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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

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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.

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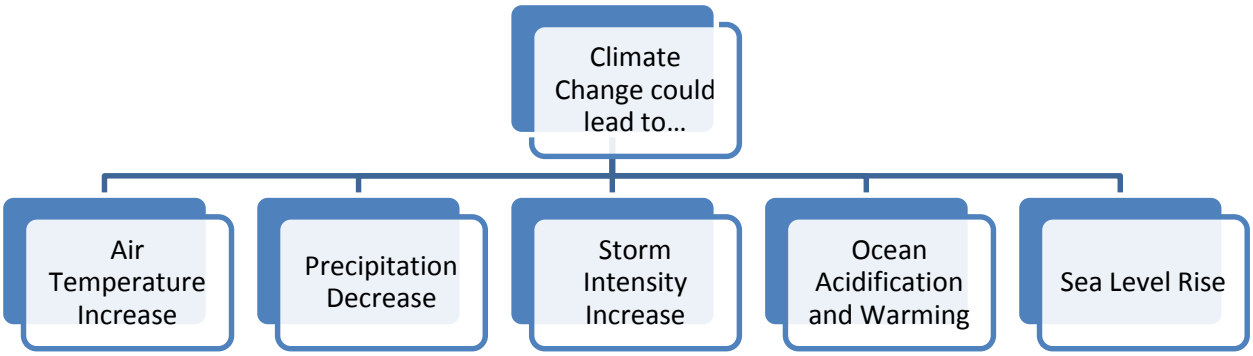
II. Impacts from Climate Change in EPA Region 9

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

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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

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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]

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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]

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- 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

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- 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]"

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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*

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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

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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

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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.

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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.

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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.

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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]

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- 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);

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- 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.

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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).

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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.

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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.

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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.

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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.

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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)

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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[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."

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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.

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- 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.

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- 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.

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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.

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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

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[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/

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