA strategy from which the action is derived. For example, many of the actions come from the Region 10 Strategic Alignment Plan while other actions come from the Puget Sound Action Agenda or EPA National Water Program Strategy.
- Relevant EPA Goal: This identifies the EPA National or Regional Goal associated with the action. These goals were included in the vulnerability assessment.
- R10 Lead/Partners: This column includes the EPA person responsible for the action and the partners EPA is working with to accomplish the actions.
- Linked to Tribes, Sustainability, and EJ: This column indicates whether the action can be linked to EPA Region 10 tribes, related to sustainability, or environmental justice. These areas are very important to EPA Region 10 and we wanted to evaluate which actions could be identified with these three areas.

Office of Air, Waste, and Toxics

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
Indoor Air Training Develop and host training for professionals (housing, medical, schools) on making indoor environments healthier for the most vulnerable. This is a particularly important Climate Change Adaptation activity because of increasing mold problems following floods as well as increasing indoor levels of ambient pollutants due to wildfires, inversions with peak pollutant levels, and increased use of back-up power generators due to extreme weather events.	Changes in precipitation, extreme temperatures, more frequent wildfires, and severe weather events impact indoor air quality as ambient air is entrained indoors	R10 Strategic Alignment Plan	Support At-Risk Communities (for Air Quality)	R10 Lead: Davis Zhen: Indoor Air/Radon Partners: State, local air & Tribal agencies; At-Risk Communities: EPA HQ	•	•	•

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
Tribal Waste Management Programs Work with federally recognized tribes in Washington, Alaska, Oregon and Idaho to address landfills and unconfined open dumps which are impacted by climate change and help develop appropriate responses to these threats. RCRA Tribal Team – 2013 ongoing work and beyond Continue to update 2011 Indian Health Service Indian Lands Open Dumps Inventory. In 2011 the EPA RCRA Tribal Team, RCRA Program Unit, Office of Air Waste and Toxics, completed an inventory of all open dumps in Washington, Oregon, Idaho and Alaska and posted this information on the national Indian Health Service Operations and Maintenance Database (OMDS). This database includes information on all open dumps on Tribal lands, including Alaska. Partner with Tribal communities, Tribal Consortia such as the Tribal Solid Waste Advisory Network, the EPA Tribal Trust and Assistance Unit and the Alaska Department of Environmental Conservation (ADEC) to develop appropriate responses to address the needs of tribal communities which are threatened by climate change impacts to their landfills and unconfined open dumps. Actions include: - Convening teleconferences with partners to ascertain the state of knowledge about climate impacts to tribal landfills and unconfined open dumps in Washington, Oregon, Idaho and Alaska and strategies to address these impacts. - Providing on-site technical assistance to interested tribal communities to help them to address climate change impacts to landfills and open dumps on their lands.	Increased precipitation and floods Increasing extreme temperatures, increasing heavy precipitation events, changes in storm intensities, and increasing frequency of floods may increase the exposure to and risk associated with hazardous chemicals (i.e. contained at RCRA sites. Thawing permafrost and sea ice changes lead to damaged roads, runways, water and sewer	R10 Strategic Alignment Plan	R10 Strategic Alignment Plan Goal 4.4 –See Existing Actions column to left	R10 Leads: Lisa McArthur UM Fran Stefan-Tribal SW Program Mgr Partners: Alaska Native Villages; rural communities	•	•	

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
	systems, and other infrastructure including solid waste landfills and RCRA containment sites.						
Materials Management and Pollution Prevention Program Climate change is expected to continue to adversely impact the cost of raw materials. Materials management enables the use of the highest and best substitutes for materials that may become scarce or too costly. Facilitate Climate Change Adaptation by: -Helping the public and regulated community adapt to the production and use of new materials, processes, and products that support the transition to sustainable materials management processes and away from: a) the use of more costly and limited natural resource based materials, and b) disposal- based systems with high uncontrolled emission and waste product management impacts. Materials Management Adaptation work includes: - Promoting More Sustainable Practices in Materials Management (SMM) and in Our Own Cleanup Work through: a) the recruitment and retaining participants for the Federal Green Challenge (helping our federal partners to reduce their GHG emissions through work on energy, transportation, waste and water), and b) recruiting for the Food Recovery Challenge in support of the EPA's Sustainable Materials Management (SMM) Program which seeks to reduce the environmental impact of a material throughout its entire life cycle - including how it is extracted, manufactured, distributed, used, recycled, and disposed (See Appendix E – Supporting Documentation).	Increased impacts from GHG emissions released from non-sustainable materials mgmt. practices.	R10 Strategic Alignment Plan WCMMF	Goal 4.6 – Sustainable Materials Mgmt	R10 Leads: Kris Colt UM Federal Green Challenge: Melissa Winters Food Recovery Challenge & WCMMF: Ashley Zanolli Partners: R9; state and local governments		•	

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
- Continuing to work with state and local governments through the West Coast Climate and Materials Management Forum (WCMMF) in their transition to materials management.							

Office of Water and Watersheds

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
Water infrastructure							
Work with the State of Alaska in the R&D of alternative technologies with providing first time service to unserved homes in a more sustainable way compared to a traditional piped system. The State has provided $1M for this effort.. The most promising proposals for pilot system development will be identified in 2013. Systems approved for field installation and testing will be identified in 2014. Field testing is expected to begin in 2015 and be concluded by 2016.	Melting permafrost	R10 strategic alignment plan; sustainability	Building Strong State & Tribal Partnerships, EJ, Protecting America's Waters	R10 Lead: OWW-Dennis Wagner Partner: State of Alaska	•	•	•
Work with the WaterSense program to reach out to potential partners to encourage water efficiency in homes, landscaping and commercial buildings. A focus is new homes.	2A: Drought, floods,	R10 strategic alignment plan; National Water Program Strategy	Goals 1, 2, and 3	R10 Lead: Bevin Horn		•	
Continue implementing the Sustainable Energy Management Program with a Western Washington cohort of drinking water and wastewater utilities. This project is led by Washington State University-Energy Extension, with support from several partners.	2A: drought, floods, erosion, heavy precipitation	National Water Program Strategy; R10 strategic alignment plan;	Goals 1, 2, and 3	R10 Lead: Cyndi Grafe		•	
Freshwater fisheries							
Continue with pilot program for including Climate Change in an ongoing TMDL. EPA Region 10 and ORD Corvallis are working with the Washington Department of Ecology, the Lummi Nation and the Nooksack Tribe to identify the best way to integrate available climate change data into Ecology's TMDL for temperature stress on salmon in the South Fork Nooksack River, Washington. This will provide a case study of both process and climate change science as a basis to support	Increased temperatures.	R10 strategic alignment plan;	Goals 1 and 2 and Regional Goal 7	R10 Leads: OEA-Bruce Duncan; OWW-Laurie Mann	•	•	

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
future Tribal Consultation, Co-Management, Policy and Regulation Development as needed. Examining the way temperature can be improved in the Nooksack watershed in order to support salmon restoration is a high priority for the Nooksack and Lummi Tribes. The climate change pilot will identify available science for the watershed, and document technical issues in a parallel effort to the ongoing TMDL.				ORD-WED – Steve Klein Partners: WA Dept Ecology Nooksack Tribe Lummi Nation			
Training and Outreach							
Maintain current participation in the National Water Program Climate Change Workgroup, including identifying a single point of contact for the Regional water program.		OW Climate Strategy	Goals 1 and 2.	R10 Lead: Paula VanHaagen			
Help to develop and implement the Office of Water Climate Change Adaptation Implementation Plan (due to the Council on Environmental Quality in Fall 2013) and to coordinate between the National Water Program 2012 Strategy and the EPA Regional Adaptation Implementation Plans		OW Climate Strategy; R10 strategic alignment plan;	Goals 1 and 2.	R10 Lead: Paula VanHaagen			
After the Fall completion of the Office of Water Climate Change Adaptation Implementation Plan, provide training for water program staff on the challenges that climate change poses for water programs, and familiarize them with the National Water Program Climate Strategy and Regional Climate Adaptation Plans through a variety of means such as “all hands” meetings, webinars, seminars, and dissemination of the plans		OW Climate Strategy; R10 strategic alignment plan;	Goals 1 and 2.	R10 Lead: Mike Cox			
Support national program efforts to inform and educate water program managers in the public and private sectors on climate change and water issues through a variety of means such as identifying key stakeholders and expanding professional networks, improving educational outreach efforts on National and		OW Climate Strategy; R10 strategic alignment plan;	Goals 1 and 2.	R10 Lead: Mike Cox		•	

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
Regional climate change websites and in other media, and disseminating clear and credible messaging on climate change science and impacts							
In program meetings with States and Tribes in 2013, include discussion of ongoing Agency and Region climate change adaptation planning, the new National Water Program climate change strategy, and climate change activities related to State water programs as appropriate		OW Climate Strategy	Goals 1 and 2 and Regional Goal 7	R10 Lead: Mike Cox	•		
Coordinate with the regional offices of other Federal agencies on climate change adaptation matters and participate, where appropriate, with related interagency cooperative and collaborative efforts to address climate change challenges on a regional scale		OW Climate Strategy	Goals 1 and 2.	R10 Lead: Mike Cox			
Work with municipal and private water utilities to promote their use of the new Climate Ready Resilience and Awareness (CREAT) Version 2.0 to recognize and respond to climate change risks, and with National Estuary Program partners to promote the use of the new Climate Ready Estuaries Vulnerability Assessment Handbook to develop local climate resilience plans		OW Climate Strategy; National Water Program Strategy	Goals 1 and 2 and sustainability.	R10 Lead: Paula vanHaagen		•	
Work with States, Tribes, municipalities, non-profit organizations and businesses to promote the Water Sense Program in the region		OW Climate Strategy; National Water Program Strategy	Goals 1 and 2 and sustainability.	R10 Lead: Bevin Horn	•	•	
Support the national Water Program in revising the State Revolving Loan Funds "Green" paper and the Annual Review Guidance for on-site reviews to incorporate climate change, including a new "Climate Change" checklist. The Green paper will provide information on best practices and tools to help state SRF programs support climate change activities. The guidance and checklist would identify opportunities for States to develop priorities and make investments that respond to the climate change risks in that State		OW Climate Strategy	Goals 1 and 2 and sustainability.	R10 Lead: Paula vanHaagen		•	•

Office of Ecosystems, Tribal, and Public Affairs

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
NEPA							
Through NEPA review comments, seek to protect waters of the United States and promote management of sustainable surface water resources. Encourage green infrastructure and low-impact development to protect water quality and make watersheds more resilient	Decreasing precipitation days and increasing drought intensity	National Water Program Strategy[124]	Goal 2.	R10 Lead: NEPA Review staff Partners: Lead federal agency (HUD, DOT, STB)			
Through NEPA review, ensure consideration of climate change on federal projects that may be at risk due to inundation, flooding, or salt water intrusion • Retention ponds at mine sites • Transportation/road infrastructure (road/rail/culvert failure) • Dam sites • Flood risk management (levies)	Increasing risk of floods		Goal 2.	R10 Lead: NEPA Review staff Partners: Lead federal agency (BLM,USFS FERC,USBR, DOT, STB)			
Work with federal partners through the NEPA process to identify, protect, and maintain a network of healthy watersheds and supportive habitat corridor networks • Collaborate with partners on terrestrial ecosystems and hydrology so that effects on water quality and aquatic ecosystems are considered.	Changes in abundance and geographical distributions of plant species and habitats for aquatic and terrestrial wildlife	National Water Program Strategy[125]	Goal 2.	R10 Lead: NEPA Review Staff Partners: Lead federal agency (USFS, BLM, NPS, USFWS)			

[124] Goal 12 SA 33. See http://water.epa.gov/scitech/climatechange/upload/NWP_Draft_Strategy_03-27-2012.pdf
[125] Goal 3 SA 9. See http://water.epa.gov/scitech/climatechange/upload/NWP_Draft_Strategy_03-27-2012.pdf

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
Work with federal partners through the NEPA process to incorporate climate resilience into watershed restoration and floodplain management • Work with partners to protect and enhance buffers to rivers, streams, lakes, wetlands, and coastal resources as a means of building resiliency	Changes in abundance and geographical distributions of plant species and habitats for aquatic and terrestrial wildlife	National Water Program Strategy[126]	Goal 2.	R10 Lead: NEPA Review Staff Partners: Lead federal agency (Forest Service, BLM, Park Service, USFWS)			
Work with federal partners through the NEPA process to incorporate climate change adaptation into forest restoration plans • Encourage appropriate use of prescribed burning/thinning to reduce risk of uncharacteristic wildfire. Where appropriate, encourage managing for species best adapted to future climate	Increased frequency or intensity of wildfires	R10 Strategic Alignment.	Goal 1.	R10 Lead: NEPA Review Staff Partners: Lead federal agency (Forest Service, BLM, Park Service, USFWS)			
ETPA will include ocean acidification language in NEPA review comment letters as appropriate. • Refine template language in letters and example NEPA analyses that include ocean acidification information	Increase in ocean temperatures, with potential for changes in ocean chemistry and increased ocean acidification	R10 Strategic Alignment.	Goal 2.	R10 Lead: NEPA Review Staff Partners:			
Wetlands							
Wetlands and Climate Change Research Meeting focused on new approaches and tools to better understand, manage, and conserve wetlands in a changing climate.	Loss of wetland ecosystems and services	U.S.EPA Climate Adaptation Plan[127]	Goal 2.	R10 ARU Lead: Linda Storm Partners:			

[126] Goal 4 SA 13. See http://water.epa.gov/scitech/climatechange/upload/NWP_Draft_Strategy_03-27-2012.pdf
[127] 3.3.4 Priority: Strengthen Adaptive Capacity of EPA Staff and Partners Through Training. http://www.epa.gov/climatechange/pdfs/EPA-climate-change-adaptation-plan-final-for-public-comment-2-7-13.pdf

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
				OEA and the R10 Science Advisory Council			
Incorporate climate change considerations into the CWA 404 regulatory program as they relate to permit reviews and compensatory mitigation • Consider the effects of climate change, as appropriate, when making significant degradation determinations in the CWA Section 404 wetlands permitting and enforcement program • Evaluate, in conjunction with the U.S. Army Corps of Engineers, how wetland and stream compensation projects could be selected, designed, and sited to aid in reducing the effects of climate change	Loss of wetland ecosystems and services	National Water Program Strategy[128]	Goal 2.	R10 Lead: Linda Storm Partners: USACE			
As resources allow, improve baseline information on wetland extent, condition and performance to inform effective adaptation to climate change • Expand wetland mapping by supporting wetland mapping coalitions and training on use of the new federal Wetland Mapping Standard. • Produce a statistically valid ecological condition assessment of the nation's wetlands	Loss of wetland ecosystems and services	National Water Program Strategy[129]	Goal 2.	R10 Lead: Maryann Thiesing Partners: ORD, USFWS, UW Wetlands Adaptation Group			
FY13 and FY14 Region 10 Wetland Program Development Grants RFP integrates climate adaptation by considering how the design							

[128]National Water Program 2012 Strategy: Response to Climate Change. Available at http://water.epa.gov/scitech/climatechange/upload/NWP_Draft_Strategy_03-27-2012.pdf

[129]National Water Program 2012 Strategy: Response to Climate Change. Available at http://water.epa.gov/scitech/climatechange/upload/NWP_Draft_Strategy_03-27-2012.pdf

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
and installation of demonstration projects would take relevant potential impacts from climate change into account when considering long-term viability [130]							
Ocean Programs							
Participate in interagency development and implementation of federal strategies through the National Ocean Council (NOC) and the National Ocean Policy Implementation Plan	Increase in ocean temperatures, with potential for changes in ocean chemistry and increased ocean acidification	National Water Program Strategy[131]	Goal 2.	R10 Lead: Sediment Management Staff Partners: NOC			
Tribes							
Build the capacity of Tribes to develop adaptation actions (plans) and to engage in the collaboration with local, state and federal agencies.	All (mitigation)	Regional Tribal Operations Committee	Goal 1.	R10 Lead: Michelle Davis-TTAU;	•	•	
EPA R10 Tribal Trust and Assistance Program will provide GAP funding as appropriate to support Tribes who have climate change in their GAP workplans to learn how to research climate change impacts upon their environment, natural resources, infrastructure to be used for development of a planning mechanism for adaptation and mitigation.	All	RTOC	Goal 1.	R10 Lead: TTAU; AIEO/OITA Partners: R10 Tribal Governments			
Through the GAP program, Tribes may be able to do baseline environmental assessments that will add to documentation of the impact on climate change on Tribal communities and their ecosystems and support their adaptation planning.	All	National Tribal Science Council	Goal 1.		•		

[130] http://www.epa.gov/region10/pdf/wetlands/FY13_Wetland_Program_Development_Grants_Request_for_Proposals.pdf
[131] Goal 11 SA 28 and SA 31. See http://water.epa.gov/scitech/climatechange/upload/NWP_Draft_Strategy_03-27-2012.pdf

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
Share information to support climate change educational outreach and adaptation activities within Tribal communities	All	National Tribal Science Council	Goal 1.		•		
Tribal Program staff will regularly submit articles on climate change to Tribal newsletters. Coordinate with other programs and their Tribal specialists on climate change info and resources to include in the EPA Tribal newsletter.	All	2010 Tribal Leader's Summit Action Plan	Goal 1.		•		
Continue to offer quarterly calls to Alaskan Tribes with Institute for Tribal Environmental Professionals on tribal climate change adaptation models and resources.	All	2010 Tribal Leader's Summit Action Plan	Goal 1.	R10 Lead: Michelle Davis Partners: ITEP	•		
Puget Sound Program							
Address Climate change in Puget Sound Grants, consistent with the Puget Sound Action Agenda. Grant activities include: Conduct an erosion survey to evaluate sea level rise threat in San Juan County; b) Map habitat and infrastructure vulnerability in Puget Sound and restoration potential for reducing vulnerability; c) Several Tribes and counties will incorporate climate change in their plans and/or analyses. Puget Sound Grant partners include: *Puget Sound Partnership, Friends of the San Juan's, The Nature Conservancy, Snohomish County, Washington Dept. of Ecology, Samish Indian Nation, Swinomish Tribe, Nooksack Tribe, Suquamish Tribe, Port Gamble Indian Commission*.	Sea Level Rise/erosion	Puget Sound Action Agenda	Goal 2.	R10 Lead: ETPA/Puget Sound: Angela Bonifaci; See partner list under description	•	•	
Puget Sound Partnership is working to control source pollution. • No Discharge Zone Evaluation and Petition. Draft petition to EPA by September 2013	Increasing heavy precipitation events. Increased pollutant	Puget Sound Action Agenda[132]	Goal 2.	R10 Lead: EPA Team			

[132] http://www.psp.wa.gov/downloads/AA2011/083012_final/Action%20Agenda%20Book%201_Aug%2029%202012.pdf

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
• Pollution Control Action Team to respond quickly when areas are identified where water quality problems threaten shellfish areas. The first effort will be in Drayton Harbor and Portage Bay. • Pollution Identification and Correction Programs to identify and correct nonpoint source pollution sources.	loads in runoff and the velocity of runoff will scour and erode creek beds.			Partner: Puget Sound Partnership, Washington Department of Ecology, DOH,WSDA, Tribes			
The Puget Sound Partnership has developed climate change indicators which will allow them to track climate-driven changes and identify vulnerabilities or ecological thresholds	Increase in ocean temperatures, with potential for changes in ocean chemistry and increased ocean acidification	Climate Ready Estuaries[133] National Water Program Strategy[134]	Goal 2.	R10 Lead: Michael Rylko Partners: OCPD, National Estuary Programs, EPA Climate Change Division			
Puget Sound Grants process integrates climate adaptation concepts by considering how the design and installation of projects would take relevant potential impacts from climate change into account	All	U.S. EPA Climate Adaptation Plan/ FY 2011-2015 EPA Strategic Plan [135]	Goal 2.	R10 Lead: Puget Sound Grants Team			
A four part effort, comprising climate statistics, GIS visualization and analysis, data delivery platform development, and engagement with policy and management entities, will underlie the proposed development and delivery of information about the	All	Puget Sound NEP.	Goal 2.	R10 Lead: Jon Schweiss. Partners: UW			

[133]Climate Ready Estuaries 2012 Progress Report. Available at http://water.epa.gov/type/oceb/cre/upload/CRE_2012Report_122612a.pdf
[134] Goal 9, SA 23. See http://water.epa.gov/scitech/climatechange/upload/NWP_Draft_Strategy_03-27-2012.pdf
[135] 3.3.1 Priority: Fulfill Strategic Measures in *FY 2011-2015 EPA Strategic Plan.* Strategic Measure 2: Integrate climate adaptation into financial mechanisms. http://www.epa.gov/climatechange/pdfs/EPA-climate-change-adaptation-plan-final-for-public-comment-2-7-13.pdf

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
projected time of emergence of various elements of a changing climate in the Puget Sound Basin.							
Children's health and vulnerable populations							
Through work on children's health, develop and host training for professionals in the housing, health and educational fields on making indoor environments healthier for the most vulnerable populations	Changes in precipitation, extreme temperatures, more frequent wildfires, and severe weather events will impact outdoor air quality and indoor air quality since ambient air is entrained indoors		Goal 1 and Regional Goal 7	R10 Lead: Margo Young			•
Provide technical assistance and training to affected communities on risks associated with poor outdoor air quality • Work with Tribal Air Program • Convene Rural Alaska Children's Environmental Initiative			Goal 1 and Regional Goals 6 and 7.	R10 Lead: Margo Young, Erin Mader Partners: EPA Tribal Air Program, ANCH	•		•
Outreach/risk communication to vulnerable and economically deprived communities.	Decreasing precipitation days and increasing drought intensity	U.S.EPA Climate Adaptation Plan	Regional Goals 6 and 7.	R10 Lead: Sheryl Stohs Partners:			•

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
	Increasing risk of floods			Beyond Toxics, Eugene; Verde of Portland; DRCC of Seattle			
Regional Clean Air Act Grants are provided to Tribes to build capacity and knowledge and assess and address air quality concerns. Many grant-funded programs aim to prevent the presence of and exposure to indoor air pollution, for example, through supporting clean burning practices for wood stoves and adequate and effective ventilation in homes and public buildings. Ambient pollutants are also targeted, for example, from idling vehicles, diesel generators, outdoor burning, agricultural burning, wood stoves, and wildfires. Many of these factors will worsen with climate change, making tribal capacity building in these areas critical.	Indoor air quality	R10 Strategic Alignment Plan.	Regional Goals 6 and 7.	R10 Lead: Erin Mader Partners: Tribes	•		
Region 10's Children's Environmental Health and Tribal Air Program co-lead the Rural Alaska Children's Environmental Health Initiative and its two active workgroups, the Alaska Healthy Homes and the Alaska Healthy Schools Workgroups. These groups were established in December 2010 and work together regularly to protect children from harmful environmental exposures in rural Alaska, including factors related to climate change.	All.	R10 Strategic Alignment Plan.	Goals 6 and 7.	R10 Lead: Erin Mader Partners: Tribes	•		•
The Tribal Air Program has an IPA position in the Anchorage office serving as the Alaska Tribal Air Liaison. She provides direct assistance to Alaska Tribes and GAP grantees to do air quality work, including climate change related topics.	Air quality	R10 Strategic Alignment Plan.	Goals 6 and 7.	R10 Lead: Michelle Davis Partners: Tribes	•		•
Other actions							
As appropriate, communicate with the public about hazards posed by climate change and EPA response/ remedies to events exacerbated by climate change (storm events, flood, drought)	All	U.S.EPA Climate	Goal 3.	R10 Lead: Public Affairs Unit			

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
		Adaptation Plan					
As appropriate, raise public awareness about climate change and actions being taken by the EPA to address climate change	All	U.S.EPA Climate Adaptation Plan	Goal 3.	R10 Lead: Public Affairs Unit			
Puget Sound Projects							
Vulnerability and Resilience of Puget Sound Estuaries to Climate Change. Vulnerability assessments will allow decision makers to understand known risks, key uncertainties and the level of vulnerability their habitats and communities face from future storms and elevated sea levels (Cooper et al. 2008).	In the Puget Sound basin these include increased winter precipitation, higher river flooding, lower summer low flows (Hamlet and Lettenmaier 2007), sea level rise (Mote et al. 2008), and uncertain effects on wind storms, sediment recruitment, and larger scale wind and ocean currents.	Puget Sound Action Plan. Objective 3. Vulnerability analysis	Goal 2.	R10 Lead: Michael Rylko Partners: The Nature Conservancy in collaboration with USGS and UW CIG			
The Puget Sound Partnership plans to launch a tree planting/canopy cover campaign in FY13	Increased stream temperatures	Puget Sound Partnership Stewardship grant	Goal 2.	R10 Lead: Partner: Puget Sound Partnership			
In FY13, Snohomish County's Department of Public Works will address the threats of climate change and increased population growth with a focus on addressing altered basin hydrology.	Change in basin hydrology	Puget Sound NEP.	Goal 2	R10 Lead:			

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
				Partner: Snohomish County's Department of Public Works			
The Washington State Department of Ecology will continue to work on a Puget Sound Circulation and Dissolved Oxygen Model (v2.0) in order to determine climate change effects on Puget Sound water quality.	Increase in ocean temperature.	Puget Sound NEP.	Goal 2.	R10 Lead: Ben Cope Partner: WA Ecology			
King County will produce modeled flow and water quality conditions in the rivers and streams of WRIA 9 for idealized fully forested conditions, and anticipated 2040 conditions considering population growth and climate change	Sea level rise.	Puget Sound NEP.	Goal 2.	R10 Lead: Michael Rylko Partner: King County.			
Tribal Related projects in Puget Sound							
The Samish Indian Nation will continue its climate change monitoring of Fidalgo Bay waters in FY13 providing continuous temperature data for trend analysis	Increasing ocean temperature.	Puget Sound NEP.	Goal 2 and Regional Goal 7.	R10 Lead: Lisa Chang Partner: Samish Indian Nation	•		
The Swinomish Tribe will hold its annual workshop on climate change issues in the Skagit, with a written report to follow	All.	Puget Sound NEP.	Goal 2 and Regional Goal 7.	R10 lead: Lisa Chang Partner: Swinomish Tribe	•		
The Nooksack Tribe will attend climate change conferences, meeting, and presentations, and review technical reports to evaluate the magnitude of expected local changes. This	All.	Puget Sound NEP.	Goal 2 and Regional Goal 7.	R10 lead: Lisa Chang	•		

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
information will be considered in the salmon recovery plan implementation for WRIA 1				Partner: Nooksack Tribe			
The Suquamish Tribe will continue to monitor the work of the Climate Change Study Group, review climate change related studies and documents, and attend related meetings in order to build tribal capacity with respect to climate change	All.	Puget Sound NEP.	Goal 2 and Regional Goal 7.	R10 lead: Lisa Chang Partner: Suquamish Tribe	•		
The Port Gamble Indian Commission of the Port Gamble Reserve plans to participate in climate change and ocean acidification programs in order to inform the development of a climate change program in FY13	Ocean acidification.	Puget Sound NEP.	Goal 2 and Regional Goal 7.	R10 lead: Lisa Change Partner: Port Gamble Indian Commission	•		

Office of Environmental Assessment

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
Inreach Project – Meet with each unit within OEA (including our Manchester Environmental Laboratory Director) and determine where climate science can be used in our work for programs: e.g., EJ related apps and heat stress/vegetation; riparian setbacks and hyporheic flow models; TMDL models; Any modeling involving temperature or flow terms.	All	R10 Strategic Alignment plan		R10 Lead: Mike Cox Partners: POCs in Offices	•	•	•
Regional Outreach/Training – Continue to brief offices on vulnerabilities and tee up discussions where climate science can be used in decisions.	All	R10 Strategic Alignment plan		R10 Lead: Mike Cox Partners: POC in offices	•	•	•
Coordination with other federal agencies by participating on Climate Change Cooperative	All	R10 Strategic Alignment plan		R10 Lead: Mike Cox; Partners: Other federal agencies	•		
Support Pacific NW Landscape Conservation Cooperative - Steering Committee – OEA Director, Sci TEK subcommittee – CC Science Advisor	All coastal & marine-related	R10 Strategic Alignment plan		R10 Leads: Joyce Kelly an; Mike Cox; Partners: NPLCC participants.	•		
Participate on the National Tribal Science Council, and support actions related to climate change and tribes	All	National Tribal Science Council	Goal 1.	R10 Lead: Lon Kissinger Partners: RTOC	•		

Office of Compliance and Enforcement

					Linked to		
	Vulnerability	**Relevant Agency Direction**	**Relevant EPA Goal**	**R10 Lead/ Partners**	**Tribes**	**Sustain-ability**	**EJ**
Climate change may have more impact on overburdened communities as these communities, due to various concerns, adapt less well than other communities. OCE is using an Environmental Justice Screening tool to identify regulated facilities located in these overburdened communities. This tool was nationally developed to screen for communities with environmental justice concerns for implementation in various EPA programs.	All	R10 Strategic Alignment plan	Goal 5	R10 Lead: Anne Dalrymple Partners: Running Grass			•
Permitting Class I Underground Injection Control (UIC) Wells in the North Slope of Alaska. The permafrost in the North Slope of Alaska has been identified as a vulnerable resource. In substitution for retention ponds used to store oil and gas industry's drilling wastes, the UIC program continues to permit several Class I wells for underground injection of those wastes. This reduces the need to establish waste retention ponds on the increasingly vulnerable permafrost.	Permafrost thawing.	R10 Strategic Alignment plan	Goal 5	R10 Lead: UIC Compliance Team Partners:	•		
Continuing to support the Regional Support Corps by deploying staff for varying emergency response efforts (e.g. Hurricane Katrina).	All	R10 Strategic Alignment plan	Goal 5 and Operations and Facilities.	R10 Lead: Wendy Adams Partners: Ann Williamson			
Continuing to look for opportunities to encompass green infrastructure as part of settlement agreements. An example of this is the City of Seattle, Washington and King County, Washington CSO settlement agreements. These settlements allow for the City of Seattle and King County to substitute green infrastructure projects for gray infrastructure projects (e.g. green roofs, permeable pavements, urban gardens).	All	R10 Strategic Alignment plan	Goal 5	R10 Lead: Depends on the case. Partners:		•	

Appendix D: Comparison of Vulnerabilities and EPA Region 10 Existing Actions

Appendix D compares the vulnerabilities identified in Section 2 and Appendix B with the existing actions identified in Section 3 and Appendix C. This comparison provides valuable information as EPA Region 10 evaluates how to best proceed to integrate climate change into the programs.

Goal 1: Taking Action on Climate Change and Improving Air Quality

Vulnerability	Action(s)
Increase in tropospheric ozone pollution may occur in certain areas due to increased average summertime temperature	No specific existing actions.
Increase in air toxics from anthropogenic sources is uncertain due to variability in effects of temperature increase on individual air toxics.	No specific existing actions.
Increase in particulate matter levels is occurring now and is very likely to increase due to increased frequency or intensity of wildfires due to increased summertime temperatures, prolonged droughts, and decreased soil moisture.	No specific existing actions.
Indoor air quality is very likely to be impacted, especially in Alaska, due to changes in precipitation, extreme temperatures, more frequent wildfires, and severe weather events.	Develop and host training for professionals (housing, medical, schools) on making indoor environments healthier for the most vulnerable. Assist Tribes to build capacity and knowledge and assess and address air quality concerns including those related to climate change through the Regional Clean Air Act Grants.
Stratospheric ozone layer is likely to be impacted in Alaska due to climate change effects	No specific existing actions.
Increased rate and deposition of sulfates, nitrates, and mercury is uncertain due to changes in precipitation patterns.	No specific existing actions.

Goal 2: Protecting America's Water

Vulnerability	Action(s)
Drinking water, wastewater, stormwater, and agricultural infrastructure is likely to be impacted by increased heavy precipitation, more frequent flood events, storm surge, coastal erosion, and drought.	Work with the State of Alaska to identify alternative technologies for providing first time service to unserved homes in a more sustainable way compared to a traditional piped system. Work with the Water Sense program to encourage water efficiency in homes, landscaping and commercial buildings with a focus on new homes.

Vulnerability	Action(s)
	Continue implementing the Sustainable Energy Management Program with a Western Washington cohort of drinking water and wastewater utilities.
Impacts to freshwater fisheries is occurring now and likely to increase due to earlier stream runoff and scouring of streambeds due to earlier snow melt, decreased summer stream flows and increased steam temperatures, and longer periods of low stream flow.	Continue with pilot program examining how to integrate climate change in an ongoing TMDL by examining how temperature can be improved in the Nooksack watershed in order to support salmon restoration.
Estuarine watersheds, aquatic ecosystems, and wetlands are very likely to be impacted by sea-level rise, sea surface temperature and increasing heavy precipitation events during the winter months, and decreasing precipitation days and increasing drought intensity during the summer months.	Coordinate a *Wetlands and Climate Change Research Meeting* focused on new approaches and tools to better understand, manage, and conserve wetlands in a changing climate. Incorporate climate change considerations into the CWA 404 regulatory program as they relate to permit reviews and compensatory mitigation. As resources allow, improve baseline information on wetland extent, condition and performance to inform effective adaptation to climate change. Integrate climate adaptation in the FFY13/14 Region 10 Wetland Program Development Grants RFP.
Forest ecosystems will likely be impacted by warming temperatures and more frequent and intense drought conditions.	Through the NEPA review process ensure consideration of climate change in review of all federal projects and incorporate climate change adaptation into land management planning and other projects as appropriate.
Loss of sea ice is occurring now and will very likely increase in Alaska due to warming air and water temperatures.	No specific existing actions.
Ocean acidification is occurring now and is very likely to increase due to increasing concentrations of CO_2 in the atmosphere.	Include ocean acidification language in NEPA review comment letters as appropriate and develop template language in letters and example NEPA analyses that include ocean acidification information. Participate in interagency development and implementation of federal strategies through the National Ocean Council (NOC) and the National Ocean Policy Implementation Plan
Change in vegetation is likely in eastern Washington and Oregon and Idaho due to pest outbreaks, invasive species, increased fire, shifts in species ranges and increased erosion, drier soils, and depletion of water.	Through the NEPA review process ensure consideration of climate change in review of all federal projects and incorporate climate change adaptation into land management planning and other projects as appropriate.

Vulnerability	Action(s)
Puget Sound: Many of these projects address multiple vulnerabilities.	Support Tribal projects on climate change in Puget Sound through the National Estuary Program. A listing of those projects is included in Appendix C. Continue to support projects in Puget Sound related to climate change. There are several on-going projects that are highlighted in Appendix C. Work with the University of Washington to develop a system for visualizing and analyzing a variety of climate change-related features that are shifting with time and probability across the Region.
Training and Outreach	Inform and educate water program managers in the public and private sectors on climate change and water issues and EPA related activities such as the National and Regional climate change adaptation strategies. Work with States, Tribes, municipalities, non-profit organizations and businesses to promote the Climate Ready Water Utilities (CRWU) and Climate Ready Estuaries (CRE) Programs and new Climate Ready Resilience and Awareness (CREAT) Version 2.0. Support Development of a Climate Change Section in the "Green" Paper for the State Revolving Loan Funds and Annual Review Checklists.

Goal 3: Cleaning Up Communities and Advancing Sustainable Development

Vulnerability	Action(s)
Remedial, removal, brownfield, corrective action or permitted sites may be impacted due to flooding, sea level risk, storm surges, extreme events, and landslides.	No specific existing actions.
Increase in work for Alaska's Tribal and emergency response programs is occurring now and likely to increase due to thawing permafrost and changes in sea ice that leads to damage of roads, runways, water and sewer systems, and other infrastructure.	Work with federally recognized tribes in Region 10 to address landfills and unconfined open dumps which are impacted by climate change and help develop appropriate responses to these threats.
EPA Region 10, Tribal and state partners will have increasing workloads in many aspects of site and waste management as well as work related to the formation and implementation of sustainable	Work with our partners through the West Coast Climate and Materials Management Forum and our pollution prevention technical assistance providers and grants to assist in the transition to

development and materials management programs, partnerships and initiatives.	sustainable materials management processes and source reduction.
Availability of raw materials and the cost of mining and refining raw materials, producing products, transporting products, and disposing products may increase due to impacts of climate change.	Recruiting and retaining participants for the Federal Green Challenge and for the Food Recovery Challenge in support of the EPA's Sustainable Materials Management (SMM) Program.

Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution

Vulnerability	Action(s)
Increased exposure and risk to hazardous chemicals is likely due to increasing extreme temperatures and heavy precipitation events, changes in storm intensities, and increasing frequency of floods.	Incorporating green remediation in corrective action decision-making and raising issues nationally regarding the potential impacts of climate change on alternative landfill covers.

Goal 5: Enforcing Environmental Laws

Vulnerability	Action(s)
Non-compliance at regulated entities may increase due to extreme weather events and changing weather patterns.	Continue to use an Environmental Justice Screening tool to identify regulated facilities located in overburdened communities. Continue to look for opportunities to encompass green infrastructure as part of settlement agreements.
Shift in regional enforcement priorities due to changes in compliance (both increased compliance and non-compliance in different sectors) and increased number of inquiries from industry about maintaining compliance due to extreme weather events and changing weather patterns.	No specific existing actions.
Increased permitting of Class VI Underground Injection Control (UIC) wells for Carbon Dioxide sequestration and Class V UIC wells for stormwater management.	No specific existing actions.
An increase in regulated industrial activities in Alaska may result as the melting of sea ice opens new areas for activities.	No specific existing actions.

Facilities and Operations

Vulnerability	Action(s)
Drinking water may be limited and an increase in demand for air conditioning is possible due to increasing drought frequency and intensity.	No specific existing actions.

Operations of Region 10 facilities may be impacted by increasing risk of floods and increasing intensity of storms.	Continuing to support the Regional Support Corps by deploying staff for varying emergency response efforts

Tribal and Vulnerable Populations

Vulnerability	Action(s)
Vulnerable population such as children, the elderly, poor, and the infirm may be at increased health risk due to increased temperatures, failing infrastructure, and extreme weather events.	Support the Rural Alaska Children's Health Initiative which works to protect children from harmful environmental exposures in rural Alaska, including factors related to climate change. Through work on children's health, develop and host training for professionals in the housing, health and educational fields on making indoor environments healthier for the most vulnerable populations. Provide technical assistance and training to affected communities on risks associated with poor outdoor air quality (e.g., work with Tribal Air Program and convene Rural Alaska Children's Environmental Initiative). Outreach/risk communication to vulnerable and economically deprived communities.
Food security for native Alaskans and Tribal people in the Pacific Northwest who live a subsistence lifestyle may be at risk due to warming associated with climate change.	Support Tribes to develop adaptation actions (plans), to document that impact from climate change and to engage in the collaboration with local, state and federal agencies working on broad based adaptation plans. Provide GAP funding as appropriate to Tribes with climate change in their GAP workplans to do baseline environmental assessments and support adaptation planning.
Increased erosion of shorelines is likely to increase risk to coastal native villages due to increased intensity of coastal storms and rising sea levels.	No specific existing actions.
Decreased access to clean drinking water is very likely due to loss of permafrost.	No specific existing actions.
Reduced availability of fish and shellfish resources is occurring now and is likely to increase due to changing water conditions.	No specific existing actions.
Training and Outreach which will address all vulnerabilities.	Raise awareness by providing educational outreach, training, and webinars to Tribes and work with the Institute for Tribal Environmental Professionals on tribal climate change adaptation models and resources.

Training and Outreach (supports all the goals)

Vulnerability	Action(s)
General training and outreach that supports all the goals and programs	Provide outreach/trainings to increase awareness of climate science to regional staff, and work with staff to incorporate climate science into their work programs. Communicate with the public about hazards posed by climate change and actions being taken by the EPA to address climate change. Coordinate with other federal agencies by participating on Climate Change Cooperative and supporting the Regional Landscape Conservation Cooperatives.

Appendix E: EPA Region 10 Approach for Measuring Success

Several key steps to developing the Region 10 approach to meeting our Strategic Alignment Plan, measuring our progress, and adapting as we go are discussed below. In Region 10 we have identified a point of contact (POCs) for each of our offices to assist with developing the Implementation Plan and they will have a critical role in collecting measures from their offices.

Collate the measures and reporting requirements for the existing actions.
Section 3 identifies existing actions that Region 10 has underway. Many actions are part of the Region 10 Strategic Alignment Plan and SMART (Specific, Measurable, Attainable, Relevant and Time-sensitive) and some may have measures associated with them. These available measures will be collated. For all other actions, we will seek clarification through our POC network on the status of development of SMART measures and how to prioritize completion of the SMART process.

Consider developing Logic Model as the underlying framework for Measures.
Under a Logic Model, the ultimate goal is to measure changes, commonly called outcomes, which often are changes in behavior. In the figure below shared nationally by the Office of Water, goals of awareness are followed by the desired behavior that climate science is incorporated into federal policies and programs. Measures of outcomes also benefit from determining a baseline condition as well as benchmarks for success. Both of these will be considered in implementing the Region 10 approach.

The Logic Model example below is based on the following considerations:

- Diagram/Text illustrating the relationships among program elements
- Identifies key activities, "players", and expected results
- Identifies program span of control and external influences
- Span of control: Region 10 only has direct influence over key activities & outputs

The model is developed keeping in mind that:

- To meet ultimate goals, Region 10 will seek to change the attitudes, knowledge, and behavior of others (outcomes).
- The challenge of the measurement approach is to balance output vs outcome measurement.
- In order to obtain Buy-In we will clearly define the purpose of the measurement effort to staff (how will the information be used) and minimize staff time needed to report the measures.
- We will need to address Measurement "apprehension": Programs recognize progress toward outcomes is important, but hesitate to be held "accountable" for things outside their direct control.

Consider existing climate vulnerabilities in refining/selecting Measures.
For climate change adaptation, successful adaptation would be measured against conditions we do not expect to face for several decades. However, some conditions are occurring now and actions in response to these conditions are ones where meaningful measures of outcomes could be generated. In Region 10, particularly Alaska, we are seeing accelerated changes that are documented in our vulnerability analysis. And, in Puget Sound, ocean acidification is already affecting larval cultures of oyster growers.

Include other considerations in refining/selecting Metrics:
How many measures are too many?
How "measureable" are the metrics (precision of language, access & availability of data)?
Output (short term) vs. Outcome (longer term) Focus
Challenges to Analysis:
How will reporting and analysis take place (process)

How information can/will be presented to meet the needs of key stakeholders (utility)
Retaining the flexibility to modify the measurement framework as the program "learns" vs. need to retain core metrics for comparability.

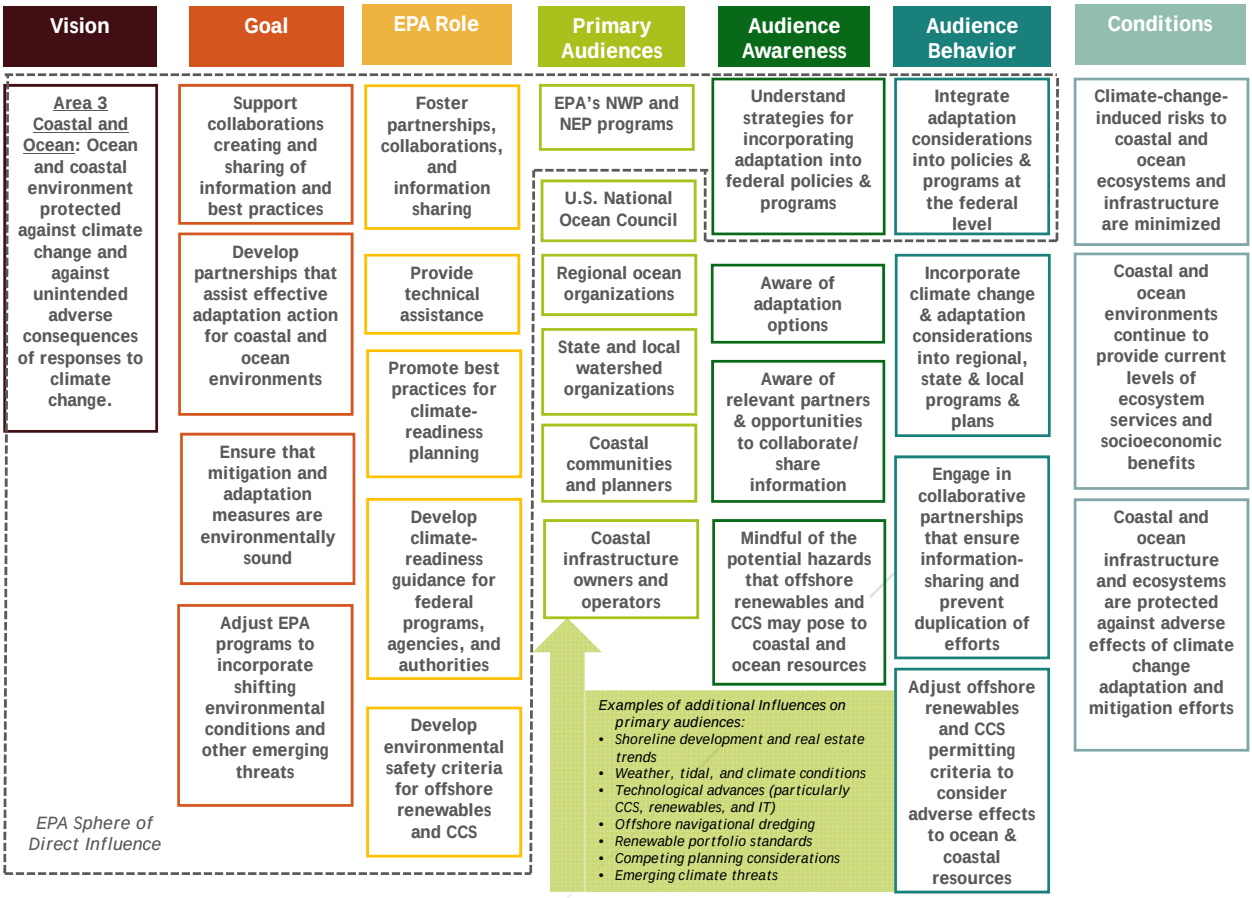
Learn from other regions and the national program.
The key areas Region 10 will look for concerning measures are specific benchmarks/ commitments, ease of reporting, matching with national and regional reporting requirements, ability to adapt/adjust measures in the future, how closely measures relate to outcomes, and how other efforts have developed measures based on immediacy of vulnerabilities (for example, how hurricane Sandy and other recent extreme events have shaped measures developed for the east coast).

How to track and report progress

- Consider an annual *Highlights of Progress* document that is excerpted from the existing Region 10 reporting requirements and provided in a useful format common to other regions and national programs
- Consider how our strategic action contacts would report internally on adaptive management phase, with guidance provided from the Climate Change Science Advisor
- Region 10 Strategic Alignment could include an adaptive management phase at the Goal level in Highlights of Progress.
- The Climate Change Science Advisor will use the Evaluation and state of management phase to:
    - Inform any needed changes to the Region 10 Climate Change Adaptation Strategy.
    - Identify appropriate performance measures for measuring the effectiveness of the Strategy.

Document regional program awareness and use of climate science even as we develop measures.
Even without a logic model structure in place for climate change adaptation actions, in Region 10 we are seeing awareness of the availability and use of climate science increasing, and can begin to document this trend. An example is awareness and use of climate science and tools in our Office of Water and Watersheds TMDL program. For approximately the past two years, we have been conducting an ongoing pilot project where we have been incorporating climate science into an ongoing temperature TMDL. As follow-on to this process, the TMDL unit in March 2013, held an internal demonstration of where to find downscaled 7Q10 flow data projections under climate change scenario models on an interactive website. Similarly, our regional wetlands program led (co-sponsored with our Region 10 Science Steering Council) a workshop on new tools to assess the impact of climate change on wetlands.

Office of Water, Logic model example:


Vision
Goal
EPA Role
Primary Audiences
Audience Awareness
Audience Behavior
Conditions
Area 3 Coastal and Ocean: Ocean and coastal environment protected against climate change and against unintended adverse consequences of responses to climate change.
Support collaborations creating and sharing of information and best practices
Develop partnerships that assist effective adaptation action for coastal and ocean environments
Ensure that mitigation and adaptation measures are environmentally sound
Adjust EPA programs to incorporate shifting environmental conditions and other emerging threats
Foster partnerships, collaborations, and information sharing
Provide technical assistance
Promote best practices for climate-readiness planning
Develop climate-readiness guidance for federal programs, agencies, and authorities
Develop environmental safety criteria for offshore renewables and CCS
EPA's NWP and NEP programs
U.S. National Ocean Council
Regional ocean organizations
State and local watershed organizations
Coastal communities and planners
Coastal infrastructure owners and operators
Understand strategies for incorporating adaptation into federal policies & programs
Aware of adaptation options
Aware of relevant partners & opportunities to collaborate/ share information
Mindful of the potential hazards that offshore renewables and CCS may pose to coastal and ocean resources
Integrate adaptation considerations into policies & programs at the federal level
Incorporate climate change & adaptation considerations into regional, state & local programs & plans
Engage in collaborative partnerships that ensure information-sharing and prevent duplication of efforts
Adjust offshore renewables and CCS permitting criteria to consider adverse effects to ocean & coastal resources
Climate-change-induced risks to coastal and ocean ecosystems and infrastructure are minimized
Coastal and ocean environments continue to provide current levels of ecosystem services and socioeconomic benefits
Coastal and ocean infrastructure and ecosystems are protected against adverse effects of climate change adaptation and mitigation efforts
EPA Sphere of Direct Influence
Examples of additional Influences on primary audiences:
• Shoreline development and real estate trends
• Weather, tidal, and climate conditions
• Technological advances (particularly CCS, renewables, and IT)
• Offshore navigational dredging
• Renewable portfolio standards
• Competing planning considerations
• Emerging climate threats