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DRAFT

US EPA Region 4

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.

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September 2013

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PART 1

INTRODUCTION & BACKGROUND

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I. Background and Direction

Pursuant to Executive Order 13514, *Federal Leadership in Environmental and Energy Performance*, all federal agencies are tasked with evaluating agency climate-change risks and vulnerabilities to manage short- and long-term climate-change effects on each agency's mission, programs, and operations.[1] Federal agencies are required to evaluate climate risks, identify program vulnerabilities, and prioritize activities to reduce their climate risk.[2]

Consistent with EO 13513, EPA issued its first Policy Statement on Climate-Change Adaptation in June 2011[3] calling for EPA to develop and implement an agency-wide Climate Change Adaptation Plan to integrate climate adaptation into its programs, policies, rules and operations. Every EPA Program and Regional Office was directed to develop their own, independent, stand-alone Climate Change Adaptation Implementation Plan to identify how priorities will be met and the agency-wide plan implemented. These Program and Regional Office-identified priorities are to be reflected in annual budget submissions.

The Agency's draft Climate Change Adaptation Plan includes a national-level qualitative assessment of EPA-program vulnerabilities. The Regions are tasked with using this plan to guide their adaptation planning.[4] Each Region is to capture its regional uniqueness, identify vulnerabilities of greatest importance including its vulnerable people and places. EPA expects the severity and importance of identified program vulnerabilities to vary reflecting projected regional climate-change impact projections. The Regions' plans are expected to describe how climate change adaptation is to be integrated into their planning and work in a manner consistent and compatible with their own circumstances and objectives. The following provides Region 4's *texture* called for in the Agency's Climate Change Adaptation Plan.

II. Description of EPA Region 4

The eight states comprising Region 4 make it EPA's most southeasterly region. Alabama, Georgia, Florida, Kentucky, North and South Carolinas, and Tennessee plus six federally-recognized tribes comprise Region 4, see Figure 1 below. EPA Region 4's borders are primarily large water-bodies: the Mississippi River to the west, the Ohio River to the north, the South Atlantic Ocean to the east, and the Gulf of Mexico to the south. The Region is dissected by several major river basins. Nine of these basins drain into the South Atlantic while eight drain into the Gulf of Mexico. Consequently, the Region is rich with aquatic ecosystems, barrier islands, beaches, estuaries, and wetlands supporting important industries of fishing, recreation, transportation, and tourism. The Region has numerous coastal and inland ports with associated transportation hubs. Every state has a port. The Region has more river ports than sea ports, for example the State of Mississippi has four Gulf ports and 12 river ports.[5] Florida has 15 seaports, the most of any Region 4 state.[6]

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A. Climate Patterns

Region 4's climate is predominately mild, humid, and subtropical, with southern Florida being primarily humid subtropical to tropical savanna. The Region is characteristically hot and humid in the summer with mild winters. The Central Appalachian, Western Allegheny, and portions of the Blue Ridge and the Ridge and Valley ecoregions (see the next section, *EPA Region 4's Ecoregions*) can experience cold winters and have the least number of frost-free days, ranging from 125 - 200.

For most of Region 4, the number of frost-free days ranges from 170 to 360, with the coastal areas experiencing the most. The southern part of Florida is nearly frost free and is the only ecoregion in the continental U.S. to have the climate, hydrology, vegetation, and terrain characteristics of tropical wet forests.[7] The annual mean temperature for Region 4 ranges from 55 to 77°F with the more mountainous ecoregions having the coolest, ranging from 55 to 63°F. Precipitation ranges from 35 to 59 inches in the Piedmont, Ridge and Valley, and Western Allegheny ecoregions, to between 43 and 65 inches for the rest of the Region.

1. Climate Factors

a) Weather Phenomena

(1) The Bermuda High

The Bermuda High is a semi-permanent high-pressure area usually centered in the vicinity of Bermuda during the spring and summer. Prolonged heat waves in the East are attributed to the Bermuda High. Weather fluctuates in response to its east - west migrations. The Bermuda High can move high-moisture tropical air masses west over land causing showers and thunderstorms. When it is east over the Atlantic Ocean, hurricanes tend to curve out to sea avoiding land. When it is west toward land, hurricanes tend to impact the nation's East and Gulf Coasts.

(2) El Niño-Southern Oscillation

The El Niño-Southern Oscillation is a cyclic Pacific Ocean weather pattern in which the sea-surface temperature cycles between abnormal warming (El Niño) and cooling (La Niña) conditions, influenced by changes (oscillations) in atmospheric pressure between the tropical east and west Pacific (the Southern Oscillation (SO)).

(3) North Atlantic Oscillation

The North Atlantic Oscillation (NAO) describes fluctuations in atmospheric pressure differences between permanent low- and high-pressure systems. While the NAO directly influences Western Europe's climate, it may impact much of eastern North America's weather.

b) Large water bodies

(1) Mississippi and Ohio Rivers

The Mississippi and Ohio Rivers delineate EPA Region 4's western and most of its northern geographic borders, respectively. Two major coastal water bodies, the Atlantic Ocean and the

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Gulf of Mexico, delineate its eastern and southern borders, respectively. These water bodies strongly influence the Region's climate. Large water bodies take longer to heat up and cool down than land, such that land areas in the vicinity of large water bodies remain cooler in summer and warmer in winter.

(2) Gulf Stream

The Region's climate is strongly influenced by the Gulf Stream, which flows seven hundred miles north from Key West, FL, to Cape Hatteras, NC. It is a strong, fast moving, warm ocean current. The Gulf Stream's surface temperature ranges 80°F and above due to the solar heating of tropical Atlantic and Caribbean waters. The Gulf Stream system's warm surface-temperature causes Florida and much of the Southeast to be mild all year round. The warm sea-surface temperature also aids the formation and strengthening of hurricanes moving through the Gulf of Mexico.

c) Topography

Lastly, the Region's topography is highly diverse, ranging from the Mississippi River Valley Plain to the west, the southeastern and southern coastal plains of the Atlantic and Gulf Coasts, the interior Piedmont's rolling low plateaus, the Southern Appalachian Mountains, and the inland, elevated, and severely eroded Cumberland Plateau extending from Alabama through Tennessee to Kentucky. Various weather patterns intersect with this diverse topography to create numerous microclimates, facilitating the variety of ecosystems and species diversity characteristic of EPA Region 4.

B. EPA Region 4's Ecosystems

Because of its climate, proximity to large water-bodies, and topography, EPA Region 4 has tremendous aquatic ecosystems and associated biodiversity. It is overlain by fourteen ecoregions.[8] Half are in the Southern Appalachians where the mountains interact with local weather patterns in complex ways, creating numerous local microclimates. Precipitation responses are especially sensitive to the shape of mountain ranges and wind flow direction.[9] Two of the Region's ecoregions are riverine in character: one is the Piedmont, and the other coastal, including the Everglades' subtropical wetlands.

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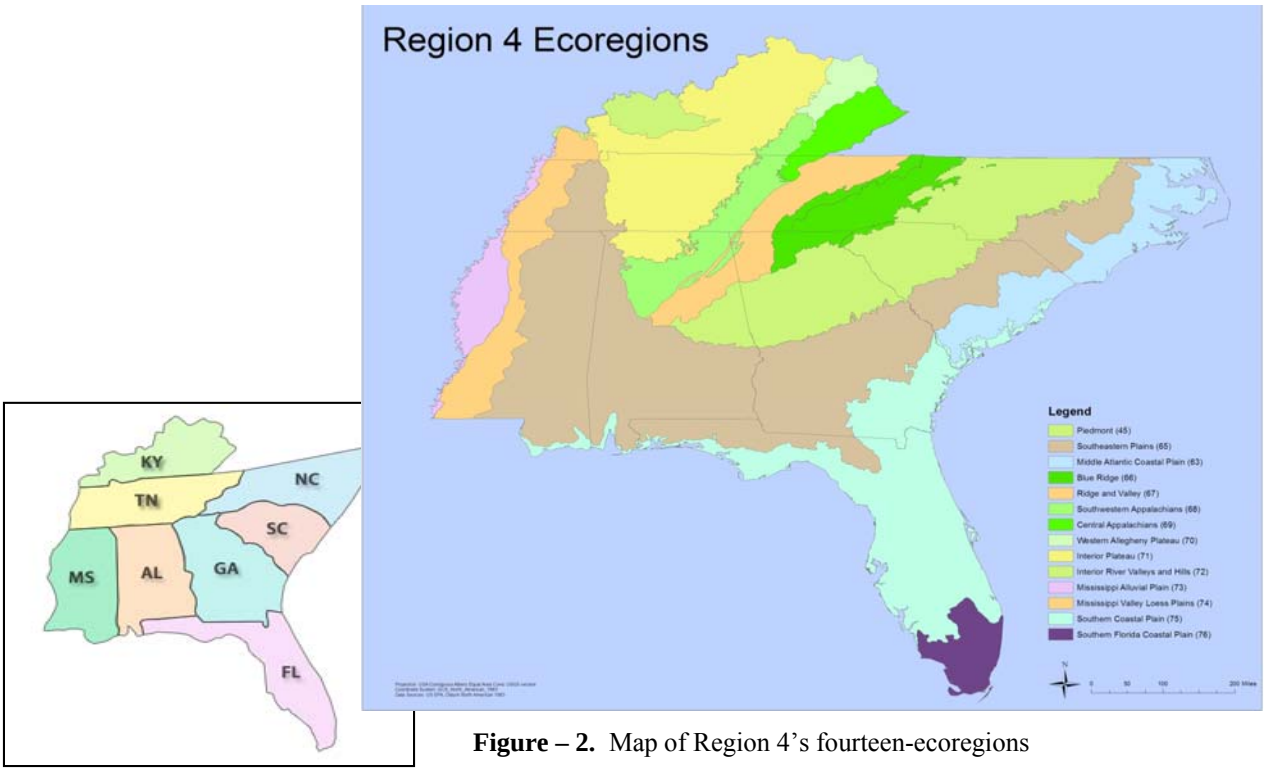

Figure – 2. Map of Region 4's fourteen-ecoregions

1. Overview of Ecosystems

Most of EPA Region 4's land area lies within the *Piedmont*, *Southeast Plains*, and the *Southern Coastal Plain* ecoregions, see Figure 2.[10] Three ecoregions, the *Piedmont, Mississippi Alluvial Plain,* and the *Southern Florida Coastal Plain* (the Everglades) have undergone extensive land-use changes. The Piedmont has experienced several major land-cover transformations over the past 200 years: forest to farm, back to forest, and spreading urban- and suburbanization. The *Mississippi Alluvial Plain* is one of the nation's most altered ecoregions, extensively cleared for cultivation where bottomland hardwood forests once dominated. The Everglades, or the *Southern Florida Coastal Plain,* has undergone extensive hydrological and biological alterations.[11]

Mountain top, surface, and underground bituminous coal mining occurs within four of the southern Appalachians ecoregions. Mining is extensive in the *Interior River Valleys and Hills* and the *Western Allegheny Plateau* ecoregions, common in the *Central Appalachians,* and occurs in several parts the *Southwestern Appalachians* ecoregion. Significant habitat loss and water-quality degradation, particularly sedimentation and acidification of many the ecoregions' water bodies are coal mining's legacy.[12] Within Region 4, the *Interior River Valleys and Hills* and the *Western Allegheny Plateau* ecoregions only occur within the Commonwealth of Kentucky.[13]

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Agriculture occurs in 11 of the Region's ecoregions in the form of pulpwood and lumber pine plantations, beef pasture, cropland (planted with wheat, blueberries, corn, cotton, soybeans, peanuts, onions, sweet potatoes, melons, tobacco, or rice), citrus groves in the south, poultry and hog livestock, and dairy farming. In the *Mississippi Alluvial Plain,* extensive agricultural land-use occurs with most of the ecoregion planted in soybeans, cotton, corn, rice, wheat, and pasture, and some sugarcane in the south. Pine plantations are common in the *Southeast Plains* and the *Middle Atlantic Coastal Plain* ecoregions, and occasional in the *Ridge and Valley*. The *Middle Atlantic Coastal Plain* has a high density of chicken, turkey, and hog production in some areas, with North Carolina the second-largest hog producing state in the nation. The *Southeast Plains* ecoregion also supports poultry and hogs.[14]

The 2007 Census of Agriculture counted 6,409 farmers and ranchers reporting aquaculture sales in the United States; the three states with the largest number of operations with sales were Florida, Louisiana and Mississippi. Catfish and crawfish are commercially produced in ponds in the *Mississippi Alluvial Plain*.[15] More than 50 percent of the total value of sales from aquaculture come from the top five states, including Mississippi ($237.9 million).[16]

The Region's forests are mostly located within 5 ecoregions. The *Blue Ridge* ecoregion contains one of the richest temperate broadleaf forests in the world, with a high diversity of plants within the large areas of National Forest, National Parks and state-owned lands. The *Western Allegheny Plateau* ecoregion is mostly forested, with public national forest lands, and logging a predominant activity. Forest uses prevail within the *Central Appalachians* and *Southwestern Appalachians* ecoregions. The *Mississippi Alluvial Plain*'s floodplain forest ecosystems include river and hardwood swamp forests. The ecoregion is still a major bird migration corridor despite the widespread loss of forest and wetland habitat. The *Interior River Valleys and Hills* ecoregion is partially forested.[17]

Between 1973 and 2000, the Southeast Climate Region had the highest rate of change due to active forest timber harvesting and replanting.[18] In this region, forests, not cropland, are expected to be lost.[19] Projected land-use and land-cover changes likely will depend upon population rates and economic growth.[20] The exurban and suburban areas generally are projected to expand by 15 to 20 percent between 2000 and 2050.[21] Climate change will cumulatively impact the existing and projected land-use changes to the Region's ecoregions. Aquatic ecosystems in those ecoregions where mining already provides significant stress and where forests are converted to other uses may likely be less resilient to climate-change impacts.

2. Determining Climate Change Impacts to Aquatic Ecosystems

EPA and its state partners use aquatic bio-assessments to evaluate biological criteria to determine whether CWA-regulated surface waters are maintaining their biological integrity consistent with their designated use, e.g., cold-water fishery.[22]

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To monitor stream health, states are delineated into bioregions to organize similar sampling sites together; i.e., those having similar stream physical, chemical, and biological attributes. These bioregions often mirror ecoregion boundaries. Since all of the streams within a bioregion generally have similar attributes, the differences in aquatic organism assemblages between reference sites (which receive high biological index scores) and stressed sites (which receive low index scores) are typically expected to reflect human impacts, e.g., land-use changes.

Table 1. The Number of Ecoregions and Bioregions by State

State	Level III Ecoregions[1]	Level IV Ecoregions[2]	Macroinvertebrate bioregions	Fish Bioregions	Algae Bioregions
AL	6	29	2 (high and low gradient streams)	NA[3]	NA
FL	3	16	3	NA	NA
GA	6	28	24	4	NA
KY	7	25	4	6	4
MS	4	21	4	NA	NA
NC	4	28	3	5	NA
SC	5	12	3	NA	NA
TN	8	31	15	NA	3

1: Ecoregions along the coast (Southern Florida Coastal Plain (76), Southern Coastal Plain (75), Mississippi Alluvial Plain (73), and Middle Atlantic Coastal Plain (63)) do not have aquatic communities that currently support index development and are not included in any bioregions.
2: Level IV Ecoregions are subunits of Level III, see: http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm#Level IV
3: All "Not Applicable" cells represent a state that does not use that index for making regulatory decisions (though most states are in the process of developing new indices or may use that assemblage for other monitoring purposes, like evaluating best management practices.) Information was gathered from Standard Operating Procedures for biomonitoring and index development papers that states operated under in 2011.

If climate change were to cause streams in the same bioregion to become dissimilar, it could hinder EPA and the states' ability to determine low index-score causes, i.e., human versus climate-change induced impacts. Biological monitoring and assessment program success will require an understanding of what and how climate-associated changes are occurring and how monitoring programs can account for them.[23] Likely climate-change impacts to Region 4's freshwater aquatic ecosystems are described below but further research is necessary to determine actual impacts.

a) Climate-Change Induced Temperature Impacts

In EPA Region 4, climate change-associated warmer water temperatures are expected to drive aquatic species to cooler waters, either north or to higher elevations. Local extinctions are expected where migration barriers exist, e.g., dams, reservoirs, logging, mountain-top mining,

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etc., and a lack of higher elevations. In Region 4, cold-water habitat is generally associated with its mountain and high-elevation plateau ecoregions of the Southern Appalachians, i.e., the Piedmont, Ridge and Valley, Blue Ridge, Central Appalachian, Western Allegheny and Interior Plateau, Interior River Valley and Hills ecoregions.[24] For example in North Carolina, the mountain ecoregion and higher elevation sites generally have the highest cold-water taxa richness, which are expected to shift either north or to higher elevation as temperatures increase.[25] While the cold-water tax either migrate to cooler water conditions or are subject to local extinctions, those species thriving in warm temperatures or which are tolerant to warmer temperatures, will likely increase their populations at their current location and extend their range into formerly colder-water habitat.[26]

At this time, it is uncertain where the greatest climate change-induced impacts to aquatic organisms and their ecosystems within the Region may occur: in the transitional areas aquatic species may already be close to their temperature tolerance limits, while species may be more sensitive in those coldwater habitats expected to experience warming. Within Region 4, the Piedmont (the transitional area) and Mountain (coldwater habitat) ecoregions are expected to see the greatest climate-change impacts to its aquatic ecosystems.[27] Predictions are further confounded by the probability that temperature change likely will not occur evenly across the Region. The Region finds it difficult to predict how warm- and cold-water taxa will respond to changing water temperatures since other environmental factors, e.g., land-use changes, also strongly influence species' population densities and geographic distributions

b) Climate-Change Induced Water Flow Impacts

Biological integrity is strongly correlated with stream flow.[28] Expected climate change-related impacts to the Region 4's aquatic ecosystems include longer durations of low summer stream flows, average stream flow decreases, higher flooding incidences, and increased periods of extremely high and low flows (greater flashiness), with resultant scouring. Scouring and sedimentation already negatively impact habitat and biota in Piedmont streams, and more frequent severe precipitation events may exacerbate those impacts.

Insect-rich habitat-diversity tends to decrease with decreasing flow.[29] Under lower flow conditions, non-flowing (lakes and ponds) fish and insect community populations tend to increase while those requiring flowing water to survive decrease. Additionally, drought or flood-related stream-flow changes can change nutrient and sediment loadings and habitat availability.[30] Moreover, lower flow results in less dilution facilitating higher in stream concentrations of potentially harmful chemicals and aquatic toxicity. Overall, climate change-induced flow changes are expected to cause significant changes to the Region's aquatic communities.[31]

At a reduced flow of 20-90%, the Region could lose 3 to 38% of its fish species.[32] The North Carolina Department of Environment and Natural Resources (NCDENR) researched invertebrate responses to the 1999 to 2002 drought experienced by both North and South Carolina. The study found a decline in invertebrate communities. NCDENR found stream flow, drainage area,

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underlying geology, and the tributary stream type and size appeared to influence invertebrate species' degree of impact and resiliency, i.e., speed of recovery to drought.[33]

NCDENR also studied tropical and hurricane storm-related flooding impacts to invertebrate species and stream health. In 2004, North Carolina experienced five tropical Storms (Bonnie, Frances, Gaston, Ivan, and Jeanne) and two hurricanes (Alex and Charley) during a two-month period (August 3 – September 27). During its study, NCDENR documented a decline in biological index scores associated with the invertebrate species' responses to the storm-related flooding.[34]

C. EPA Region 4's Communities

Region 4's mild climate, extensive coasts, and large river basins attract people, both for residential and recreational purposes. Within its geographic borders, the Region is home to a population of 61,762,344.[35] The State of Florida's population, 19,057,542, is greater than the individual populations of four EPA regions (see figure 3 below). The Region's population of children and elderly comprise approximately 6.1 and 14 percent, respectively, of the Region's total population. The Region is home to six federally-recognized tribes, with a population of 33,500 enrolled members.

All eight states had positive growth from 2000 through 2010, with the overall regional population growing by 8.9 million people, about 13%.[36] The population grew fastest in North Carolina (18.5%), Georgia (18.3%), Florida (17.6%), and South Carolina (15.3%). Most of this growth has been in urban and peri-urban areas. Population growth is expected to compound climate-related impacts. For example, increasing urban and suburban competition for finite water resources likely will affect agriculture, aquatic ecosystems, energy production, fisheries, and natural ecosystems.[37]

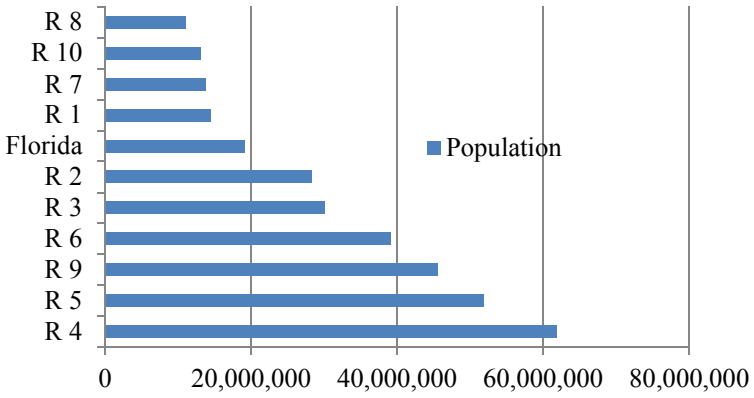

Figure-3. EPA Region population comparisons.

By 2030, Florida, Georgia, and North Carolina are projected to have some of the largest elderly American populations.[38] All three states are in the top ten projected to have the largest numbers of Americans aged 60 and older. Florida, with 9,737,256 elderly, is projected to be second only to the State of California, with a projected elderly population of 10,595,771 by 2030.

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Most of Region 4's population lies within the *Piedmont*, *Southern Coastal Plain*, *Southeastern Plains*, *Interior Plateau*, and *Southern Florida Coastal Plain* ecoregions. Within the *Southern Florida Coastal Plain* (the Everglades), urban areas are extensive along the Atlantic Coast and include Miami, Fort Lauderdale, West Palm Beach, and other adjacent coastal cities.[39]

The Southeast Climate Region (see the following section, *Observed and Projected Climate Change in Region 4*) includes 28 of the top 100 metropolitan statistical areas by population, and is the second most urbanized region after the Northeast, having 131 persons-per-square mile. Miami (#8), Atlanta (#9), Tampa (#18), and Orlando (#26) all rank in the top 30 of U.S. urban centers.[40] The Region has three of the ten fastest-growing areas: the Florida areas of Palm Coast and Cape Coral-Fort Meyers, and Myrtle Beach, SC.[41] All three areas are along the coast and vulnerable to sea-level rise and storm surge.[42] Since 1980, the Southeast has had more billion-dollar weather disasters (hurricanes, floods, and tornadoes) than any other region.[43]

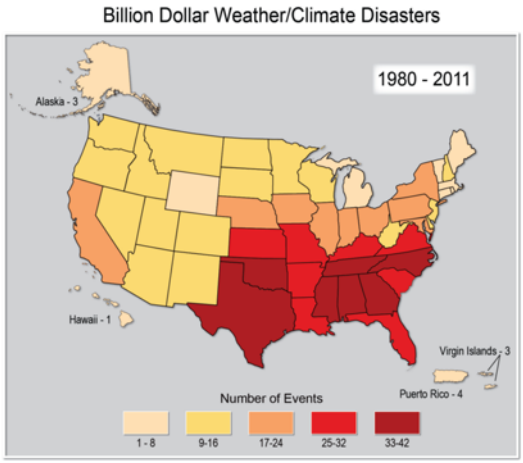

Figure 4.[44]

Billion Dollar Weather/Climate Disasters (1980-2011). This map summarizes the number of weather and climate disasters over the past 30 years that have resulted in more than a billion dollars in damages.

III. Observed and Projected Climate Change in Region 4

This section summarizes climate change impacts anticipated for EPA Region 4. The climate change literature defines the Southeast Climate Region differently than EPA defines its southeastern region. The Southeast Climate Region is defined to include all of the EPA Region 4 states plus Arkansas, Louisiana, two of EPA Region 6 states, and Virginia, one of EPA Region3's states.

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Figure 11. - Map of EPA Region 4

Figure 12. – Map of the Southeast Climate Region

The Southeast Climate Region is exceptionally vulnerable to sea-level rise, extreme heat events, and decreased water availability. Within this Region the spatial distribution of these impacts and vulnerabilities is uneven, since it encompasses a wide range of ecoregions, from the Appalachian Mountains to the coast.[45] The high variability of the Region's climate makes it difficult to assess the impacts of variability from climate change.

The Southeast Climate Region is home to more than 80 million people, drawing hundreds of million visitors every year.[46] Located in low-lying coastal areas particularly vulnerable to flooding, extreme storms, and sea-level rise, this Region has a disproportionate number of the country's fastest growing metropolitan areas and important economic sectors.[47] Palm Coast, FL, Cape Coral-Fort Meyers, FL, and Myrtle Beach, SC, are all vulnerable to sea-level rise and storm surge.[48]

Sea-level rise and temperature and precipitation changes are expected to be the most severe and widespread anticipated impacts to the Region, which ultimately may affect water availability.[49] The vulnerable Gulf and Atlantic coasts are major producers of seafood and home to several ports.[50] The Southeast Climate Region is a major energy producer of coal, crude oil, and natural gas, and the highest energy user of any of the National Climate Assessment regions.[51] Changes in land use and land cover, more rapid in the Southeast than most other areas of the country, often interact with and serve to amplify the effects of climate change on southeastern ecosystems.[52]

A. Temperature

1. Observed

Average annual temperature during the last century cycled between warm and cool periods across the Southeast Climate Region.[53] A warm peak occurred during the 1930s and 40s, followed by a cool period in the 60s and 70s, and warmed again from 1970 to the present by an average of 2°F, with more warming occurring during summer months.[54] Since 1970, the number

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of days above 95°F and nights above 75°F have increased, while the number of extremely cold days has decreased.[55]

2. Projected

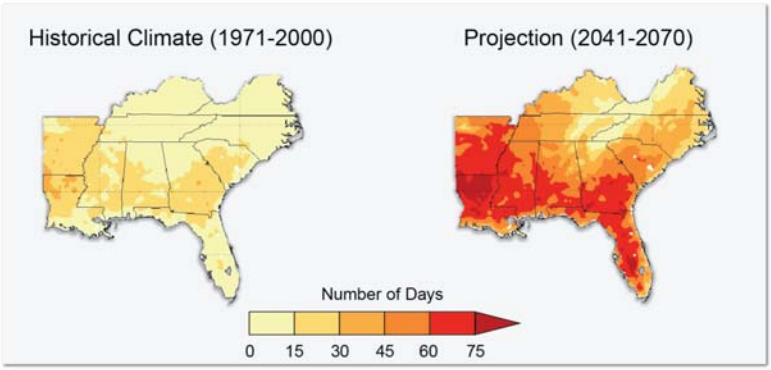

Figure 13. The projected number of days exceeding 95°F.

Temperatures across the Southeast Climate Region are expected to increase during this century, fluctuating over time because of natural climate variability (annually and decade-to-decade).[56] Major warming consequences include significant increases in the number of hot days exceeding 95°F and decreases in freezing events.[57] Projections for the region by 2100 include increases of 10°F for interior states of the Region with a regional average increase ranging from 2°F to 6°F.[58]

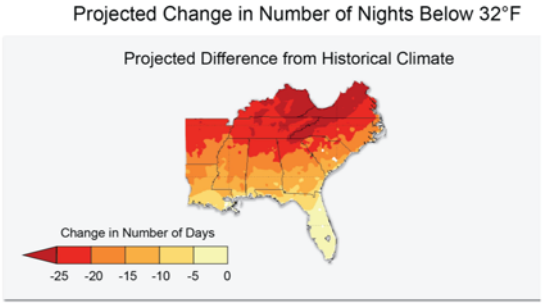

Figure 14. Projected Number of Nights below 32°F[59]

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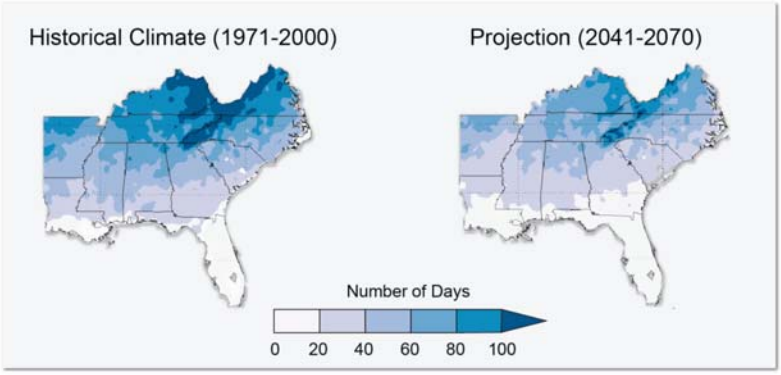

Figure 15. Projected annual number of days with temperatures less that 32°F for 2041-3 2070 compared to 1971-2000, assuming emissions continue to grow (A2 scenario).[60]

Summer heat stress is projected to reduce crop productivity, especially when coupled with increased drought. The 2007 drought cost the Georgia agriculture industry $339 million in crop losses, and the 2002 drought cost North Carolina $398 million.[61] A 2.2ºF increase in temperature could reduce overall productivity for corn, soybeans, rice, cotton, and peanuts across the South – although rising CO_2 levels might partially offset these decreases, based on a crop yield simulation model.[62] In Georgia, climate projections indicate corn yields could decline by 15% and wheat yields by 20% through 2020.[63]

3. Extreme Heat Events

Rising temperatures and the associated increases in frequency, intensity, and duration of extreme heat events are expected to affect public health, natural and built environments, energy, agriculture, and forestry.[64] The negative effects of heat on human cardiovascular, cerebral, and respiratory systems have been established.[65] Within EPA Region 4, Atlanta, Miami, and Tampa have already seen increases in the number of days with temperatures exceeding 95ºF, during which the number of deaths was above average.[66] The expected increase in elderly population of the Region enhances the health risks of extreme heat events. By 2100, the Southeast Climate Region is expected to have the highest increase in heat index, the measure of comfort combining temperature and relative humidity, of any region of the country.[67] Additionally, higher temperatures can contribute to the formation of harmful air pollutants and allergens, with associated health impacts.[68] Ground-level ozone is projected to increase in the Southeast Climate Region's largest urban areas, potentially leading to increased deaths.[69] Hospital admissions for respiratory illnesses, emergency room visits for asthma, and lost school days may increase.[70]

A. Precipitation

1. Observed

The Gulf Coast regions of Mississippi, Alabama, and the Florida Panhandle receive over 60 inches of precipitation, while much of northern Kentucky, the central sections of the North and South Carolinas, and Georgia receive between 40 and 50 inches of precipitation annually.[71] Higher amounts of precipitation are found along the Atlantic coast and across the Florida

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Peninsula due in part to the lifting of the air associated with sea breeze circulation.[72] Tropical cyclones also contribute significantly to annual precipitation totals in the Region, especially over the Southeast Atlantic coast.[73] The Southeast Climate Region's wettest locations occur in southwestern North Carolina.[74] The Region's daily and five-day rainfall intensities have increased while summers have been either extremely wet or increasingly dry.[75] Only along the northern Gulf Coast has precipitation increased during the last 100 years.[76]

Across the Southeast Climate Region's northern tier, the average annual snowfall ranges from 5 to 25 inches, except at the higher elevations of the southern Appalachians in North Carolina and Tennessee.[77] These locations can receive up to 100 inches of snowfall annually, comparable to annual snowfall amounts experienced in New England.[78] The Region's southern extent experiences very little snowfall (i.e., less than 1 inch per year) and several years may elapse before any measurable snowfall occurs.[79]

2. Projected

Future precipitation-pattern projections are more uncertain than temperature projections.[80] Under a *high* greenhouse-gas-emission scenario, average changes in annual precipitation range from nearly 10% reduction in the far southern and western portions of the Region – with most of that reduction in the summer – to about 5% increases in the northeastern part of the Region by later this century.[81] Average annual precipitation is projected to decrease by 2% to 4% over South Florida, while increases in precipitation of up to 6% are projected across North Carolina.[82] Precipitation is expected to increase across most of the Southeast Climate Region in all seasons except summer, where a decrease of 15% is noted for South Florida.[83]

3. Extreme Events

a) Precipitation

The extreme-precipitation-event frequency has been increasing across the Region, particularly pronounced over the last two decades.[84] This increase is pronounced across the lower Mississippi River Valley and along the northern Gulf Coast.[85] Despite a long-term increase in extreme precipitation events, no discernible trend exists in flood magnitude for the Region.[86] An increased risk of flooding of the Region's urban areas is expected from increases in extreme-precipitation events and the associated increased runoff, compounded by the magnitude of impervious surface that has resulted from increased urbanization.[87]

The annual number of days with extreme precipitation is expected to increase across most of the Region by the mid-21st century, particularly along the southern Appalachians as well as parts of Tennessee and Kentucky.[88]

b) Severe Thunderstorms & Tornadoes

Thunderstorms are frequent across the Southeast Climate Region, especially during the warmer months. Severe thunderstorms, i.e., characterized by winds in excess of 58 mph, hail a

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minimum one inch in diameter, or a tornado, occur most frequently in the late winter and spring months.

Within EPA Region 4, damaging winds and large hail occur most frequently across Alabama, Mississippi, and western Tennessee.[89] These states also experience the highest number of strong tornadoes (F2 and greater) and experience more killer tornadoes than the notorious "Tornado Alley" of the Great Plains.[90]

Cloud-to-ground lightning is a significant hazard. The greatest lightning-strike frequency within the nation occurs across the Gulf Coast and the Florida Peninsula.[91] Additionally, eight of the eleven states comprising the Southeast Climate Region rank in the top 20 for lightning-related fatalities from 1959 to 2006.[92] Cloud-to-ground lightning has started house fires and wildfires.

c) Tropical Storms and Hurricanes

In the Southeastern Climate Region, tropical storms and hurricanes frequently make landfall along North Carolina's Outer Banks and south Florida and rarely appear to land along the concave portions of the coastline, the western bend of Florida and the Georgia coast.[93] Major hurricane (categories 3 to 5) landfalls have been most frequent in South Florida (once every 15 years) and along the northern Gulf Coast (once every 20 years).[94] While these storms primarily impact the coast, significant effects are experienced several hundred miles inland.[95] Storms with wind gusts exceeding 75 mph have occurred every five to 10 years across portions of the Region's coastal plain and every 50 to 75 years across portions of the Carolina Piedmont, central Alabama, and Mississippi.[96]

Tropical storm and hurricane-associated precipitation contribute significantly to the Southeast Climate Region's precipitation, surface and ground water levels, water supply, and soil moisture.[97] Heavy rainfall also periodically causes deadly inland flooding, especially when a storm is large or is stalled by a weather front.[98] Hurricane landfalls appear to have declined slightly over the past century from a decadal frequency perspective.[99]

B. Sea-level rise in Region 4

The National Water Level Observation Network's 150-years database consistently depicts a rise in sea level. From this data, a 0 to 3 millimeter-per-year sea-level rise rate has been estimated off the west Florida, Alabama, and Mississippi coasts.[100] Two data sources, the historical tide-gauge records over the past century and geologic evidence over the past several centuries, indicate steadily rising sea level off North Carolina's coast. The NC Coastal Resources Commission's Science Panel on coastal hazards recommended a projected sea-level rise of one meter by 2100 be adopted for policy development and planning purposes.[101]

Large portions of the Region are highly vulnerable to sea-level rise, although how much sea-level rise is experienced in any particular place depends upon whether and how much the local land is sinking (i.e., subsidence) or rising, and offshore-current changes.[102] Global sea-level rise

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over the 20th century has averaged approximately eight inches. The rise rate is expected to accelerate through the end of this century.[103]

Figure 16 below depicts the relative risk, as determined by the Coastal Vulnerability Index, that physical changes will occur as sea-level rises. The Coastal Vulnerability Index is based on tidal range, wave height, coastal slope, shoreline change, landform and processes, and historical rate of relative sea-level rise. The index estimates a coastal system's susceptibility to change and its natural ability to adapt to changing environmental conditions to formulate an estimation of a system's natural sea-level rise vulnerability or risk.[104]

Figure 16. [105] The Southeast Climate Region's Vulnerability to Sea-Level Rise

In the Southeast Climate Region, numerous cities, roads, railways, ports, airports, oil and gas facilities, and water supplies are in low-elevation areas, making them vulnerable to sea-level rise. The North Carolina Department of Transportation is raising U.S. Highway 64's roadbed by four feet; 18 inches of which is to address sea-level rise projections.[106] The major cities of Miami and Tampa, FL, are among those most at risk. [107]

Sea-level rise impacts upon agriculture may decrease freshwater availability and increase land loss and saltwater intrusion. Salt-water intrusion is projected to reduce the availability of groundwater for irrigation, thereby limiting crop production in some areas.[108] Agricultural areas around Miami-Dade County with shallow groundwater tables are at risk of enhanced inundation and associated cropland loss; an estimated 37,500 acres in Florida are projected to be lost to production with a 27-inch sea-level rise.[109]

Additionally, higher sea levels are expected to accelerate saltwater intrusion into rivers, streams, and groundwater sources of freshwater in coastal areas. In areas with porous aquifers, groundwater is particularly vulnerable to saltwater intrusion. Salt water intrusion impacts water

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quality for agriculture, drinking water, and industrial purposes. In the City of Hallandale Beach, FL, officials have already abandoned six of the city's eight drinking water wells due to salt-water intrusion.[110]

C. Drought trends in Region 4

1. Watersheds

Several watersheds within EPA Region 4 cross multiple state boundaries with growing populations needing water for agriculture, energy production, navigation, drinking, and other needs. Alabama shares most of its major streams with neighboring states.[111] Five rivers originate in Alabama and flow through Florida before draining into the Gulf of Mexico. Both the Coosa and Tallapoosa Rivers originate in Georgia and flow into Alabama where they join the Alabama River. The Tombigbee River originates in Mississippi and flows into Alabama, becoming a tributary to the Mobile River. The Escatawpa River originates in southwest Alabama and becomes a tributary to the Pascagoula River, straddling the AL-MS state line before draining into the Mississippi Sound. The Tennessee River, the largest tributary to the Ohio River, is formed at the confluence of the Holston and French Broad Rivers in northeast Tennessee. It flows through Alabama forming a small section of the AL – MS border before flowing back into Tennessee via Kentucky, then discharging into the Ohio River. Additionally, the Catawba River originates in North Carolina eventually forming approximately 10 miles of the NC-SC border before becoming a tributary to the Wateree River of SC. The Savannah River flows along the GA – SC border before draining into the Atlantic Ocean.

2. Population Effects

The Region's rapid population growth and development has greatly increased water demand and drought vulnerability. Yet, drought is a *normal* component of the Region's climate system.

EPA Region 4, its state, local and tribal government partners and stakeholders face challenges in managing drought conditions in light of the Region's growing population and the anticipated climate change impacts.

3. Dams and Basins

Within EPA Region 4 the Tennessee Valley Authority (TVA) and the U.S. Army Corps of Engineers (US ACOE) operate a number of dams on significant waterways. According to US ACOE's National Inventory of Dams,[112] the federal government operates 404 dams within Region 4. The TVA operates 47 dams for hydropower within a region primarily encompassing Alabama, Georgia, Kentucky, North Carolina, and Tennessee (see figure 23 below).

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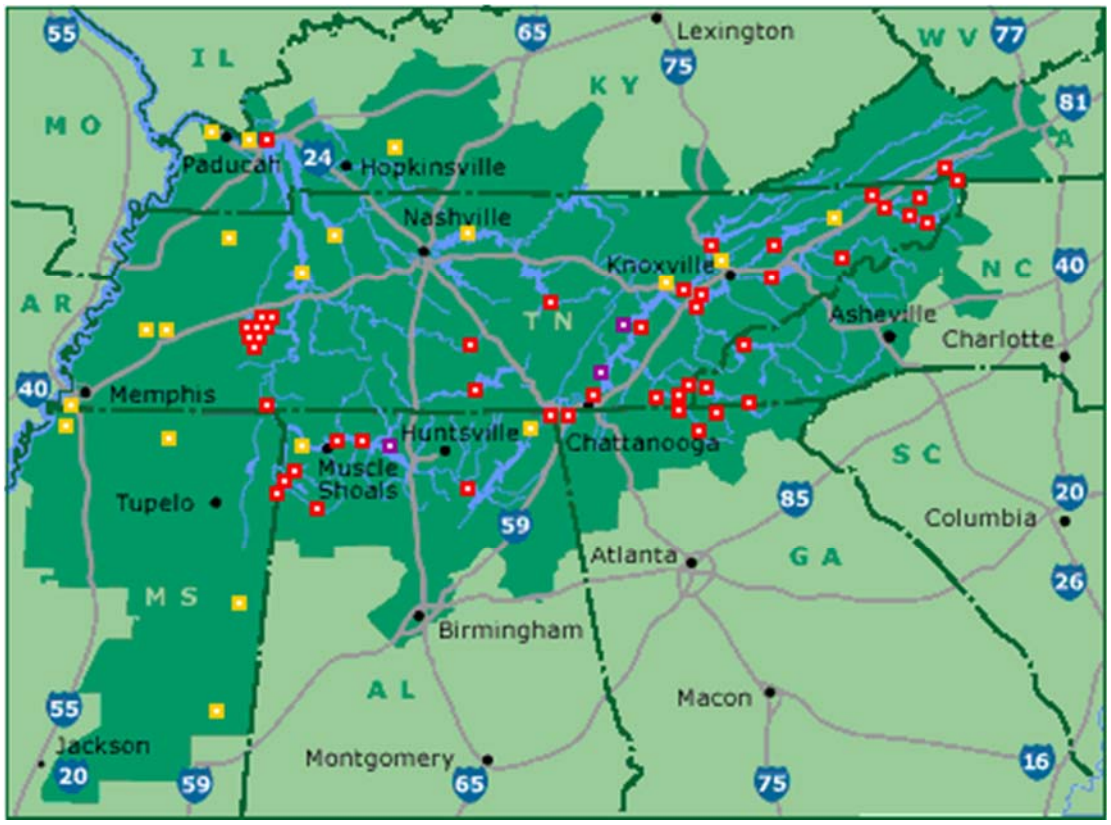

Figure 23. Map of TVA's reservoirs and dams.[113] The red boxes identify 45 of the 47 hydro dams. The yellow boxes identify coal-power plants. The purple boxes identify nuclear-power plants.

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a) Apalachicola-Chattahoochee-Flint River Basin

The Apalachicola-Chattahoochee-Flint River (ACF) Basin is an important part of the socioeconomic structure of Georgia, Alabama, and Florida's urban population, agriculture, power generation, recreation economy, and North Florida's commercial fishery. This Basin overlies 19,800 square miles of southwestern Georgia and southeastern Alabama. The Centerpiece of the Basin is the Chattahoochee River. Its headwaters are in northeast Georgia in the Blue Ridge Mountains. It flows southwest to Columbus, GA, then south along much of the AL-GA border, before crossing into Florida where it confluences with another Georgia river, the Flint River, creating the Apalachicola River which discharges into the Gulf of Mexico at the Apalachicola Bay.

Despite human alterations to most of the ACF Basin, it still supports a rich and abundant diversity of plants and animals. The Chattahoochee's headwaters (the Blue Ridge ecoregion) are the only cold-water fishery habitat. The Apalachicola Bay lies within the Southern Coastal Plain ecoregion while the rest of the Basin is within the Southeastern Plains ecoregion. These ecoregions represent areas where unique and localized natural processes have facilitated the Basin's noteworthy aquatic biodiversity: amphibians, fish, reptiles, and invertebrate fauna

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(crayfish, insects, mussels, worms).[114] Ninety-nine species of breeding birds, including migratory water fowl and 52 species of mammals depend upon its water resources.[115]

The Basin has the largest fish-species diversity of all the river basins draining into the Gulf of Mexico east of the Mississippi River.[116] Seven fish species live only in the Basin (endemic). Sixteen fish species have been listed for protection by Federal or State agencies. And the Apalachicola River Basin has the largest freshwater-fish assemblages in Florida.[117]

Living in the Basin are 16 species of freshwater aquatic turtles, 21 species of salamanders, 26 species of frogs, and the American alligator. All require freshwater to complete or sustain their lifecycles.[118] Numerous snake and lizard species inhabit streams and wetlands. Fifteen species of amphibians and reptiles are noteworthy because of their rarity or protected status: two are designated as threatened and five are designated Endangered Species Act candidate species.[119] The Apalachicola River Basin's upper reaches have the highest amphibian and reptile species density on the continent north of Mexico, and 116 plant species are found; 17 are listed as endangered, 28 threatened, and 30 are rare; with 9 plant endemic species.[120]

The source of the Apalachicola River's flow is primarily the Chattahoochee and Flint Rivers (80 percent), the Chipola River (11 percent) and the remaining from groundwater and overland flows. Because of rainfall-distribution patterns, the Chattahoochee River's average annual runoff exceeds the Flint and makes a greater contribution to the Apalachicola River's peak flows than the Flint. During droughts because the Flint River's base flow is sustained by groundwater, it contributes the greater flow into the Apalachicola River.[121] However, agriculture is the primary land use within the Flint, which depends heavily upon groundwater. Agricultural irrigation can and has depleted the lower Flint River's base flow. Drought combined with high irrigation demand, e.g., high crop prices, can cause the Flint River's component of the Apalachicola River's flow to be nonexistent.

Apalachicola Bay produces 90 percent of Florida's and 13 percent of the Nation's oyster harvest. It is a nursery for shrimp, blue crab, and a variety of fish species. The largest National Estuarine Research Reserve is located in the Bay. The State of Florida has declared both the Apalachicola River and Bay to be an Outstanding Florida Water. The United Nations has designated Apalachicola Bay as an International Biosphere Reserve.[122]

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A Southeast River Basin Under Stress

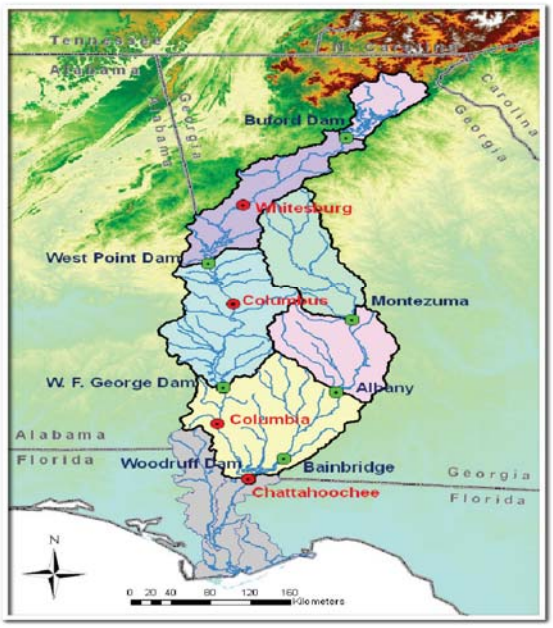

Figure 11.[123] - The ACF Basin in Georgia.

b) Alabama, Coosa, and Tallapoosa Basin

The Alabama, Coosa, and Tallapoosa (ACT) Basin has 16 reservoirs of significance. Its series of dams are operated by the Corps of Engineers and the Alabama Power Company primarily to meet for navigation and hydropower production. Lake Martin, managed by the Alabama Power company, is the largest reservoir with 60.6 percent of the conservation storage. Lake Allatoona, managed by the Corps, is the second largest reservoir in the ACT basin with 11.4 percent of the conservation storage.[124]

The ACT has been called a hotspot of aquatic biodiversity but it has lost some of its diversity. The Coosa River in Georgia historically included 36 native mussel species; today the US Forest Service knows of only four. The Etowah River once included 43 mussel species, now none are known. The Oostanaula River once included 43 mussel species, now only 12 are known. The Conasauga River once included 43 mussel species, now only six are known. The Coosawattee River once included 20 mussel species, today only 11 are known.[125] Changes in the Coosa Basin are just as dramatic. The extinction rate in freshwater snails in the Coosa Basin is second only to some of the rainforest in South America.[126] Since the early 1900's, more than 40 species of freshwater snails and several mussel species are now presumed extinct. Other species being affected by the 2007 – ongoing drought include striped bass fishery, a world-class spotted bass fishery, and in Mobile Bay, recreational fisheries and commercial shrimp and oyster fisheries.[127] Since the ACT's 16 reservoirs and associated dams are operated primarily to meet navigation and hydropower production needs, the ACT Basin's aquatic ecosystems may not prove resilient to climate change.

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[124] Alabama-Coosa-Tallapoosa Basin, US FWS, available at http://www.fws.gov/southeast/drought/archive/pdf/ACT-BasinQ-A.pdf

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PART 2

VULNERABILITY ASSESSMENT

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I. Introduction

The Agency's draft Climate Change Adaptation Plan has defined "vulnerability" as *the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes*.[128] EPA's systems are the various programs implementing its strategic plan goals and statutory mandates. Region 4 is an extension of these systems into the nation's southeastern eight states and the fourteen ecoregions described earlier. This chapter contains an assessment of the vulnerabilities of key EPA Region 4 Programs to the impacts of climate change. It builds on the work presented in Part 2 of EPA's agency-wide Plan, and is structured by the goals in EPA's FY 2011-2015 Strategic Plan. The following begins the discussion of Region 4's program vulnerabilities to climate change in context of the Agency's five strategic plan goals:[129]

Goal 1 - Taking Action on Climate Change and Improving Air Quality within Region 4

Goal 2 - Protecting EPA Region 4's Waters

Goal 3 - Cleaning Up Communities and Advancing Sustainable Development within Region 4

Goal 4 - Ensuring the Safety of Chemicals and Preventing Pollution within Region 4

Goal 5 - Enforcing Environmental Laws within Region 4

Note that EPA Region 4 has not conducted a quantitative vulnerability assessment, but has qualitatively evaluated the nature and magnitude of risks associated with climate change impacts.

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

A. Overview of Potential Climate Change Impacts

Communities within the Southeast face public health and environmental challenges from ambient and indoor air pollution. Climate change will increase these challenges. EPA Region 4 partners with federal, state, tribal and local agencies to protect public health and the environment by directly implementing programs that address air quality (indoor and outdoor), toxic pollutants, climate change, energy efficiency, pollution prevention, industrial and mobile source pollution, radon, acid rain, stratospheric ozone depletion, and radiation protection. Several program areas are vulnerable to future climate conditions that may be characterized by elevated baseline temperatures, increased frequency and duration of heat waves, more extreme swings in weather conditions (drought and precipitation events), and more severe hurricanes and coastal storms. These future conditions will present challenges to EPA to achieve its core mission.

The Clean Air Act (CAA) requires EPA to establish National Ambient Air Quality Standards (NAAQS) for six criteria pollutants. EPA is required to review and consider revisions to these criteria pollutant standards every five years. Once a NAAQS has been established or revised, the

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CAA requires states to develop specific plans, State Implementation Plans (SIPs), to attain the standards for each area designated as "nonattainment" for that NAAQS. In other words, the states must demonstrate how its areas will achieve and maintain compliance with standards.

Two criteria pollutants, ozone and particulate matter (PM), appear to be at risk for future ambient level increases caused by a warming climate. Tropospheric (ground-level) ozone pollution is likely to increase due to meteorological conditions that would become more favorable to ozone formation, particularly in the southeastern U.S.[130] Ambient particulate matter levels would likely be affected in some areas by an increase in frequency or intensity of wildfires.[131] Another area of vulnerability to climate change is indoor air quality.

1. Ozone

The current health-based ozone NAAQS is 0.075 parts per million (ppm) on an 8-hour average. While most areas of Region 4 currently meet that standard, the EPA is set to begin considering an even more protective ozone standard sometime this year (2013), which would be followed by a new round of area attainment/ nonattainment designations.

Impacts on ozone programs

- A warming climate could induce ambient ozone level increases, which would in turn may require more stringent pollution controls to attain and maintain the ozone NAAQS than would be necessary under the present-day climate.
- Ground-level ozone is projected to increase in the largest urban areas of the Southeast (Chang et al. 2010).[132]
- Emissions of ozone precursors, such as nitrogen oxides (NOx), are expected to increase from fossil-fuel burning power plants due to increased demand that accompanies increased ambient temperatures.
- Complying with the ozone NAAQS may become more difficult for some Region 4 states, especially those with areas already facing existing ozone problems. Figure 8 presents the results of a modeling study which predicts increases of ground-level ozone concentrations across the southeast up to approximately 3 parts per billion in some urban areas.

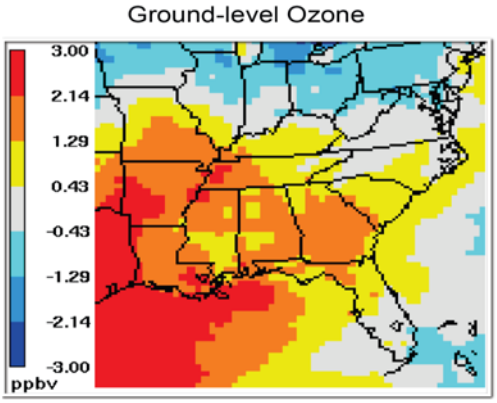

Figure 8. Map showing projected increases in ground level ozone pollution in 2050 as compared to 2001, using a mid-range emissions scenario (A1B, assuming some decrease from current emissions growth trends).

(Adapted from Tagaris et al. 2009)[133]

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2. Particulate Matter (PM)

The current PM NAAQS comprise standards for fine particulate matter ($PM_{2.5}$) and coarse particulate matter (PM_{10}). The existing health-based $PM_{2.5}$ NAAQS are a short-term (24-hour average) standard of 35 micrograms per cubic meter ($\mu g/m^3$) and a long-term (annual average) standard of 15 $\mu g/m^3$. In December 2012 the EPA strengthened the annual $PM_{2.5}$ NAAQS by finalizing a new standard of 12 $\mu g/m^3$.[134] The health-based PM_{10} NAAQS is a short-term (24-hour average) standard of 150 $\mu g/m^3$. All areas of Region 4 currently meet the existing $PM_{2.5}$ and PM_{10} NAAQS. EPA will designate areas as being in attainment or nonattainment with the 2012 $PM_{2.5}$ NAAQS in December 2014.

While the impact of climate change on ambient PM levels remains somewhat uncertain, existing evidence suggests that climate change may cause increasing frequency or intensity of wildfires.[135] This potential is particularly important in Region 4, where the Southeast leads the nation in the rate of wildfire occurrences, averaging approximately 45,000 fires per year from 1997 through 2003.[136] Wildland fires contribute an estimated 15 percent of total PM and 8 percent of carbon dioxide (CO_2) emissions over the southeastern USA.[137] An increase in wildfire activity would cause more frequent elevated PM events, which would be hazardous to human health. For example, a study conducted in the Carolinas showed that peat bog wildfires pose a health hazard, with even brief exposure to smoke associated with these types of wildfires has being associated with negative respiratory and cardiovascular outcomes.[138]

Impacts on PM program

- The potential for greater PM concentrations due to wildfire activity may need to be considered when preparing SIPs to demonstrate attainment with the PM NAAQS. For example, increasing background $PM_{2.5}$ levels when modeling future $PM_{2.5}$ concentrations may need to be assumed.
- More information is needed with regard to the potential for increases in both short-term exposure and long-term exposure to PM due to an increase in wildfires.
    - For a short-term exposure assessment, more data is needed on the human population in areas that are most likely to be in close proximity to wildfire activity.
    - To assess the vulnerability to long-term exposure, additional data is needed on how many wildfires per year can be expected, the expected total $PM_{2.5}$ emissions from those wildfires, and modeling to estimate the impact of those emissions on ambient $PM_{2.5}$ levels. This data gap has been identified as a research need by the federal land management agencies.[139]
    - Funding has been made available by the federal Joint Fire Science Program (JFSP) for research on the potential increases in wildfires and resulting air pollution and human health impacts at a regional level. The results of this research are expected to be available in 2015.[140]

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3. Indoor Air

The Agency's Indoor Air Program is a non-regulatory program. While Program staff share information, there are no metrics of control and few methods of monitoring results. In Region 4, Program staff largely focus on mold, radon, and asthma, and work with state and local agencies with indoor air quality interest or legislation. Regional staff also tries to be aware of emerging issues in indoor air quality.

Due to the nature of Region 4's hot and humid climate and the nature of the work place, the Region estimates most its population spends 92 percent of its time indoors, consistent with the national population.[141] The anticipated climate change attributes of heavy rains, increased temperatures and high humidity cycles will likely facilitate this trend to continue whereupon the population will be exposed to poorer indoor air quality (from lower ventilation levels, carbon monoxide from emergency power generators); dampness, moisture, and flooding; infectious agents and pests (which may also increase pesticide use); thermal stress; and building ventilation, weatherization, and energy use.[142]

Impacts on Indoor Air program

- The Region expects its population to have increased exposure with identified indoor air agents of concern: heat and biological materials – pollen, molds and infectious agents associated with climate change and associated health concerns.[143] See also the section on impacts to vulnerable populations.

III. Goal 2: Protecting America's Waters

Region 4's waters include the Gulf Coast; Florida Keys; South Atlantic Coast; and the Coastal Plain, Southern Appalachian Mountains, Tennessee River, lower Ohio River, and the southeastern Mississippi River watersheds. The region includes a wealth of ecological and economic resources, such as rivers and streams, barrier islands, extensive estuaries, coral reefs, coastal and freshwater wetlands, busy shipping ports, major metropolitan cities, extensive agricultural production and important commercial and recreational fishing resources. The Southeast has over 434,000 farms on more than 80 million acres, over 138 million acres of timberland, and is home to over one third (1,935 miles) of the lower 48-states' continental coastline, 33 percent of U.S. coterminous estuaries, and nearly 30 percent of all U.S. wetlands.[144,145,146,147,148] Pressures from the continuing population and business growth in the southeastern states on the coastal, piedmont and mountain zones of this region are compounded by increased incidence of drought as well as increased flooding, sea level rise, intense tropical storms and heat-related stress on aquatic ecosystems and human health.

A. Overview of Potential Climate Change Impacts

In March 2012, EPA published the draft *2012 National Water Program Climate Change Strategy,*[149] which described impacts that were documented in reports of the

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Intergovernmental Panel on Climate Change (IPCC). These impacts are relevant to the Southeast and can be summarized as follows. [150]

- *Increases in Water Pollution Problems*: Warmer air temperatures will result in warmer water that will hold less dissolved oxygen making instances of low oxygen levels and hypoxia more likely, foster harmful algal blooms and change the toxicity of some pollutants, and could cause an increased number of waters to be recognized as "impaired".
- *More Extreme Water-Related Events*: Heavier precipitation in tropical and inland storms will increase the risks of flooding, expand floodplains, increase the variability of stream flows (i.e., higher high flows and lower low flows), increase the velocity of water during high flow periods and increase erosion. These changes will have adverse effects on water and wastewater management facilities as well as water quality and aquatic system health. For example, increased intense rainfall will result in more nutrients, pathogens, and toxins being washed into water bodies.
- *Changes to the Availability of Drinking Water Supplies*: In some parts of the Southeast, droughts, changing patterns of precipitation, and increased water loss due to evaporation as a result of warmer air temperatures will result in changes to the availability of water for drinking and for use for agriculture and industry. In other areas, sea level rise and salt water intrusion will have a similar effect. Warmer air temperatures may also result in increased demands on community water supplies and the water needs for agriculture, industry, and energy production are also likely to increase.
- *Water body Boundary Movement and Displacement*: Rising sea levels will move ocean and estuarine shorelines by inundating lowlands, displacing wetlands, and altering the tidal range in rivers and bays. Changing water flow to lakes and streams, increased evaporation, and changed precipitation in some areas, will affect the size of wetlands and lakes.
- *Changing Aquatic Biology*: As waters become warmer, the aquatic life they now support will be replaced by other species better adapted to the warmer water (i.e., cold water fish will be replaced by warm water fish). This process, however, will occur at an uneven pace disrupting aquatic system health and allowing non-indigenous and/or invasive species to become established. In the long-term (i.e., 50 years), warmer water and changing flows may result in significant deterioration of aquatic ecosystem health in some areas.
- *Collective Impacts on Coastal Areas*: Most areas of the Southeast will see several of the water-related effects of climate change, but coastal areas are likely to see multiple impacts of climate change. These impacts include sea level rise, increased damage from floods and storms, changes in drinking water supplies, and increasing temperature and

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acidification of the oceans. These overlapping impacts of climate change make protecting water resources in coastal areas especially challenging.

- *Indirect Impacts:* The Southeast is susceptible to impacts due to unintended consequences of human response to climate change, such as those resulting from carbon sequestration and other greenhouse gas reduction strategies.

B. Program-Specific Vulnerabilities and Potential Actions

1. Watershed Management

EPA Region 4, working with its state, local and tribal partners, is responsible for managing regulatory and non-regulatory programs to protect and improve water quality in the Southeast's watersheds and estuarine, coastal and ocean waters. As better information is developed for local decision making, changes may be needed in how EPA Region 4 and our partners implement water quality programs, including Water Quality Standards, monitoring and assessment, Total Maximum Daily Loads (TMDL), Effluent Guidelines, National Pollutant Discharge Elimination System (NPDES), nonpoint pollution control programs, stormwater management and other watershed management programs. Potential vulnerabilities to Region 4 Watershed Management efforts include:

- Higher air and water temperatures combined with nutrient pollution may result in increased growth of algae and microbes that threaten aquatic ecosystems.
- Higher air and water temperatures may increase pollutant concentrations and lower dissolved oxygen levels, potentially resulting in additional water bodies not meeting water quality standards and being listed as impaired.
- Areas experiencing periods of less precipitation, drought, lower stream flow and limited ground water recharge may result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments.
- Areas with increased intensity of drought or that may experience increases in events such as wildfires may see alterations in the structure and function of watersheds potentially affecting regional and state wetlands delineation and protection programs.
- Increased intensity of rainfall events and storms may cause an increase in the number of sewer overflows and wastewater bypasses, fouling streams and requiring increased water quality enforcement.

2. Water Quality Standards

Water Quality Standards are the foundation of the Clean Water Act – they designate the goals and uses for water bodies, setting criteria to protect those uses, and establishing provisions to protect water bodies from pollutants. States, territories, and authorized tribes establish water quality standards, and EPA reviews and approves those standards. Potential vulnerabilities to Region 4 Water Quality Standards efforts include:

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- Warmer waters and other ecological shifts will threaten aquatic habitats and aquatic species, such as cold water fisheries and potentially requiring changes in State stream classifications. Rising stream temperatures could significantly reduce viable habitat for several species of cold-water fish in North Carolina, including brook trout.
- Salinity changes due to seal level rise may create a need to reclassify some water bodies from fresh to salt water. Sea-level rise may also result in a shifting from fresh water communities to salt water communities, such as is happening in the Chassohowitzka River System in Florida. Increased anthropogenic use of freshwater upstream may be a significant contributor in converting fresh to salt water.

3. Monitoring, Assessing, and Reporting

Our nation's waters are monitored by state, federal, and local agencies, universities, dischargers, and volunteers. Water quality data are used to characterize waters, identify trends over time, identify emerging problems, determine whether pollution control programs are working, help to direct pollution control efforts to where they are most needed, and respond to emergencies such as floods and spills. Potential vulnerabilities to Region 4 Monitoring efforts include:

- Stream ecosystems will be affected directly, indirectly, and through interactions with other stressors. Biological responses to these changes will vary regionally and could include altered community composition, interactions, and functions. .
- Monitoring locations may need to be re-located in order to effectively monitor and assess changes in stream ecology or water quality.
- Timing of monitoring may need to change in order to pick up seasonal shifts and the full range of climate vulnerability, especially for recreational and aquatic life uses.

4. Total Maximum Daily Loads

Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop Total Maximum Daily Load ("TMDLs") for these waters. A TMDL is a calculation of the maximum amount of a pollutant a waterbody can receive and still safely meet water quality standards. Potential vulnerabilities to Region 4 TMDL efforts include:

- Some areas may experience periods of less precipitation, drought, lower stream flow and limited ground water recharge resulting in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments; these considerations will need to be taken into account in the development of new TMDLs, and potentially result in the need for revision of existing TMDLs.
- Some areas may experience episodes of increased intense precipitation resulting in increased runoff of pollutants; these considerations will need to be taken into account in

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the development of new TMDLs, and potentially result in the need for revision of existing TMDLs.

5. National Pollutant Discharge Elimination System

Water pollution degrades surface waters making them unsafe for existing uses, including drinking water, fishing, swimming, and other water recreation. As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. NPDES permits have a five-year permitting cycle. Potential vulnerabilities to Region 4 NPDES efforts include:

- Areas experiencing periods of less precipitation, drought, lower stream flow and limited ground water recharge will result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments. National Pollutant Discharge Elimination System (NPDES) permits will need to take these factors into consideration during permit renewal or new permit issuance. These precipitation changes are compounded in certain areas by increased human uses of the water resources.
- Increased intensity of rainfall events and storms may cause an increase in the number of sewer overflows and wastewater bypasses, fouling streams and requiring increased water quality enforcement.
- Increased aquatic temperatures may result in the need to modify existing discharge limits.

6. Nonpoint Source Management

Nonpoint source pollution comes from many diffuse sources and is caused by rainfall runoff that picks up natural and human made pollutants and deposits them in lakes, rivers, wetlands, coastal waters and ground water. State nonpoint source programs, developed under the Clean Water Act (CWA) Section 319 Program, are working to meet this challenge. Potential vulnerabilities to Region 4 Nonpoint Source Management efforts include:

- Increased intensity of rainfall events and storms will cause increased pollutant loads in runoff, and the velocity of runoff will scour and erode creek beds.
- Accounting for greater quantities of runoff and pollutants, with more variability, from both urban and suburban stormwater and agricultural sources will stress existing nonpoint source best management programs.

- Decreasing frequency of precipitation days and more concentration of runoff in intense storms, which is likely to be more damaging to aquatic habitats, and carry more erosion-related pollutants into water bodies will stress existing nonpoint source best management programs.

7. Wetlands

Section 404 of the Clean Water Act requires EPA concurrence before the U.S. Army Corps of Engineers may issue permits to allow dredging or filling of wetlands. Wetlands function to

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protect ecosystems, streams and other aquatic resources. Wetlands provide crucial climate change functions including: 1) coastal protection in the face of sea level rise and increased hurricane intensity, including the ability to reduce wave energy; 2) protection of water supplies in the face of increased drought conditions by providing groundwater recharge and maintaining minimum stream flows; 3) flood mitigation in the face of increased precipitation and storm frequency; and 4) carbon sequestration. The capacity of wetlands and headwater streams to reduce flood peaks, detain stormwater, and filter pollutants is critical to the protection of life, property, and water quality. Potential vulnerabilities to Region 4 Wetlands Program efforts include:

- Areas with increased intensity of drought or that may experience increases in events such as wildfires may see alterations in the structure and function of wetlands and watersheds potentially affecting regional and state wetlands delineation and protection programs.
- Sea-level rise combined with coastal development will challenge the ability of coastal wetlands to migrate, potentially affecting coastal wetland protection programs. This migration will likely result in loss of coastal wetlands where development has encroached on natural migration pathways.
- Drying out of seasonal wetlands with increased drought could affect wetland delineations and programs.
- Physical damage or elimination of wetlands and dune structures that protect them due to hurricanes and other seasonal changes could affect wetland delineation and restoration efforts.

8. Dredging/Ocean Dumping

The Ocean Dumping and Dredged Materials Management programs established by Congress in 1972 prohibit ocean dumping of materials that would unreasonably degrade or endanger human health or the marine environment. Potential vulnerabilities to Region 4 Dredging/Ocean Dumping efforts include:

- Increased need and frequency of ocean dumping due to increased precipitation and rainfall intensity that cause erosion and sedimentation of rivers, channels and harbors.
- Shifting sediments and forming of shoals due to higher intensity storms that impede safe navigation in harbors and channels may require increased use of emergency dredging.
- Need for dredged materials to protect shorelines, beaches, dunes and marshes from sea level rise may stress existing regulatory programs.

9. National Estuary Program and South Florida

The National Estuary Program (NEP) was established in 1987 to restore and protect the physical, chemical, and biological integrity of "estuaries of national significance" by focusing our Clean Water Act authorities in these highly productive ecosystems. There are 28 NEPs across the country, six of which are entirely or partially within EPA Region 4. Region 4 NEPs promote collaborative actions and best management practices to accelerate and embellish implementation of "core" Clean Water Act programs. Lessons learned by the NEPs are shared

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across the network of 28 programs nationally, as well as with other coastal watersheds facing similar water pollution and water quality impairments. This approach has proven to be a success over the past 25 years and the NEP is seen as a model for other comprehensive watershed and community-based programs.

The Florida Keys Water Quality Protection Program (FKWQPP), established in 1994, is administered by EPA and FL DEP, and includes a working group consortium of local, state, federal agencies and non-government representatives. The FKWQPP works to recommend and implement management activities designed to maintain and restore the water quality needed for healthy native plant and animal populations in the FL Keys National Marine Sanctuary waters. Through the Water Quality Protection Program, water quality, seagrass meadows, and coral reefs have been monitored in the sanctuary since the mid-1990s.

Potential vulnerabilities to Region 4 NEP and South Florida Program efforts include:

- Successful implementation of NEP Comprehensive Conservation and Management Plans may be adversely affected. Efforts to restore or enhance water quality, habitat, living resources, hydrologic alterations, and human uses may be affected.
- Increased ocean temperatures and acidification resulting from the absorption of CO_2 will continue to stress coral reefs potentially affecting coral reef protection programs.

10. Drinking Water, Wastewater, and Stormwater Infrastructure

Much of the Southeast has enjoyed the benefits of clean and safe water resulting from an extensive network of drinking water, wastewater and storm water infrastructure. EPA recognizes that this infrastructure is aging and is being further taxed by the impacts of climate change. As state, local and tribal governments face more demands for increasingly limited resources, the ability to respond to these growing infrastructure pressures becomes more complicated. Potential vulnerabilities to Region 4 Drinking Water, Wastewater, and Stormwater Infrastructure Program efforts include:

- Higher air and water temperatures combined with nutrient pollution will result in increased growth of algae and microbes that affect drinking water treatment needs.
- Increased intensity of rainfall events and storms could contribute to additional infiltration/inflow in wastewater conveyance systems, which could cause an increase in the number of sewer overflows and wastewater treatment plant overloads, requiring expensive modifications and improvements to both wastewater conveyance and treatment systems.
- Increased drought will place demands on both surface and ground water resources resulting in water supply problems.
- Reduction in assimilative capacity of existing surface waters due to reduced stream flows and/or increased temperatures could lead to more stringent discharge limits on existing wastewater facilities, resulting in the need for expensive improvements or upgrades to maintain permit compliance.
- Sea level rise could result in: 1) saltwater intrusion into the collection system of wastewater treatment systems; 2) wet wells in pumping systems leading to increased

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corrosion damage to pumping equipment, and treatment plant tankage and equipment; and 3) malfunction of gravity conveyance systems and discharges.

- Increases in flooding from extreme precipitation, storm surges, and loss of wetlands could cause damage to infrastructure resulting in increased needs for SRF funding.
- Source water intake changes may be needed due to droughts and summertime extreme heat. Coastal aquifers may experience salt water intrusion where withdrawals are outstripping recharge and increased pressure head from higher sea levels may worsen this problem resulting in the need for relocation of water and wastewater facilities.
- Drinking water and wastewater utilities emergency planning for extreme weather events may need to be reviewed and modified to account for climate change. Vulnerable and economically deprived communities may be particularly at risk, both for access to clean and safe water as well as for their ability to respond to emergencies during extreme events. Coastal and mountain communities will be particularly vulnerable.
- Changes in rainfall patterns may lead to additional water supply infrastructure, with associated impacts on ecosystem fragmentation, aquatic life, physical stability, water quality, disruption of sediment and nutrient dynamics, downstream users, and system losses due to increased evaporation from impoundments. CWA Section 404 permit applications for reservoir creation in response to drought have increased in some states.

11. Drinking Water Quality

The Safe Drinking Water Act (SDWA) is the main federal law that ensures the quality of Americans' drinking water. EPA sets standards for drinking water quality and oversees the state, local, and water suppliers who implement those standards. EPA Region 4 ensures that the public water supply systems comply with national drinking water quality standards and underground sources of drinking water are protected from contamination.

Potential vulnerabilities to Region 4 Drinking Water Quality efforts include:

- Higher air and water temperatures will promote increased growth of algae and microbes, which will increase the need for drinking water treatment and potentially affect the aesthetic quality of drinking water supplies.
- Increased storm water runoff will wash sediment and other contaminants into drinking water sources, requiring additional treatment.
- Sea-level rise could increase the salinity of both surface water and ground water through saltwater intrusion, encroaching upon coastal drinking water supplies. Additionally, extreme weather events such as hurricanes and extreme droughts could impact and potentially permanently affect both the availability and quality of drinking water sources. In southeastern areas with saltwater intrusion, Region 4 states may receive more permit applications and issue more permits for Class V aquifer recharge injection wells under the Underground Injection Control (UIC) program in an attempt to combat the effects of saltwater intrusion caused by sea-level rise.
- Reduced annual precipitation or increased intensity and duration of drought in some regions will affect water supplies, causing drinking water providers to reassess supply plans and consider alternative pricing, allocation and water conservation options.
- In areas with less precipitation, public water supply systems water demand may rely more heavily on underground aquifers or development of underground storage of treated water

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to supplement existing sources. Changes in the salt front of estuaries and tidal rivers due to sea level rise and over use of fresh surface and ground water resulting in flow changes may result in increased pressure to manage freshwater reservoirs to increase flows and attempt to maintain salinity regimes, in order to protect estuarine productivity and drinking water supplies.

IV. Goal 3: Cleaning up Communities and Advancing Sustainable Development

Contaminated site cleanup occurs under a variety of EPA programs, most commonly Superfund (i.e., remedial, time-critical removal, emergency response programs), the Resources Conservation and Recovery Act (RCRA), the Toxic Substances Control Act (TSCA) (e.g., PCBs), Brownfields, Underground Storage Tanks (UST)/Leaking Underground Storage Tanks (LUST) and the Oil Pollution Act (OPA). A high percentage of cleanups, including most brownfields sites, are regulated through State programs.

The potential climate change impacts described in Section IV.A below broadly apply to each of these programs; however, the implications of these climate change impacts may differ by program. Potential program-specific focus areas and vulnerabilities are discussed in Section III.B.

A. Overview of Potential Climate Change Impacts

For the Southeast, the impacts that could most likely pose risks to contaminated site cleanups and waste management facilities are sea level rise, extreme storm events (precipitation and wind), temperature extremes, wildfires, decreasing precipitation days and increasing drought intensity. Ocean acidification and increased water temperatures may also pose additional risks to coastal facilities and affect the natural bio-degradation of chemicals released to the environment. Potential environmental conditions arising from these impacts and specific examples illustrating how they could potentially influence contaminated sites are described below. The likelihood and severity of climate change impacts can also be expected to vary considerably from site-to-site depending on the location, cleanup technologies and approaches, and many other factors.

1. Sea Level Rise

As discussed previously, sea level rise is expected to impact coastal areas affecting every state in the Region 4 except for Tennessee and Kentucky. This impact on contaminated sites and petroleum storage facilities may be partially mitigated because it is expected to occur gradually over the course of several decades. This allows additional time to appropriately plan for and respond to sea level rise (e.g., construction of berms, removal of wastes, and completion of shorter-term treatment activities). Contaminated sites and petroleum storage facilities located in vulnerable areas could experience impacts due to inundation and salt water intrusion. Examples

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include flooding of petroleum storage facilities, long-term waste management areas, and uncontrolled (or undiscovered) contamination leading to the release and dispersal of contaminants; corrosion of underground tanks, piping, and other equipment; and degradation of coastal aquifers that impacts cleanup performance goals. Saltwater intrusion may impair habitat restoration efforts of impacted surface areas (like wetlands); and may change soil and water chemical and biological properties, thereby impacting toxicity, transport, natural degradation of contaminants, and treatment efficacy. For example, intrusion may impact the ability of native microorganisms to play a role in bioremediation of petroleum-impacted soils.

2. Extreme Storm Events

Existing climate studies suggest that Region 4 has been experiencing more intense storm events. Unlike sea level rise which predominantly affects coastal areas, extreme storm events can impact a much wider range of contaminated sites. These impacts could include:

- flooding of surface water bodies and surrounding land areas due to heavy precipitation events (i.e., regional drainage)
- flooding of coastal areas and rivers from storm surge due to higher intensity hurricanes,
- increased local surface runoff,
- increased infiltration of storm water into soils and elevation of water tables, and
- increased wind damage and dispersion of contaminants.

Prior to the enactment of environmental laws, industrial wastes were routinely discharged to rivers, streams and other water bodies. As a result, many contaminants may exist within the layers of sediment that accumulated over the years. One potential impact of extreme storm events is the spread of contaminants through erosion, exposure of formerly buried contaminants, dissolution or suspension of contaminants, and deposition of contaminated soils or sediments. River flooding that breaches dams may result in the spread of contaminated sediment previously contained by the dams. Flooding of chemical facilities may mobilize contaminants through stormwater runoff. Increased precipitation events and hurricanes can potentially impact sites even if they are remote from coastal areas and rivers.

Extreme weather can delay or impair active removal and remedial operations, and complicate a remedy due to such impacts as flotation of tanks or drums, , damage of engineered sediment caps, damage to treatment systems, impacts to contaminated structures, and damage to containment systems by the forces of wind and water – all of which can create risks to human health and the environment.

3. Temperature Change

The direct consequence of elevated temperatures on contaminated site cleanups is not expected to be significant. However, elevated temperatures could lead to increased pressurization of storage containers, volatilization of hazardous materials, and other factors which may affect design and operation of remediation systems and emergency response actions.

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Worker health and safety concerns during site operations may also be impacted by higher temperatures (e.g., handling of pressurized drums, heat stress to responders).

4. Wildfires

The increase in wildfires may impact treatment facilities and above ground storage units. The disruption of treatment will impact costs and restoration time frames.

5. Ocean Acidification

The acidification of sea water may adversely impact the corrosion and degradation of pipelines and construction materials (e.g. concrete pads/berms) used to convey, store, or contain petroleum products at coastal facilities.

6. Increased Water Temperatures

Increased water temperatures may lead to a change in native or endemic organisms available for biotic degradation of petroleum released to the environment.

B. Program-Specific Vulnerabilities and Potential Actions

1. Longer-term Cleanups (e.g., Superfund Remedial, Superfund Time-Critical Removal, RCRA Corrective Action, TSCA, Brownfields Cleanup Sites, and Polychlorinated Cleanup)

Longer-term response cleanups such as the Superfund remedial program and the RCRA corrective action program are intended to protect human health and the environment, maintain protection over time, minimize the amount of untreated waste, and reduce ecological risks to levels that will result in the recovery and maintenance of healthy local populations and communities of biota. These cleanups are generally viewed as "permanent" solutions. Other cleanup programs such as the Superfund time-critical removal program address more immediate threats; however, in many cases these may also result in long-term cleanup remedies.

2. Impacts on Longer-term Cleanups:

Cleanups where waste is left in place (e.g., landfills, cap-in-place remedies) or cleanups that involve treatment that occurs over a long period of time (e.g., ground water pump & treat systems) could be especially vulnerable to changes in climate. For cleanup operations that are typically of much shorter duration (e.g., soil vapor extraction, enhanced thermal treatment), the impacts of climate change are more predictable and easier to factor into the selection and design of a particular remedy.

a) Programmatic Vulnerabilities

- Physical impacts to Superfund actions of all durations are likely to include the following:
  - Both removals and remedial actions may involve labor-intensive operations, sometimes for an extended length of time, and are therefore vulnerable to the acute impacts of climate change: e.g. flooding, ground water hydrology, temporary or long-term power outages, extreme heat, wind impacts.
  - Such impacts may complicate assessment phases.

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- There may be heightened risk of physical damage to buildings and other components of the existing site and the remedy, such as storm movement of drums or other containers, or damage to booms and other containment structures.
- Off-site disposal, waste transport, equipment capabilities and laboratory capabilities may be overwhelmed by extreme storm events. Temporary on-site staging of hazardous materials may be compromised.
- Extreme storm events may provide increased hazards for EPA staff and contractors on site.
- Climate impacts to infrastructure may hamper response time and capability, including but not limited to the ability to move equipment and to transport hazardous materials for disposal.

- Programmatic impacts to the Superfund program include an ability to adequately plan for and execute in a changed environment:
  - The preliminary assessment/site investigation (PA/SI) phase of time-critical removal actions or an Remedial Investigation/Feasibility Study (RI/FS) are based on existing information -- typically historical information, not future predictions. Without incorporating potential climate change impacts, an accurate risk may not be factored into planning or prioritization. Assumptions and modeling previously relied upon in an area may no longer be valid
  - The remedy selection process must also adequately consider climate impacts. Precipitation records and floodplain maps used for remedy selection and design may not account for future climate change impacts, for example.
  - More robust remedies such as excavation and removal of wastes may be required for sites potentially vulnerable to sea level rise and flooding, increasing short-term costs.
  - Climate change may increase the mobility of contaminants and reduce the effectiveness of containment as a remedy.
  - Designs may have to be based on conservative assumptions to reflect uncertainty over future environmental conditions, including extreme storm events that increase surface water runoff or infiltration.
  - Future population growth will most likely result in people living in areas near Superfund sites previously less occupied, contributing to a need for reassessment of scoring, risks and protectiveness of existing sites and remedies. Reevaluation of sites previously considered for the NPL may be necessary.
  - Changes in exposure pathways for both human and ecological receptors will result from sea level rise, coastline alteration and other factors. These may include such aspects as changes to drinking water system intakes, floodplain reach to residential areas, and rates of erosion. Remedy design and standards may need to reflect projections.
  - Climate impacts may also alter the biological communities impacted by a Site, such as increasing risk to seafood sources.
  - Health and Safety Plans should adequately anticipate extreme storm events.
  - Not only will potential impacts on ecological receptors differ from past experience, but also the ecological receptors themselves may differ due to migration of species and habitat alteration. Remedies should anticipate additional future impacts.
  - Increased sophistication of modeling and planning may raise engineering costs as well as execution costs.

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b) State by State Assessment

- *Alabama*: Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in Alabama, only Mobile is located on the coast. Most other large cities are located on or near waterways may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 15 Superfund or Superfund Alternative Sites are located in the State; 10 of these sites have ongoing five-year reviews required by residual waste.
- *Florida*: Most of the state will be susceptible to flooding and coastal areas will be susceptible to saltwater intrusion. Seven out of 10 of the largest population centers in Florida are located on the coast (Jacksonville, Miami, Tampa, St. Petersburg, Ft. Lauderdale, Port St. Lucie, and Coral Gables). Because of population and groundwater impacts, there are more Superfund Remedial sites in Florida than other Region 4 states. Currently 66 Superfund or Superfund Alternative Sites are located in the State; 39 of these sites have ongoing five-year reviews required by residual waste.
- *Georgia*: Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in Georgia, only Savannah is located on the coast. Most other large cities are located on or near waterways and may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 15 Superfund or Superfund Alternative Sites are located in the State; 9 of these sites have ongoing five-year reviews required by residual waste.
- *Kentucky*: There are no coastal areas, and saltwater intrusion will not be a concern. Large cities located on or near waterways, such as the Ohio River, may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 14 Superfund or Superfund Alternative Sites are located in the State; 12 of these sites have ongoing five-year reviews required by residual waste.
- *Mississippi*: Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in Mississippi, only two (Gulfport and Biloxi) are located on the coast. Most other large cities are located on or near waterways and may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 8 Superfund or Superfund Alternative Sites are located in the State; 1 of these sites has ongoing five-year reviews required by residual waste.
- *North Carolina:* Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in North Carolina, only Fayetteville, Wilmington and Greenville are located in the coastal plain. Most other large cities are located on or near waterways and may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 41 Superfund or Superfund Alternative Sites are located in the State; 25 of these sites have ongoing five-year reviews required by residual waste.
- *South Carolina:* Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in South Carolina, only Charleston and Mount Pleasant are located on the coast. Other large cities are located on or near waterways and may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 30 Superfund or Superfund Alternative Sites are located in the State; 22 of these sites have ongoing five-year reviews required by residual waste.
- *Tennessee:* There are no coastal areas, so saltwater intrusion is not a concern. Large cities located on or near waterways, e.g., the Cumberland and Mississippi Rivers may be

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more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 25 Superfund or Superfund Alternative Sites are located in the State; 10 of these sites have ongoing five-year reviews required by residual waste.

Table 4. State Comparisons of Coastline and Superfund Sites

	AL	GA	FL	KY	MS	NC	SC	TN
General Coastline[1] (statute miles)	53	100	1350	0	44	301	187	0
Tidal Coastline[2] (statute miles)	607	2344	8426	0	359	3375	2876	0
Superfund and SAS Sites	15	15	66	14	8	41	30	25
Five-Year Review Sites	10	9	39	12	1	25	22	10
Population	4,822,023	9,919,945	19,317,568	4,380,415	2,984,926	9,752,073	4,723,723	6,456,243
Climate-Change Impact Rank	5	4	1	8	6	2	3	7

Notes:

1. Figures are lengths of general outline of seacoast. This does not include freshwater coastlines. Measurements are made with unit measure of 30 minutes of latitude on charts as near scale of 1:1,200,000 as possible. Coastline of bays and sounds is included to point where they narrow to width of unit measure, and distance across at such point is included.
2. Figures were obtained in 1939–1940 with recording instrument on the largest-scale maps and charts then available. Shoreline of outer coast, offshore islands, sounds, bays, rivers, and creeks is included to head of tidewater, or to point where tidal waters narrow to width of 100 feet.

**Source:* Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service.

3. Emergency Response Programs

EPA coordinates and implements a wide range of activities to ensure that adequate and timely response measures are taken in communities affected by hazardous substances and oil releases where state and local first responder capabilities have been exceeded or where additional support is needed. EPA's emergency response program responds to chemical, oil, biological and radiological releases and large-scale national emergencies, including homeland security incidents. EPA conducts time-critical and non-time-critical removal actions when necessary to protect human health and the environment by either funding response actions directly or overseeing and enforcing actions conducted by potentially responsible parties.

EPA Region 4 has an approximate total coast line of 2,035 miles that may be impacted by large weather events, such as hurricanes. An increase in storm severity and sea level rise may cause large storm surge damage in communities and industrial facilities along Region 4's coast line. In addition, inland flooding due to intense and frequent storms may cause extensive flood damage in communities and industrial facilities that were not predicted to be affected under current flood maps. These large events will require the need of ample resources of On Scene Coordinators, Remedial Project Managers and Response Support Corps (RSC) members to be deployed to respond in the following areas:

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a) Impacts on Emergency Response Programs

- Smaller entities with hazardous materials may lack resources for emergency planning, which may increase the risk of abandoned hazardous materials during a flooding or storm event.
- Local capacity to treat and dispose of hazardous and municipal waste may be overwhelmed by surges in mixed waste from climatic events.
- Releases of hazardous materials or chemicals through high winds, flooding, and storm surge may create a need for increased frequency and intensity of emergency response for both hazardous materials and oil. Current response resources, including laboratory requirements, may not be adequate for responses to extreme events. Specific impacts include:
  - Increased number of brown/black outs will potentially lead to impacts on facility processes (i.e. runaway reactions, heat reactions, failure of chemical processes)
  - Coastal hazardous material and oil facilities may be impacted by extreme events and storm surge. The United States Coast Guard (USCG) has jurisdiction over hazardous material and oil spills along the coast, but EPA has interagency agreements in place to support the USCG during responses.
- Extreme storm and flooding damage to homes will produce an increase in the amount of household hazardous waste and white goods (i.e., refrigerators, air conditioners, etc) that may need to be collected and placed in landfills. An increase in household hazardous and industrial waste collected during disaster events may strain waste landfill capacity and require the construction of additional landfill capacity.

- Storm surge caused by coastal storms, hurricanes and sea-level rise may adversely impact industrial facilities located along the coast and cause releases of chemicals, discharges of oil and mobility of orphan containers (i.e., above-ground storage tanks, drums, and totes) in the affected area.
  - Oil facilities that are required to have Facility Response plans or Spill Prevention, Control, and Countermeasure (SPCC) plans may experience large impacts due to extreme rain fall events.
  - The Region will need to maintain the Response Support Corps concept to provide for additional personnel during the Agency response to FEMA disaster declared responses. This will require the continued recruitment of RSC members, training and exercises.
- Pest type and range may change with climate change, and there may be an increase or change in type of pesticides stored and transported across the region, resulting in a potential increase in releases.
- Twenty-seven percent of the major roads, 9 percent of the rail lines, and 72 percent of the ports in Region 4 area are built on land at or below 4 feet above sea level in elevation, a level within the range of projections for relative sea-level rise in this century. Increased storm intensity may lead to increased service disruption and infrastructure damage. More than half of the area's major highways (64 percent of interstates, 57 percent of arterials), almost half of the rail miles, 29 airports, and virtually all of the ports, are below 23 feet in elevation and subject to flooding and damage due to hurricane storm surge.
- Additional planning for emergency response may be needed:

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- Brown and black-outs may cause releases and the frequency and intensity of storms may need to be incorporated into current national and area contingency plans.
- Facility Response Plans (FRP) and SPCC plans may not consider climate change impacts.
- Current regional debris management plans rely on historical climate assumptions and do not address the increasing uncertainty in climatic extreme events.
- Additional planning may be needed as Stafford Act declaration (federal emergency declaration) may be more frequent with a changing climate.
- Current energy infrastructure (oil, natural gas, nuclear) in South East may not include climate change assumptions for emergency planning.

b) State by State Assessment.

- *Alabama:* Mobile is the largest city on the State's coast and it is the 27th busiest container port in the U.S. Areas surrounding Mobile Bay have various chemical and oil facilities that may be impacted by the storm surge caused by a very large hurricane.
- *Florida:* Of the 10 largest population centers in the State, seven (Jacksonville, Miami, Tampa, St. Petersburg, Ft. Lauderdale, Port St. Lucie, and Coral Gables) are located on the coast. The Ports of Miami, Jacksonville, Everglades, Palm Beach and Tampa, are ranked as the 13th, 14th, 15th, 23rd and 34th busiest container ports in the nation, respectively. These cities have a significant industrial and population base that has the potential to produce a large amount of household hazardous waste and industrial waste resulting from storm surge impacts due to a large hurricane.
    - Additionally, the State has a large phosphate mining and phosphate fertilizing processing industry mostly concentrated in the central Florida region. One of the byproducts of phosphate fertilizer production is phosphogypsum. There are currently about 1 billion tons of phosphogypsum stored in 24 stacks in Florida and about 30 million new tons are generated each year. One of the concerns is a large weather event (hurricane) could affect the stability of one of these stacks and may cause a release of low acidic process water to the environment.
- *Georgia:* The City of Savannah is the nation's fourth busiest container port and the second busiest in the East Coast. A large hurricane can be devastating to the area and produce a large amount of hazardous materials and debris to be spread through the area. The State has two CCR Surface Impoundments that were determined to be a High Hazard Potential by EPA.
- *Kentucky:* The State has experienced flooding in the past and increase in the severity of rain fall events will continue to cause flooding in the State.
- *Mississippi:* The State's coastline has three cities: Pascagoula, Gulfport and Biloxi. These cities were affected heavily by Hurricane Katrina and produced large amounts of household hazardous waste and industrial debris from the hurricane's storm surge. The Port of Gulfport is the 21st busiest container port in the U.S. and was heavily affected by Hurricane Katrina. A large amount of the port's cargo was dispersed by the storm surge into the bordering community.
    - The Pascagoula coast has one of the largest refineries in the U.S. and a direct hit by a large hurricane may cause the release millions of gallons of oil and gasoline to the Gulf of Mexico. Also, the area has a large phosphate fertilizer

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manufacturing plant that contains large stacks and may release low pH waste water due to heavy rain events.

- *North Carolina:* The Port of Wilmington is the 19th busiest container port in the nation and may be vulnerable to storm surge damage resulting from a hurricane. The State is prone to large flooding associated with rains caused by Hurricanes passing through the State.
    - In 1999, Hurricane Floyd caused extensive flood damage in eastern North Carolina. In 2004, Hurricane Ivan caused extensive flooding in the Appalachian Mountain region of western North Carolina. These extreme events produced large amounts of orphaned containers and household hazardous waste.
    - Due to groundwater contamination, Region 4's Superfund Removal program has had to supply an alternative water source to various communities in the State. Because of an increase in extreme rainfall events, additional contaminated groundwater wells may be identified by the State and may require EPA to provide these communities an alternative water source.
- *South Carolina:* The coastal zone of the State is described as the Low Country and includes City of Charleston. This city is also a major port and is ranked the 10th busiest container port in the nation. The area is a flat and is susceptible to flooding, and could be heavily impacted by coastal storm surge from a major hurricane.
- *Tennessee:* Even though the State does not have a coast line, heavy rainfall can cause major flooding events. During May of 2010, Nashville and surrounding counties experienced large rainfall over a two day period that caused extensive flooding in the area. EPA Region 4 Emergency Response program responded to the area and conducted assessments of major oil and industrial facilities and recovered orphan containers that were dispersed by the flood waters. The increase of the severity of rain fall events due to climate change will produce flooding in the State.

4. RCRA Hazardous Waste Management Facilities

RCRA regulates, among other things, the treatment, storage, and disposal of hazardous wastes. Owners/operators of these treatment, storage, and disposal (TSD) facilities must generally obtain a permit for those activities. Facilities that generate hazardous waste and store it for less than 90 days are also regulated under RCRA. In Region 4, the individual states are authorized to implement this program in lieu of EPA.

In order to operate as a TSD facility, the owner/operator must comply with numerous technical requirements, which ensure that covered activities are conducted in a manner that is protective of human health and the environment. These requirements apply to on-going hazardous waste management units (e.g., drum and tank storage, surface impoundments, waste piles), as well as to the closure (i.e., cleaning and decommissioning) of those units that are no longer in use. TSD facilities must also conduct cleanup of past and present releases of hazardous constituents.

a) Impacts on RCRA Hazardous Waste Management Facilities

The same climate change impacts that could affect contaminated site cleanups may also affect the management and operation of hazardous waste facilities. Some examples are:

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- Flooding may disrupt the transportation system in place to handle waste. For example, flooding may disrupt the pick-up of waste in neighborhoods and business or the work performed at transfer stations. Cities with transfer stations along waterways are at particular risk.
- A major storm event may increase the amount of solid waste generated and lead to the release of fuel or hazardous materials.
- Changes in precipitation may impact waste management practices such as composting by affecting biological processes.
- Vegetative cover on landfills may be compromised due to dry soil conditions.
- Tanks containing hazardous waste could be damaged by high winds or flying debris during hurricanes.
- Integrity of drums and drum storage areas could be compromised by flooding, allowing drums to be floated out of containment barriers, or cause intermingling of incompatible wastes, etc.
- The potential for failure of process equipment (e.g., pressure relief valves, emergency vent fans and pumps) could increase with increases in winter rain and ice storms.
- Over-pressurization of tanks containing volatile wastes and the emergency venting of these wastes could occur with extreme ambient temperatures.
- Buildings or other structures used for indoor storage of waste piles could be damaged or flooded in a hurricane causing the release of this material.
- Emergency evacuation routes for facility personnel and the surrounding community, as well as facility access by fire and other emergency response vehicles, could be flooded or otherwise restricted due to an extreme storm event.
- States may need to alter selected financial assurance remedies to ensure protection.

While Region 4 states are authorized to implement the RCRA hazardous waste management program, EPA retains oversight authority to ensure compliance with the statute and regulations and there may be a need for increased coordination to respond to climate change impacts. Region 4 will work with state programs and industry to modify operating facility permits to include enhanced emergency preparedness requirements appropriate for climate change impacts.

b) Programmatic Vulnerabilities for EPA's oversight role

- Uncertainties in the underlying assumptions that could affect the design, operation and management of hazardous waste facilities, including contingency planning (e.g., RCRA TSD facilities must meet specific requirements if waste management units are located within a 100-year floodplain).
- Financial assurance estimates for closure/post-closure may not reflect changing climate change impacts on those activities.

5. Oil Program and Underground Storage Tanks

OPA was signed into law in August 1990. The OPA improved the nation's ability to prevent and respond to oil spills by establishing provisions that expand the federal government's ability, and provide the money and resources necessary, to respond to oil spills. To reduce the likelihood

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of a spill, regulations issued under CWA Section 311(j) (published at 40 CFR Part 112) require facilities that store oil in significant amounts to prepare SPCC plans and to adopt certain measures to keep accidental releases from reaching navigable waters. Certain types of facilities that pose a greater risk of release must also develop plans to respond promptly to clean up any spills that do occur.[151]

EPA created the Office of Underground Storage Tanks to carry out a Congressional mandate to develop and implement a regulatory program for UST systems. EPA works with its state, territorial, and tribal partners to prevent and clean up releases from UST systems. The greatest potential threat from a leaking UST is contamination of groundwater, the source of drinking water for nearly half of all Americans. EPA, states, and tribes work together to protect the environment and human health from potential UST releases.[152]

a) Impacts on the Oil and Underground Storage Tank Programs

- Region 4 has a universe of USTs, which may be vulnerable to flooding events. Of particular concern is groundwater contamination from leaks from at risk tanks and damage to the supporting piping.
- Secondary containment and flooding of coastal facilities may be compromised by sea level rise.
- Alterations in shoreline geology and/or sea level rise may increase exposures of USTs or underground pipeline, increase pressure differences and gradients, and/or alter the flow of oil and hazardous substances in pipelines.
- Increase in precipitation and floods may have many impacts, as follows:
    - Decrease the effectiveness of secondary containment.
    - Increase flow and pressure to underground infrastructure/structures i.e. pipelines, wastewater treatment facilities, power plants, and paper mills. Increased flow and pressure to containment systems may result in back feed and flow of product resulting in increased discharges of oil.
    - Decrease tank headspace thereby displacing buffer space available to prevent overflow/ overfill, potentially leading to increased oil spills.
    - Increase weathering of underground and aboveground storage tanks (ASTs and USTs).
    - Increase flow and changes of navigable water depth, thereby increasing difficulty in preparing and implementing planning distance, booming strategies, and cleanup strategies.
- Failure of infrastructure (e.g. pipelines, and secondary containment) and damage or displacement of tanks due to increased intensity of hurricanes and resulting winds and storm surges. Damage to storage tanks would increase the likelihood of spills to navigable waters, coastlines and oceans.
- Increased degradation and weathering of pipelines and infrastructure due to ocean acidification resulting in oil spills.

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- As SPCC facilities are regulated solely on the probability that an oil spill from that facility will impact navigable waters, decreasing precipitation days and increasing drought intensity may reduce the number of facilities that fall under the jurisdiction of the SPCC program.
- Change in native or endemic organism availability for biotic degradation of oil due to increase in water temperatures.

6. Brownfield Program

While Brownfields Cleanup Sites will potentially be impacted much the same as Superfund, RCRA Corrective Action, and TSCA sites will be (discussed in section i), effects of climate change may also be felt by other aspects of the Brownfields Program.

a) Impacts on Brownfield Program

- Brownfield Grantees may have to make changes to their Master Plans as shorelines and flood zones change. Applicants who receive brownfield grant funds are encouraged to follow a community-developed Master Plan for redevelopment. Developing such a plan is an eligible grant expense but preference is generally given to communities who already have such a plan in place. Region 4 Project Officers should be prepared to allow changes as needed for climate adaptation.
- Development of a climate adaptation strategy for a brownfield site is an eligible grant expense. EPA Project Officers will have to become familiar with these types of plans so they can properly advise grantees.
- More sites may enter the brownfields inventory as natural disasters lead to release of hazardous substances and petroleum. EPA may begin experiencing even more competition for the already dwindling brownfields grant funding.
- Flooding could disrupt or delay work at existing Brownfield sites.

V. Goal 4: Ensuring the Safety of Chemicals and Preventing Pollution

A. Pesticides

EPA and the states (usually the State Department of Agriculture) register or license pesticides for use in the United States. In addition, anyone planning to import pesticides for use in the U.S. must notify EPA. EPA receives its authority to register pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

EPA's Pesticides program covers:

- Evaluating Potential New Pesticides and Uses
- Providing for Special Local Needs and Emergency Situations
- Reviewing Safety of Older Pesticides
- Registering Pesticide Producing Establishments
- Enforcing Pesticide Requirements

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- Risk assessment
- Pesticide Field Programs

Climate change may lead to an increase in pesticide use, due to an increase in pests and diseases which favor warm and humid climates. In the southeast, pesticides are widely used currently as the climate is hot and humid, and in most areas there is not a cold winter to kill off pests, thus pest problems tend to be a year-round issue. Many models now show the winter months in the southeast will become warmer as time goes on. The freeze-free seasons are lengthening and may result in the cessation of freezing in some areas, which may only increase the already high pest populations particularly in the northern areas of the region.[153] The southeast region has 12 major marine ports,[154] and thus the introduction of non-native pest species is a constant concern.

Currently the southeast is riddled with invasive pest species and it is likely that climate change will only continue to exacerbate this problem. The potential impacts of increasing pesticide usage include concerns about human exposure as well as concerns about non-target organism impacts, such as impacts to pollinators and beneficial insects, endangered species, aquatic organisms and others. Concerns for groundwater contamination will continue to be an issue especially in Florida, where the water table is high and soils are permeable. Karst topography is dominant in the southern part of the region and in parts of Kentucky and Tennessee.

B. Impacts on Pesticides Program

- Region 4 will experience new pest problems, many of which will be from exotic invasive species.
- Changes in pests and pest pressures will result from increases in temperatures and variations in rainfall patterns.
- There would be a potential increase in the need for emergency exemptions (FIFRA Section 18). These FIFRA exemptions are granted when an emergency pest problem appears which cannot be controlled effectively by the current pesticides registered for that pest or commodity, allowing temporary use of chemicals which are not registered for that use. The Section 18 requests are approved by EPA Headquarters. The regional role is to provide technical assistance to the states as needed.
- Urban populations have spread out into areas which at one time were largely rural which may increase citizen complaints from individuals living near farms. Region 4 may need to increase enforcement and compliance monitoring efforts to protect both farmworkers and residents living near farms.
- Increasing pesticides usage to control pests could also lead to increased resistance of the pest to the chemical being used. Resistance management will therefore become increasingly important.

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- The increase in amount and variability of precipitation projected for Region 4 can create an expanded mosquito habitat, which could increase exposure to more diseases like dengue fever and malaria.
- The Region will need to be prepared to address needs for aggressive mosquito control as well as support continued local monitoring of mosquito populations, which is currently being done by most large mosquito control districts in the southeast. Emergency exemptions for mosquito control may increase, especially after major weather events such as floods and hurricanes, which tend to spur populations of *A. aegypti* and *A. albopictus*.
- As more Section 18 requests may be anticipated, and more pesticides may be used in response to climate change, impacts to non-target endangered species will need to be considered and monitored.
- There will likely be an increase in fungal organisms in agricultural and non-agricultural settings due to extreme rainfall.
- Climate impacts may change chemical and non-chemical agricultural practices due to extreme storms and farmers' inability to work in their fields (e.g. increases the likelihood of run-off and off target movement of chemical products; limits on the potential use of certain non-chemical methods such as cultivation because it may not be possible to bring heavy farm equipment onto wet fields and saturated soils).
- Increased use of aerial applications are likely to result in increased pesticide drift due to extreme storm events.
- Drought may lead to an increase in dry condition pests (e.g. mites that feed on a variety of field, vegetable and fruit crops).

These changes in pesticide choices and quantities will require changes to the pesticide applicator certification and training programs. Changes in chemical selection could result in new and increased chemical exposures, especially for indoor applications. Types of new pest problems could include:

- Indoor and outdoor molds and microorganisms which are controlled by disinfectant pesticide products;
- Public health pests such as mosquitoes and ticks;
- Forest pests,
- Aquatic pests including weeds; and
- Various agricultural pests including weeds, insects and plant diseases.

VI. Goal 5 - Enforcing Environmental Laws within Region 4

Region 4 anticipates that in the future, climate change related issues may be raised in the context of EPA's enforcement program across the media – whether it be as part of a settlement

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negotiation, compliance issue, a mitigation project, a clean-up, or in another enforcement related context. EPA is already beginning to evaluate objectives associated with assuring compliance with the greenhouse gas reporting rule, encouraging greenhouse gas emissions reductions through settlements, and targeting the energy sector compliance with air, water and waste rules. *See, e.g.*, http://www.epa.gov/enforcement/data/goals.html. Region 4 will continue to work closely with its EPA HQ counterparts at EPA's Office of Enforcement and Compliance Assurance (OECA) to evaluate and determine appropriate options for considering and incorporating climate change adaptation principles into the Region 4 enforcement programs.

VII. Facilities and Operations

Climate change poses a range of risks to EPA Region 4's facilities and operations. The following sections detail the general risks and then delve into the risks specific to each facility. Note that each facility does not operate in isolation; the climate impacts experienced by each facility will be greatly influenced by the larger systems (utilities, transportation, communities) of which it is a part.

A. Severe Weather Preparedness

In response to severe weather conditions that may be attributed to Climate Change, EPA Region 4 has worked with the Federal Agencies at the Sam Nunn Atlanta Federal Center, the Atlanta Federal Executive Board (FEB), the Fulton County Emergency Management Agency, and FEMA to develop procedures to monitor severe weather and provide emergency alert notifications to Federal Agency Heads in the metro Atlanta area.

EPA and FEMA co-chair the Emergency Preparedness Committee of the Atlanta FEB. When potentially hazardous weather approaches the Metro Atlanta area the FEB convenes a weather alert committee by conference call to discuss the potential impact on Federal Buildings and employees. These calls include representatives for many Federal, State, and Local emergency and law enforcement agencies to provide the latest projection and assessment of weather impacts on the Atlanta areas.

The FEB Emergency Preparedness Special Weather Committee issues emergency advisory notices via phone, email, and telephone message line on early dismissal, delayed opening, and /or closure of Federal Offices. These alerts may be issued during the work day or after early morning conference calls at 4:00 am.

The EPA lead Interagency Occupant Emergency Command team at the Sam Nunn Atlanta Nunn Atlanta Federal Center (SNAFC) has incorporated weather emergencies into the building's Occupant Emergency Plan. For the past 3 years the SNAFC has conducted Shelter in Place exercises as part of Georgia's annual state-wide Tornado Drill. Over 5000 Federal employees and visitors participate in these exercises at the SNAFC each year.

EPA Region 4 has established a Continuity of Operations (COOP) site at the SESD facility in Athens Georgia. A limited number of essential personnel will report to and work out

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of this primary COOP site if the SNAFC were to be damaged by severe weather. The Region has a secondary site established at the Emergency Response Warehouse in Norcross Georgia in case the SESD facility in Athens is not operational. In this instance the executive leadership team would work out of the Norcross facility. Other employees would work remotely as needed using established Telework procedures.

EPA, FEMA, and the Atlanta FEB have joined together to plan and conduct a Multi Agency Continuity of Operations Exercise scheduled for May 2013. The event scenario for this exercise which will include all federal Agencies in the metro Atlanta area is severe catastrophic Tornado damage throughout the Atlanta and East Georgia areas. Planning for this event included a Home Security Executive Education Seminar held on March 19, 2013 attended by Agency Heads and senior executives from 28 Federal Agencies and representatives from the US District Courts. The continuity related incident used as the foundation for this executive seminar was a catastrophic tornado event approaching and then striking the metro Atlanta area. Discussion included operational roles and coordination between federal Agencies, State and local governments, and the private sector.

The Continuity of Operations exercise in May 2013 will include all of the Region 4 program offices working in cooperation with their counterparts in EPA Regions 3 and 5. Specific exercise injects are being developed to test each program's response to damage from the tornados. This will also be a Devolution of Operations exercise and program managers from the 3 EPA partner regions will work to test our readiness to continue mission essential functions by staff from another Region if Region 4 cannot functions due to the damage.

B. Overview of Potential Climate Change Impacts

From the facilities and operations perspective, the vulnerabilities associated with climate change encompass issues of energy, security, water quality and supply, severe weather damage, personnel safety, physical security, and communication interruptions. These facilities and operations support the broader agency mission of protecting air, water, and human health through the provision of functional, appropriate, and safe working spaces for personnel. Beyond the infrastructure and utilities that serve EPA rented or owned facilities and the operations that support the function of those facilities, broader impacts of climate change on transportation and communication systems are also vulnerabilities that EPA Region 4's could experience while meeting agency goals. While telework policies are in place to address these vulnerabilities, the magnitude of these impacts may extend to those alternate work locations, causing significant disruption to employee work and ultimately the EPA Region 4 mission.

However, while operations may be vulnerable in the areas described above, EPA Region 4 has developed a Continuity of Operations Plan (COOP) to maintain emergency functions should any particular facility or location be compromised. This plan provides guidance for continued uninterrupted operations and the performance of essential functions during emergency situations. The COOP includes provisions for physical relocation from current facilities and resource planning for up to 30 days.

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C. Region 4 Property Details

1. The SNAFC Building/Complex

The SNAFC Building is located on four acres in downtown Atlanta on the edge of the central business district, at the MARTA (Metropolitan Atlanta Rapid Transit Authority) Five Point Station mass transit train system. SNAFC houses 1.1 million sq. ft. of office space and 103,000 sq. ft. of joint use spaces (daycare, fitness center, health Unit, cafeteria, conference spaces, parking garage) occupied by 23 Federal Agencies. The complex consists of four connected structures: a twenty-four story high-rise tower, a ten story mid-rise tower, a six story, historic department store, restored to office use, and an eight story "Bridge" that spans the street and links the high-rise and mid-rise office buildings. EPA Region 4 is housed in the high-rise structure, occupying 330,000 rentable sq. ft. (RSF), on floors 9 through 16 and a 3rd floor bridge Conference Center. The building is serviced by underground utilities for domestic water and power/electricity and the natural gas is above. All building mechanical systems are on the roof and the Bridge building has the exhaust and fresh air exchange with two air handler units per floor in the Tower. Chillers are located in the basement.

2. SESD Laboratory

The Regional 4 laboratory, located at 980 College Station Road, Athens, Georgia, is built on a hill at an elevation of 714 feet above mean sea level, obviating any risks of direct flooding. Located on approximately eleven acres of land and is a single story structure of 57,760 RSF and open parking with covered boat/trailer parking structures. The SESD Laboratory is Region 4's COOP site, located approximately 50 miles North of the SNAFC Complex. For COOP preparedness, this Laboratory has been equipped with an emergency generator for back-up power that provides power to all private offices and training room, library and TS rooms. The emergency power is estimated to last 48 hours between refueling requirements. This time can be extended by minimizing the laboratory operations and additional fuel deliveries. Water reclamation systems and interstitial service corridors for serve and utilities between back-to-back laboratories located adjacent to the ORD Laboratory. The Laboratory is connected to well water. This Laboratory houses a mail and supply room for continued support during COOP activation.

3. SESD FEC

Located approximately 15 miles from the SESD Laboratory is a single story metal structure, occupying 13,800 RSF. This is SESD's Field Equipment and Laboratory cleaning and sterilization Center. This metal structure building has large bay doors and open parking.

4. ERRB Warehouse

Co-located property with connected structures in single-story building with open parking and large bay doors. The space is a combination of office and warehouse space 15,120 RSF. The Warehouse is approximately 20 miles North of the SNAFC Complex and is Region 4's secondary COOP location for the executive leadership team.

5. WPD S. FL Office

Region 4 occupies 3,011 RSF on the first floor of the three-story structure that was the former Florida Power and Light Hurricane Command Center. Region 4 is in the process of downsizing this space to approximately 500 RSF for two remaining employees. All the utilities and power lines are external, above ground utilities and power lines and often lose electricity with limited emergency back-up power. EPA has an emergency battery UPS to maintain server,

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LAN and router connections. There is a Water Supply Lake approximately 1000 feet away and an Intercoastal waters about 1 mile away that do not pose high threats for flooding.

6. Gulf of Mexico Program

The Gulf of Mexico Program, an EPA geographic program, occupies office space leased from NASA at Stennis Space Center (SSC) in Hancock County, Mississippi. The leased space is located on the 2nd floor of NASA Building 1100 (Main Administrative Bldg). NASA operates and maintains the office building we occupy, as well as all other facilities and operations, inclusive of security, fire and emergency services, police, highways, parking, power, water, sewer, and climate control. NASA has redundant power supply to the Stennis Space Center from two separate power grids located in the region. In 2012, we participated on a NASA SSC Stakeholder Conference focused on understanding potential climate change impacts to the SSC and beginning the adaptation planning process for the facility.

7. EPA's Gulf Ecology Division Laboratory campus

In the wake of Hurricane Ivan in 2004, six of the EPA's Gulf Ecology Division Laboratory campus' 40 buildings were destroyed. Located on the 16-acre Sabine Island, off the Florida Panhandle coast, it was especially vulnerable to Ivan's devastating winds and rain. The destroyed buildings were rebuilt incorporating sustainable technologies to protect it from coastal hazards and minimize its environmental footprint. Aluminum was chosen as the primary roofing material since shingles tend to come loose in high winds. Its light color reflects sunlight to keep cooling costs down. Local building codes required windows to be equipped with storm shutters or made of high-impact glass. EPA selected high-impact glass to provide safety and durability and added skylights to reduce artificial lighting use. Because the buildings are exposed to frequent rain, high humidity, and corrosive ocean spray, EPA selected a sturdy wood pulp, sand, and cement composite made of recycled material for the building's siding. The siding is a reflective, UV-resistant, white color. And a large porch lines the front to lower the building temperatures.[155]

VIII. Climate Change Impacts on the Most Vulnerable People

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

This Implementation Plan identifies key programmatic vulnerabilities and the priority actions that will be taken to address those vulnerabilities over time. As the work called for in this

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

EPA values its unique government-to-government relationship with Indian tribes in planning and decision making. This trust responsibility has been established over time and is further expressed in the *1984 EPA Policy for the Administration of Environmental Programs on Indian Reservations* and the *2011 Policy on Consultation and Coordination with Indian Tribes*. These policies recognize and support the sovereign decision-making authority of tribal governments.

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

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

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

Networks and partnerships already in place will be used to assist tribes with climate change issues, including Regional Tribal Operations Committees, the Institute for Tribal Environmental Professionals and the Indian General Assistance Program (IGAP). Additionally, efforts will be made to coordinate with other Regional and Program Offices in

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

A. Children

Children are likely to suffer disproportionally from both the direct and indirect adverse health effects of climate change.[156] Children are more vulnerable to environmental health risks resulting because of their developing systems, immature body organs, and weaker immune systems. Young children breathe more rapidly and inhale more air relative to their body weight than adults. Their metabolic rate is faster and they proportionately consume more fluids and food than that of adults. Their kidneys excrete toxicants and wastes at a slower pace compared to adults. Children are less able to protect themselves and their behavior, such as crawling on the ground and putting hands and foreign objects into their mouths, exposes them to different environmental hazards.

The Region's CEH Program goals are aligned with EPA's strategic goals of improving air and water quality, cleaning up communities, ensuring the safety of chemicals and preventing pollution. With the support of the Region's Program Offices and partnership with other organizations, the CEH program has conducted education and outreach and supported interventions at schools, daycare centers and in communities throughout the Region. The program has also provided support to address children's health hazards associated with environmental disasters or in higher risk communities.

1. Air Quality

The climate-change aspect of rising temperatures may detrimentally impact air quality in Region 4 by increasing ground-level or "bad" ozone formation, formed by nitrogen oxides chemically reacting with volatile organic compounds in the presence of sunlight.[157] Ground-level ozone is the major ingredient of smog and may lead to detrimental effects to children's health, particularly asthmatics. When children spend time outdoors during high-level ozone days, they may become more vulnerable to ozone health effects,[158] which include wheezing and coughing, inflammation of airways, lung function impairment, and infections in the lower respiratory tract.[159]

Changes in long-term weather patterns may result in more wildfires and drier soils, and increased emissions of smoke and dust-related particulate matter. When inhaled, fine particles associated with wildfire smoke and dry-soil dust can cause serious respiratory health problems of coughing and breathing difficulty, lung-function impairment, asthma attacks, and chronic bronchitis.[160] Rates of preterm births, low birth weight, and infant mortality have been found to increase in those communities with high particulate pollution exposure.[161]

2. Indoor Air

In the United States, children spend an estimated 90 percent of their time indoors.[162] The anticipated climate change attributes of heavy rains, increasing temperatures, and high-humidity

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cycles will facilitate this trend. Consequently children will likely have increased exposure with identified indoor air agents of concern: heat and biological materials – pollen, molds and infectious agents, and air pollutants.[163]

3. Infectious Diseases

The expected changes in temperatures and rainfall in Region 4's climate is likely to facilitate the growth, survival, and transmission of vector-borne infectious diseases. Vector-borne is a term used to describe disease transmission by insects, animals, birds, and other living organism. Emergence of new infectious diseases, and changes in the evolution and geographic ranges of pests, infectious agents, and disease vectors, may lead to shifting patterns of indoor pesticide use and creation of new pesticides. The Region anticipates children may be detrimentally affected by anticipated changes in both indoor and outdoor pesticide use.

4. Flooding

The Atlantic and Gulf coasts are vulnerable to storms and hurricanes. Six of the eight states that have the experienced highest number of hurricanes are in Region 4.[164] Vulnerable populations, such as children, the elderly, and pregnant women could experience both direct and indirect consequences of floods. Direct exposures result in risks for drowning, injuries from debris, chemical contamination, and hypothermia. There are also risks associated with the damage done by the water to the natural and built environments which include infectious diseases, carbon monoxide poisoning, respiratory problems, malnutrition, physical and mental trauma, poverty related diseases, and diseases associated with displaced populations.

5. Clean Water

Warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms. Harmful algal blooms also occur in freshwaters, and as these waters warm it is expected algal blooms will increase in frequency and intensity. Children are especially vulnerable when they swim in surface waters, and eat contaminated shellfish because their immune systems are developing and they consume more food and drink more water-per-pound of body weight than adults.

6. Safe Drinking Water

Lack of safe drinking water may cause gastrointestinal diseases that may be fatal for some or detrimentally impact other children's health.[165] The climate change aspects of extreme and severe weather may result in the breakdown of sanitation and sewer systems resulting in exposure to unsafe flood and storm water exposure and unsafe drinking water increasing the potential for children's exposure to disease-causing organisms, such as gastroenteritis and infectious diarrhea.

7. Impacts on Region 4 Children's Environmental Health (CEH) Program

While the CEH program focuses on reducing environmental health threats to our most vulnerable populations, adequate resources and regulatory authority may present impediments in addressing the multitude of potential environmental health issues that may result from the

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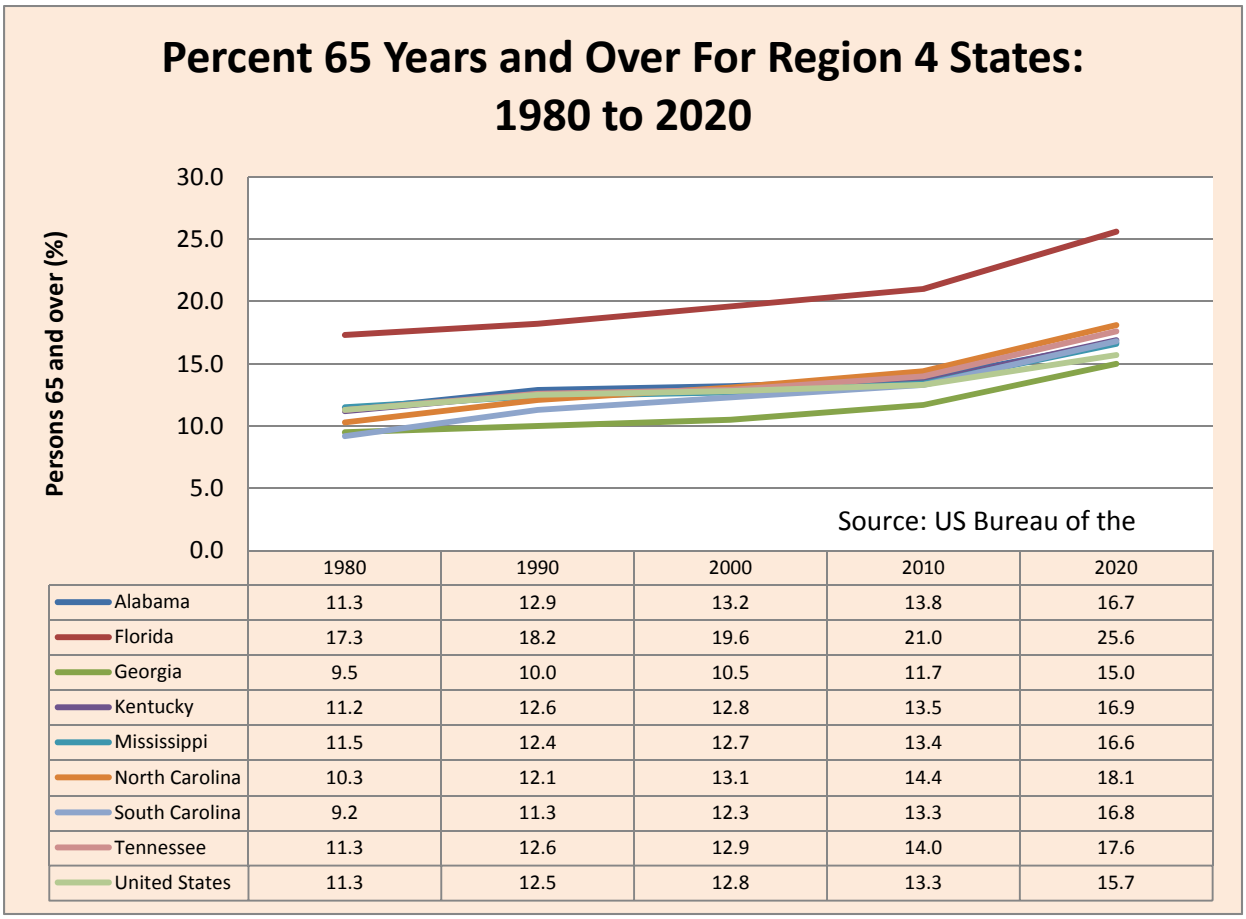
impacts of climate change. Region 4's CEH Program has some tools and resources to conduct or promote limited educational, outreach and intervention activities addressing CEH issues associated with climate change. The CEH program will have to develop additional tools and resources to address the unique concerns facing the most vulnerable groups in the most vulnerable communities.

B. Elderly Population

The vulnerable population, in addition to children, includes the elderly. Elderly is usually defined as those adults who are 65 years of age or older. Approximately 13.8 % of the population within Region 4 is elderly according to the 2010 US Census with Florida having the largest number of elderly. The projections for 2020 show an increasing trend in population growth for every state.



	1980	1990	2000	2010	2020
Alabama	11.3	12.9	13.2	13.8	16.7
Florida	17.3	18.2	19.6	21.0	25.6
Georgia	9.5	10.0	10.5	11.7	15.0
Kentucky	11.2	12.6	12.8	13.5	16.9
Mississippi	11.5	12.4	12.7	13.4	16.6
North Carolina	10.3	12.1	13.1	14.4	18.1
South Carolina	9.2	11.3	12.3	13.3	16.8
Tennessee	11.3	12.6	12.9	14.0	17.6
United States	11.3	12.5	12.8	13.3	15.7

The elderly are very vulnerable and susceptible to the effects of climate change that cause extreme weather conditions such as floods, storm surges, high winds, heat waves and hurricanes.

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In general, the elderly are very vulnerable due to various physiological, psychological, and socioeconomic factors that they cope during these extreme weather conditions.

Physiologically, they are already having higher prevalence of certain chronic diseases, medical conditions, and functional limitations that are exacerbated and impairments aggravated. An increase in ground-level ozone that occurs with climate change can lead to respiratory problems, such as asthma, heart disease, chronic obstructive pulmonary diseases (COPD), premature mortality. In addition, an increased number of emergency room visits and hospital admissions are experienced among the older adults. Extreme heat can induce heat-related mortality, heat exhaustion, heat strokes, dehydration, acute renal failure, and cardiopulmonary diseases.

Psychologically, the elderly are affected because of their functional limitations and mobility impairments that are present due to their decline in muscle strength, coordination, and cognitive functions that have occurred from illness, chronic diseases, or injuries in the older adults. The elderly are very sensitive to any extreme changes and environmental exposures resulting in decreased adaptive capacity to mentally adapt to these changes.

Socioeconomically, the older adults, especially, those living in poverty are deeply affected by not able to pay for air conditioning or well-constructed housing which would have helped them handle the extreme heat waves and hotter days. The elderly also have difficulties to access adequate transportation or other social services when needed during times of crises. Finally, they might not have sufficient financial support with lack of insurance and limited personal finances that lead to elderly not able to cope.

C. Environmental Justice

Empirical studies have shown that certain types of communities tend to suffer a disproportionate impact of environmental harms causing health-related concerns. Race and income distribution are the two most important determinants of an environmental justice community. EPA defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."[166]

Climate change poses special environmental justice challenges for communities that are already overburdened with pollution and environmentally-related illnesses. One challenge is a population's ability to prepare, respond, and recover when a disaster does occur. Hurricane Katrina helps illustrate the issue of environmental justice in the Southeast. When Hurricane Katrina struck Louisiana, Mississippi, and Alabama, it struck the three poorest states in the country; two of the states are located in Region 4.[167] The people most disproportionally impacted by the flooding and destruction of Hurricane Katrina were disadvantaged, mainly black communities.[168]

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In general, environmental justice communities tend to be located next to or near potentially harmful areas. The charts below present the poverty status and racial demographics in Region 4 states.[169]

Subject	*Total*	*Below Poverty Level*	*Percent below Poverty Level*
REGION IV STATES			
Population (as of April 1, 2010)	61,082,315	-	-
Population for whom poverty status is determined	59,932,739	10,067,497	17.7%
Under 18 years	14,044,902	3,564,293	25.4%
Related children under 18 years	13,933,500	3,515,407	25.2%
65 years and over	8,424,993	860,595	10.2%
White alone, not Hispanic or Latino	38,137,978	4,809,917	12.6%
Hispanics	6,692,784	1,734,054	25.9%
Minority	21,794,761	5,797,580	26.6%

Considering all the individual states in Region 4, the poverty status for children, elderly people, and minority is highest in the state of Mississippi.[170] Poverty status for these same categories, on average across the Region, is high in the states of Alabama, Kentucky, South Carolina, and Tennessee.[171]

Total Population	61,082,315
% White	70.8
% Black	21.3
% Asian	2.1
% American Indian	0.5
% Other Race	3.2
% Multiracial	2.1
% Minority	36.2
% Hispanic or Latino (of any race)	11.1

Florida, Georgia, and Mississippi have the highest percent minority of all the individual states in Region 4.[172] Florida also has the highest percent Hispanic or Latino of any race.[173]

Environmental justice communities are concerned with the air pollutants contributing to the issue of climate change, in particular the coal-fired power plants that emit greenhouse gases and contribute to coal ash that must be stored and disposed. Mercury, arsenic and lead are also of major concerns. According to the American Lung Association, African-Americans are twice as likely to die from asthma attacks and Puerto Ricans have the highest asthma prevalence.[174]

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Moreover, African-American, Hispanic, and Asian-Pacific Islander women who were pregnant were much likely than pregnant White women to live in areas with higher levels of air pollution.[175]

Climate change will have an adverse effect on human health, especially within environmental justice communities. Some of the human health consequences of climate change include asthma, respiratory allergies, and airway diseases, cancer, cardiovascular disease and stroke, food borne diseases and nutrition, heat and weather-related morbidity and mortality, and waterborne diseases.[176]

D. Tribal Governments

The United States has a unique legal relationship with Tribal governments based on the Constitution, treaties, statutes, Executive Orders, and court decisions. This relationship includes recognition of the right of Tribes as sovereign governments to self-determination, and an acknowledgment of the federal government's trust responsibility to Tribes. EPA works with federally-recognized Tribes on a government to government basis and, in keeping with the federal trust responsibility, consults with and carefully considers the interest of Tribes when making decisions and taking actions that may have Tribal impacts.[177]

Tribal communities are disproportionately vulnerable to climate change impacts, largely as a result of their close connection to the land, water, and natural resources. Tribes have limited relocation options due to reservation boundaries, and often depend upon their traditional homelands for natural resources to sustain economic, cultural, and spiritual practices. The accumulated knowledge and understanding of a Tribe's environmental connection with their homelands, or Traditional Ecological Knowledge (TEK), is intrinsically linked to Tribal cultural practices and threats to resources on which they depend.[178] A combination of qualitative data, gathered with TEK, and western science is needed to comprehensively understand and address Tribal climate change impacts. In Region 4, shifting habitats of to traditional food sources and medicinal plants have been observed based on TEK.

Economic impacts related to climate change are also anticipated. For example, the Eastern Band of Cherokee Indians manages a successful commercial trout fishery that attracts thousands of fishermen to the area year-round. North Carolina trout populations are predicted to experience significant reduction as a result of climate change; the estimated welfare loss is $5.63 to $53.18 per angler per single occasion.[179] A loss of this magnitude could drastically impact the viability of the Tribe's fishery program and overall economic well-being.

There are six federally-recognized Tribes in Region 4: Eastern Band of Cherokee Indians, Mississippi Band of Choctaw Indians, Catawba Indian Nation, Seminole Tribe of Florida, Miccosukee Tribe of Indians of Florida, and Poarch Band of Creek Indians (Figure below). Each Tribe is geographically diverse with unique government structures, priorities and challenges. EPA is committed to strengthening its partnership with Tribes on priorities related to climate change adaptation and to supporting the development of Tribal adaptive capacity.[180] The

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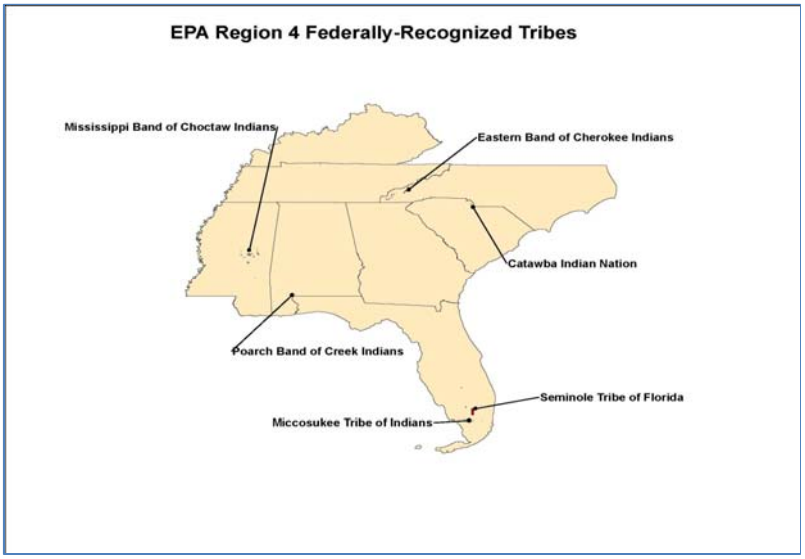
vulnerabilities listed below identify potential areas in which Region 4's ability to be responsive to Tribal climate change adaptation priorities and adaptive capacity building needs may be impacted.



1. Resources

Tribal environmental programs are severely understaffed and underfunded. In some cases, Region 4 Tribal environmental departments are staffed by as few as two environmental professionals responsible for the development and implementation of environmental programs. Fiscal Year 2015 EPA funding needs for Region 4 Tribes are estimated at$ 9.7M; Tribes are currently funded at less than 25% of the projected need.[181] Anticipated Region 4 resource vulnerabilities include:

- Lack of funding to assist Tribes in climate change adaptation planning and related activities, such as increased air quality monitoring due to the potential of more frequent wildfires.
- Increased demand for technical resources, such as access to climate change information, tools and professionals, as well as innovative approaches to assist in developing climate change adaptation plans or address climate change priorities due to limited staff availability at Tribal level.
- Increased demand for training and information dissemination regarding climate change adaptation and potential adverse effects of climate change.

2. Education and Outreach

Tribes are subject to geographical impacts and, as sovereign nations, have unique government structures, planning processes, and capabilities for adaptation and response. Generally, there are few resources available to EPA for ascertaining regional and individual Tribal climate change impacts, priorities, and readiness capabilities. Anticipated Region 4 education and outreach vulnerabilities include:

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- General lack of staff education and awareness of climate change priorities and impacts unique to Region 4 Tribes, including those related to Tribal boundaries and economic, cultural and spiritual practices.
- Lack of knowledge of existing Tribal climate change readiness and adaptive capacity.
- General lack of staff education, awareness and incorporation of TEK in Agency decision-making and planning, including traditional practices that may exclude climate change adaptation planning.

3. Communication and Collaboration

Climate change related priorities, responsibilities and activities vary by governmental agency. Tribes work with federal, state and local governments, and are often required to be responsive to complementary or duplicative requests for consultation and information sharing. Anticipated Region 4 communication and collaboration vulnerabilities include:

- Need for increased federal coordination and collaboration to share climate change adaptation efforts, as well as to inform, discuss and consult with Tribes on climate change actions, concerns, interests and priorities. Federal coordination, collaboration and consultation have been requested by Region 4 Tribes.
- Need for increased cross-program coordination and collaboration to inform, discuss and consult with Tribes on EPA and Region 4 specific climate change actions, decisions, and opportunities, such as adaptation planning process and anticipated climate change impacts to the Region.
- Jurisdictional challenges with adjacent local and state governments may impact collaboration opportunities and access to resources.

IX. Vulnerability Assessment Table

See Appendix A.

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[180] *Draft EPA Climate Change Adaptation Plan*, June 29, 2012.

[181] Region 4 RTOC Environmental Priorities; National Tribal Caucus presentation, March 2013

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PART 3

PRIORITY ACTIONS

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I. Introduction

The EPA's draft Climate Change Adaptation Plan identified nine agency-wide priorities for integrating climate change adaptation into its programs, polices, rules, and operations.[182] EPA's priorities are to:

- Fulfill the FY 2011-2015 EPA Strategic Plan measures.
- Protect EPA's facilities and operations.
- Factor legal considerations into adaptation efforts.
- Strengthen EPA's staff and partners' adaptive capacity through training.
- Develop decision-support tools to facilitate EPA staff and partners' integration of climate-change adaptation planning into their programs and operations.
- Identify cross-EPA climate adaptation science needs.
- Partner with tribes to increase their adaptive capacity.
- Focus on most vulnerable people and places.
- Measure and evaluate performance.

The Regions have been tasked with using the Agency's draft plan as guidance for their respective independent, stand alone plans.[183] The Regions have been requested to clearly articulate our criteria used to identify priority actions since limited and uncertain resources make it impossible to undertake all our proposed actions. According to the Agency's draft plan, Regional priority actions could range from addressing those vulnerabilities identified in the Region's vulnerability assessment to building Regional staff adaptive capacity through training. Some of the criteria Region 4 considered included, but were not limited to:

- Does the action support and align with other Region 4 priorities and actions, i.e. Strategic Plans?
- Is the action a priority for our partners?
- Does the action have an impact on reducing risk?
- Does the action protect a critical resource/investment?
- Is EPA uniquely situated to address the action?
- When is the climate risk likely to occur?
- Can the action be accomplished within current budget?
- Will the action be sustainable/durable?

Region 4 identified priority actions it could take to ensure that we can continue to accomplish our mission and operate at our multiple locations. The following priorities represent EPA Region 4's commitment to address the known programmatic vulnerabilities and to continue to identify other vulnerabilities that may occur over time due to climate change. By listing an action as a priority, the Region is not making a budgetary commitment to take or complete that action or to take or complete it by a particular point in time. The Region's ability will depend on resource

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availability – which is uncertain. The Region has proposed actions it thinks are consistent with its role as a Regional office and can do as resources are available or when it can accomplish the priority concurrent with or as part of its ongoing activities.

As Regional Offices have been developing their priority actions, two categories of priority actions have emerged: region specific and "national-level" priority actions. The "national-level" priority actions are those that must be taken before the Regional Offices can appropriately implement climate change adaptation within their region. Appendix B is Region 4's Priority Action Matrix that identifies each priority action as a National and/or region specific action and notes whether Region 4 will need more coordination, policy, and/or guidance from EPA Headquarters.

II. EPA Region 4's Adaptation Strategy[184]

Region 4 is currently updating its Fiscal Year 2013-14 *Draft Energy and Climate Change Strategy* (Strategy) to describe the actions it would pursue to help the Southeastern United States address clean energy and climate change challenges. Two sections of this Strategy, Adaptation and Education, address the Region's concentration on climate change adaptation. In performing this work, the Region will use good science and state of the art analysis and will work to continually improve its ability to measure positive change. The Region will also continually evaluate and, as appropriate, adjust our base regulatory and assistance programs to account for climate change.

A. Adaptation: Actions to Understand and Respond to Unavoidable Changes

The Region 4 will assist its state, local, and tribal governments and Federal resource managers to prepare for and respond to climate-related changes such as sea-level rise, weather-related impacts on agriculture, changes in water quality and availability, and impacts on human health and ecosystems. Specifically, as budgets allow, the Region will work with its stakeholders to develop and implement strategies to respond to local concerns and to share these methods with other communities through such potential actions as:

- Promote EPA's Clean Energy-Environment State Partnership that encourages states to develop and implement cost-effective clean energy and environmental strategies.
- Promote EPA's Climate Ready Water Utilities and Climate Ready Estuaries programs that aid respective water sectors to understand climate science and adaptation options, as well as assess climate change vulnerabilities, implement adaptation strategies, educate stakeholders, and share lessons learned.
- Promote the SunWise Program to teach the public how to protect themselves from overexposure to the sun through the use of classroom-, school-, and community-based tools.

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- Reduce the potential for wildfires and limit impacts on particulate matter air quality through prescribed fire and smoke management efforts with the Southeast Regional Partnership for Planning and Sustainability (SERPPAS).

- Work with local/state/federal emergency preparedness and response counterparts and businesses to develop and implement strategies to address adaptive measures needed for climate-related changes and work with state and industry to add enhanced emergency planning in operating permits.

- Promote the Southeastern Ecological Framework as a tool for evaluating and adapting to climate change impacts on important ecosystems and services across eight Southeastern states.

B. Education: Actions to Inform Internal and External Stakeholders

Region 4 will work to educate internal and external stakeholders on the science of climate change, energy efficiency and conservation, mitigation and adaptation activities, and revitalization through the following potential actions:

- Implementing activities that support national Climate for Action Education and Outreach Campaign.
- Working with the Region's National Estuary Programs and other coastal communities to assess vulnerabilities from and to adapt to climate change impacts.
- Promoting EPA's Smart Growth program to help communities grow in ways that expand economic opportunity, protect public health and the environment, and create and enhance the places that people want to live and work.
- Promoting the revitalization of contaminated land to productive environmental and economic reuse, with an emphasis on green technologies.
- Implementing additional activities that educate the public on climate change.

III. FY 2011-2015 EPA Strategic Plan measures

The following is Region 4's discussion on a goal by goal basis of possible priority actions the Region may take to integrate climate change adaptation into its programs and operations. In general, the Region does not engage in rule making activities with the exception of TMDL development, Offshore Dredged Material Disposal Site designations, and SIPs? For these limited rule making opportunities, the Region can incorporate as appropriate and consistent with Program Office guidance the best available climate change adaptation science to inform its decision making.

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A. Goal 1- Taking Action on Climate Change and Improving Air Quality within Region 4

Region 4 will pursue the following Region-specific actions to address climate change vulnerabilities related to our goal *Improving Air Quality*.

1. Ozone

Tropospheric (ground level) ozone pollution is likely to increase in Region 4 due to increased temperatures in the future. The Region will work with its partners at the state, local, and tribal levels to help them meet the ozone NAAQS.

- Work with other Regions and HQ air program managers to develop a strategy, in context to other programmatic priorities, on how to incorporate climate adaptation into air quality programs (e.g., SIP, permits).

- Criteria considerations impacts are medium for timing, medium for geographic/demographic scale, medium for programmatic scale, and low for physical.

2. Particulate matter

High local PM events are likely to increase due to changes in frequency or intensity of wildfires. The Region will work with its partners at the state, local, and tribal levels to help them reduce the potential for increased wildfires and limit the impacts on air quality.

- Mitigation actions can be implemented to reduce the potential for wildfires and resulting PM impacts. These actions include increased use of prescribed fires or alternative treatment options (e.g., mechanical clearing or herbicide treatments) to reduce the build-up of fuel loads in areas prone to wildfires.

- Smoke management is one of the important issues related to both wildfire and prescribed fire management. In the Southeast, Region 4 participates in a partnership of federal and state agencies called the Southeast Regional Partnership for Planning and Sustainability (SERPPAS). EPA has worked with the other partner agencies to develop a document containing Smoke Management Recommendations for prescribed fire. These recommendations could be applied more broadly to promote awareness of use of prescribed fire, which will reduce wildfire potential while also minimizing impacts on PM air quality. (Region-specific action)

- Criteria considerations impacts are medium for timing, medium for geographic/demographic scale, medium for programmatic scale, and low for physical.

B. Goal 2 – Protecting EPA Region 4's Waters

Region 4 has identified the following actions to begin to address climate change vulnerabilities related to our goal of Protecting America's Waters. Many of these actions will benefit from the development and implementation of appropriate national guidance to promote

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consistency across the states. The Region will implement these actions in coordination with any related national guidance.

1. Watershed Planning

- Encourage green infrastructure and low-impact development to protect water quality, to make watersheds more resilient and to reduce the demand for additional water resources.
- Work with USGS to become knowledgeable in the best methods to model for current and projected low flow and high flow conditions in gauged and ungauged rivers and streams.

2. Water Quality Standards

- Use the Triennial Review of state water quality standards to work with states and tribes on changes in stream use classification or standards, where necessary, due to climate change induced increasing temperatures or changes in stream flow.
- Encourage states and tribes to develop appropriate coordination processes between water quality and water supply decisions to ensure proper implementation of state water quality standards.

3. Water Quality Monitoring, Assessing and Reporting

- Evaluate Region 4 states' and tribes' current monitoring and assessment practices to encourage the capturing of extreme low flow or other climate related conditions, including: 1) appropriate biological monitoring and assessment techniques, and 2) water monitoring system design.
- Work with states, tribes, and other water monitoring partners to help establish a long term monitoring program to track potential changes in temperature, flow, aquatic biological communities, habitat, and chemical constituents that are occurring over time at important sentinel reference sites in the SE Region.

4. Total Maximum Daily Loads (TMDL)

- Guidance from the Office of Water on methods and approaches is needed prior to the Region identifying specific regional actions.

5. National Pollutant Discharge Elimination System (NPDES)

- Encourage States to update fact sheets at permit reissuance to include the most up-to-date critical low flow as possible and to calculate reasonable potential based on those values.
- Continue to work with states on the incorporation of green infrastructure components in MS4 permitting.

6. Non-Point Source (NPS)

- Work with states and tribes to include climate change adaptation provisions in revised Nonpoint Source Management Plans to provide flexibility to fund programs and projects to assess, evaluate, plan and implement climate change adaptations.

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7. Wetlands (CWA 404)

- Consider the effects of climate change as appropriate when evaluating Least Environmentally Damaging Practicable Alternatives (LEDPA) in the context of CWA Section 404 Wetlands Permitting.
- Ensure water conservation and efficiency measures are considered, where appropriate, as part of wetlands 404 permitting before new water resource projects are approved.

8. Dredging/Ocean Dumping

- Promote the beneficial use of suitable dredged material to support environmentally sound projects to protect from sea level rise and storm surge.
- Develop protocols to address the likely increase in emergency dredging from hurricanes of increased intensity and other extreme precipitation events that may cause unexpected sedimentation and shoaling.

9. National Estuary Program and South Florida

- Promote the Climate Ready Estuary program in Region 4 National Estuary Programs (NEPs).
- Promote the development of NEP coastal watershed management plans that consider climate change.
- Promote the development of vulnerability assessments by Region 4 NEPs.
- Work with the NEP's to revise and update the NEP Comprehensive Conservation and Management Plans (CCMPs) to address vulnerabilities to climate change.
- Work with the Gulf of Mexico Program Office, Region 6 and the Gulf of Mexico Alliance to address climate change in projects and programs under the BP Deepwater Horizon Natural Resource Damage Assessment and Restore Act procedures.
- Work with the Governor's South Atlantic Alliance to include climate change considerations into South Atlantic Alliance efforts.
- Continue to work with Monroe County, Florida (Florida Keys) to implement climate change in water quality management planning for protection of the Florida Keys National Marine Sanctuary.

10. Drinking Water, Wastewater and Stormwater Infrastructure

- Guidance from the Office of Water on methods and approaches is needed prior to the Region identifying specific regional actions.

11. Drinking Water Quality

- Include assistance to the utilities in developing vulnerability assessments to the anticipated effects of climate changes through the Region's Energy Management Initiative to reduce energy consumption at wastewater and drinking water utilities.

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C. Goal 3 - Cleaning up Communities and Advancing Sustainable Development

1. Longer-term Cleanups (e.g., Superfund Remedial, Superfund Time-Critical Removal, RCRA Corrective Action, TSCA) and RCRA Hazardous Waste Management Facilities

- Identify and assess the potential vulnerability of NPL sites within delineated GIS-mapped zones (i.e., sea level rise, flooding due to storm surge, and flooding due to higher precipitation events) based on a consideration of site-specific factors (e.g., local topography, design and duration of cleanup remedies, potential risk to the cleanup).

- Based on the findings from the evaluation of potentially vulnerable NPL sites, develop an action plan to evaluate the vulnerability of other contaminated sites (e.g., brownfields, Superfund Time-Critical Removal, RCRA corrective action) and RCRA Hazardous Waste Management Facilities.

- In conjunction with tribes and state agencies, initiate an interagency dialog to plan and coordinate efforts to consider climate change impacts at contaminated site cleanups and RCRA hazardous waste management facilities.

- Incorporate energy efficiency and conservation into green site remediation practices funded by EPA, and encourage efficiency and conservation in actions conducted by responsible parties.

2. Emergency Response Program

- Utilize GIS-based mapping tools to locate potentially vulnerable critical public infrastructure (e.g., drinking water facilities, waste water treatment facilities) and sources of potential hazardous material releases (e.g., oil facilities) to aid in planning for and responding to emergency events.

- Conduct an assessment of the hazardous waste disposal infrastructure to determine whether it can manage potential disposal needs during a changing climate and whether facility operations will be impacted (e.g. accessibility, capacity, and disposal techniques).

3. RCRA and Brownfields

- Expand green remediation practices such as those which promote waste reduction, materials re-use and recycling, energy and water efficiency and conservation, use of alternate and renewable energies, and promotion of cleaner or reduced emissions.

- Integrate materials recovery principles, practices and programs into the Region's Brownfields and Revitalization program and projects.

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4. Oil Program (e.g., Spill Prevention, Control, and Countermeasure (SPCC)/ Facility Response Plans (FRP) Facilities)

- Create layers in GIS to enhance existing mapping tools demonstrating potential impact areas, flood zones, storm surge areas etc.

- Identify SPCC and FRP facilities within EPA Region 4 and include in updated mapping tools.

- Include consideration of climate change impacts in EPA Region 4 management reviews of current and future SPCC and FRP facilities.

D. Goal 4 - Ensuring the Safety of Chemicals and Preventing Pollution

- Promote EPA's Green Building and Sustainable Materials Management challenge programs to encourage healthier and more resource-efficient models of construction, renovation, operation, maintenance and demolition of buildings.

E. Goal 5 - Enforcing Environmental Laws within Region 4

1. The Office of NEPA

Section 309 of the Clean Air Act (CAA) confers upon EPA broad review responsibilities for federal actions. It authorizes EPA to review certain proposed actions of other federal agencies in accordance with NEPA and to make these reviews public. If the proposing agency does not make sufficient revisions such that the project remains environmentally unsatisfactory, EPA may refer the matter to the Council of Environmental Quality.

The EPA Administrator has delegated to the Office of Federal Activities, the national program manager role, and the ten Regional Administrators for review of specific regional actions. Materials Which EPA Reviews Under Section 309 Authority include, proposed legislation and regulation, Environmental assessment (EA), Environmental impact statement(EIS), draft and final, any proposal that the lead agency maintains does not require an EIS but that EPA believes constitutes a major federal action significantly affecting the environment so as to require an EIS.

Region 4's Office of NEPA will

- Work to with NEPA to appropriately incorporate climate change into their environmental assessments and to promote consistency with respective Climate Change Adaptation plans.
- Region will work with other federal agencies to appropriately address vulnerable people and places as they are impacted by climate change.

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The above actions were identified because they can be incorporated into the Region's NEPA staff routine activities. The Region NEPA Office often assists federal agencies implementing major federal actions having significant environmental impacts to identify appropriate alternatives and mitigation of impacts, including cumulative effects, to account for climate change. Moreover, the NEPA Office commonly serves an internal regional coordinating role to bring in all relevant and applicable regional program review on these projects. And as appropriate, the NEPA office facilitates discussions between affected communities and the federal agencies to resolve project conflicts. Additionally, EPA's unique CAA Section 309 authority gives it the opportunity to raise those projects of significance to the Council of Environmental Quality for appropriate resolution.

IV. Protect EPA's Facilities and Operations

A. Climate Events

The Region 4 office is located in downtown Atlanta, GA, sufficiently located distant from any major water body or coastal area. The relevant potential climate change impacts to this office are in the form of intense storm-related flooding, particularly the tunnel connecting office buildings and the subway system.

Additionally, tornado activity can be a problem as evidenced by the March 14–15, 2008, tornado outbreak within Region 4. A tornado caused widespread damage across downtown Atlanta, including to the CNN Center and to the Georgia Dome. EPA Region 4's office building is within a block of the Georgia Dome and near several other city buildings damaged by the storm.

The Region has Continuity of Operations (COOP) procedures in place. It is increasingly incorporating technology to allow work to effectively occur remotely should storm damage the Region's building making it inaccessible for routine business. In order to ensure effectiveness ad preparedness, several priority actions have been identified

- Investigate alternative lodging availability at the Alternate COOP Site.
- As a GSA building occupant, EPA Region 4 will promote facility efficiencies.
- Continue to use EMS to promote sustainable business practices including energy efficiency and renewable energy strategies that promote LEED certification.
- Maintain the staff's capacity to work remotely

B. Sustainability

In 2009, Executive Order 12514: "Federal Leadership in Environmental, Energy and Economic Performance" was signed to "establish an integrated strategy towards sustainability in

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the Federal Government and to make reduction of greenhouse gas emissions (GHG) a priority for Federal agencies." To ensure that EPA Region 4's buildings meet the requirements and reflect our mission, the Agency implements a range of strategies to reduce the environmental impact of its facilities and operations supporting sustainability.

- Develop interagency federal sustainability team to promote greening federal facilities in Atlanta. Recruit Federal Green Challenge partners from federal departments to reduce their climate change impacts.

- Support the development of sustainable recycling infrastructure and commodities markets through partnerships with state and regional recycling coalitions, by developing and supporting product stewardship and extended producer responsibility models, and through efforts to encourage the recovery and recycling of organic waste streams.

- Recruit partners to implement the SMM Food Recovery Challenge to increase economically valuable and environmentally responsible use and diversion of organic waste away from land-filling to minimize the creation and release of methane.

V. Factor Legal Considerations into Adaptation Efforts

As policy and/or guidance from Program Offices become available, the Region will implement climate change adaptation planning and priority actions consistent with EPA's statutes and regulatory authorities.

No Priority Actions identified

VI. Strengthen EPA's Staff and Partners' Adaptive Capacity through Training

The Region sponsored a Climate Change Adaptation kick-off session, on March 18, 2013, as the first step in making its management and staff aware of the Agency's climate change adaptation planning efforts and the National Climate Assessment efforts at providing regional climate scenarios.

The Region recognizes climate change adaptation training is only as useful as it is relevant to staff's daily programmatic activities. The Region believes appropriate climate change adaptation-related training will inform staff how EPA intends to: 1) incorporate best available climate-change science into Agency's programs consistent with EPA's statutory and regulatory authority and the various Program Office guidance and 2) interpret existing statutory and regulatory authority to support climate change adaptation related activities to insure nation-wide consistency in implementing the Agency's mission.

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- Encourage regional employees to take EPA Headquarters created training regarding climate change adaptation.
- Utilize Region 4's Energy and Climate Change Steering Committee and Workgroups to monitor opportunities to educate and outreach to employees and look for areas where climate change adaptation can be incorporated.
- Look for opportunities to bring in guest speakers to lecture employees about climate change and potentially how other agencies are tackling adaptation.
-

VII. Partner with Tribes to Increase their Adaptive Capacity

Region 4 has invited consultation with the six-federally recognized Tribes on climate change adaptation planning, and will continue to coordinate and support Tribal climate change adaptation efforts consistent with the Agency's statutory and regulatory authorities, program office guidance, and resources.

a) Resources

- Coordinate with the Regional Tribal Operations Committee (RTOC) and individual Tribes to identify climate change priorities, assess Tribes' climate change adaptation readiness and determine training, technical assistance and/or resource needs. Determination of needs will include identification of applicable audiences (i.e., Tribal Leaders, environmental staff, community, or other stakeholders). (Region specific action)
    - Criteria considerations impacts are high for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.
- Request clear guidelines from National Program Managers to Project Officers and Tribes about the management of available funds to grant awards addressing climate change adaptation activities. As an example, revise the OAR and EPA's Tribal Air Grants Framework: Menu of Options to include Climate Change Adaptation work as an option as appropriate and following the Clean Air Act. (National specific action)
    - Criteria considerations impacts are medium for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

b) Education and Outreach

- Facilitate a workshop or training for Tribal environmental staff on climate change impacts and priorities. Training may be provided through existing resources, such as the Institute for Tribal Environmental Professionals (ITEP) at Northern Arizona University.

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ITEP is currently planning a training in the southeast in Fall, 2013. (Region specific action)

  - Criteria considerations impacts are high for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

- Collaborate with R4 Energy and Climate Change Coordinator and Divisions to incorporate Tribal component(s) in energy and climate change website. (Region specific activity)

  - Criteria considerations impacts are medium for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

- Incorporate Tribal climate change priorities, Traditional Ecological Knowledge, and related information into training opportunities for Region 4 staff. (Regional and National action)

  - Criteria considerations impacts are medium for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

c) Communication and Collaboration

- Coordinate with federal partners on a regular basis to share climate change related efforts, and to streamline education, outreach and consultation with Tribes, where appropriate. Region 4 is hosting the first southeast federal Tribal liaisons meeting on March 19. (Region specific action)

  - Criteria considerations impacts are high for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

- Enhance interagency cross-program coordination and collaboration opportunities to inform, discuss and consult with Tribes on EPA climate change actions and decisions. (Region specific action)

  - Criteria considerations impacts are high for timing, small for geographic/demographic scale, medium for programmatic scale, and low for physical.

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VIII. Focus on Most Vulnerable People and Places

a) Children's Health Priority Actions

- Conduct an inventory of tools and materials available to address issues faced by children and pregnant women. Many of these existing tools may need to be updated or modified to more effectively target specific populations and risks. (National-level action)

- Promote and disseminate tools and materials to address issues targeting children and pregnant women. The use of partners and stakeholders can be utilized to assist in preparation and then equipped to support our information dissemination campaign. (National-level and Region-specific action)

- Educate and conduct outreach directed to pediatric health care professionals to enhance their understanding of the threats on children's health, and participate as children's advocates for strong mitigation and adaptation strategies. Pediatric health care professionals can be leaders in a move away from a traditional focus on disease prevention to a broad, integrated focus on sustainability as synonymous with health.[185] (National-level and Region-specific action)

- Conuslt with the Southeast Pediatric Health Specialty Unit (PEHSU) as a resource to address environmental health medical conditions that may be exacerbated by climate change. The expertise available through the National PEHSU Network should be expanded to include perinatology. The PESHU Network should also be equipped to provide expertise though consultations and training to public health officials and health care providers and to the general public through the media and direct intervention. (National-level and Region-specific action)

b) Environmental Justice

- Host climate change and adaptation educational workshops for environmental justice communities.

- Partner with other federal and state agencies and non-profit organizations to inform environmental justice communities of various activities and programs.

- Promote and distribute climate change and adaptation tools and materials via emails, listserv, and mailings.

- Create a train-the-trainer climate change and adaptation workshop where community partners are able to lead climate change and environmental justice workshops.

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[182] Final draft *U.S. Environmental Protection Agency Climate Change Adaptation Plan* (June 29, 2012).

[183] Final draft *U.S. Environmental Protection Agency Climate Change Adaptation Plan* (June 29, 2012).

[184] U.S. Environmental Protection Agency Region 4 Energy and Climate Change Strategy Fiscal Year 2013-14 DRAFT 3-13-13.

[185] *Pediatrics, Global Climate Change and Children's Health, Committee on Environmental Health*, 2007;120; 1149, Available at http://pediatrics.aappublications.org/content/120/5/1149.full.pdf

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PART 4

PERFORMANCE MEASURES

I. Introduction

This section describes how Region 4 plans to update the information and analysis in this implementation plan, evaluate the success of any activities, and continually improve the process of programmatic climate adaptation over time. The Region will implement measures and evaluate performance consistent with the Agency's statutory and regulatory authorities, Program Office guidance, and resources. Over the coming years, Region 4 will build and strengthen its adaptive capacity and work with its partners to build capacity in states, tribes, and local communities. We will empower its staff and partners by increasing their awareness of ways that climate change may affect their ability to implement effective programs, and by providing them with the necessary data, information, and tools to integrate climate adaptation into their work.

II. Phased Approach

Region 4 plans to conduct a baseline assessment of all its priority actions to determine the status and the potential for completion of each action. Additionally, Region 4 will finalize its Fiscal Year 2014 Energy and Climate Change Strategic Plan and ensure alignment with this implementation plan.

The National Water Program 2012 Strategy: Response to Climate Change found the most amenable approach for evaluating progress is to assess institutional progress toward becoming a resilient and adaptive program. The Region 4 plan utilizes this approach. Region 4 is adopting a phased approach that uses indicators of progress and emphasizes peer-to-peer learning rather than a top-down mandate. A similar approach is in use in the United Kingdom (UK DEFRA, 2010).

Region 4's Phased Approach tracks the region's institutional *process* and *progress* in incorporating climate change considerations into EPA programs. *Outputs* will not be counted per se; rather, the collectivity of actions and their products will demonstrate *the weight of evidence* for determining the status of adaptation activities. The following Table presents a summary of the seven phases of the Region 4 approach. Recognizing that it may take years or decades to achieve adaptive preparedness and resilience, Region 4 designed phases for which progress could be demonstrated within a relatively short time frame (1 to 3 years).

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Phases of Adaptive Management		
Phases	**Explanation**	**Examples of Evidence of Achievement**
1. Initiation	Conduct a screening assessment of potential implications of climate change to mission, programs, and operations.	• Preliminary information is developed to evaluate relevance of climate change to the mission or program; a decision is made as to whether to prepare a response to climate change; further exploration of climate change implications has been authorized. • Accountabilities and responsibilities are assigned at appropriate levels within the organization and resources are available to develop a more in-depth assessment.
2. Assessment	Conduct a broader review to understand how climate change affects the resources in question. Work with stakeholders to develop an understanding of the implications of climate change to the mission, programs, and operations.	• Review science literature and assessments to understand how climate change affects the resources being protected (threat to mission); Engage internal staff and external stakeholders in evaluation. • Identify climate change issues and concerns and communicate with internal and external stakeholders and partners. • Identify which specific programs are threatened and what specific information or tools need to be developed. • Communicate findings to partners and stakeholders and engage them in dialogue on building adaptive capacity.
3. Response Development	Identify changes necessary to continue to reach program mission and goals. Develop initial action plan. Identify and seek the research, information, and tools needed to support actions. Begin to build the body of tools, information, and partnerships needed to build capacity internally and externally.	• Develop initial program vision and goals for responding to climate change. • Identify needed response actions or changes that will allow the organization to begin to address climate impacts on its mission. • Initiate strategies and actions in a few key areas to begin to build organizational ability to use climate information in decision processes. • Identify program partners' needs for building adaptive capacity. • Begin working with an external "community of practice" to engage in tool and program development. • Rudimentary methods are put in place to track progress. • Develop a research strategy and partnerships to obtain additional needed research.

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4. Initial Implementation	Initiate actions in selected priority programs or projects.	• Make it clear within the organization that incorporating climate change into programs is critical. • Initiate actions and plans identified in Step 3. • Initiate cooperative projects with partners. • Develop a range of needed information and tools. • Begin to institute changes to incorporate climate change into core programs. • Some program partners have begun to implement response actions.
5. Robust Implementation	Programs are underway and lessons learned are being applied to additional programs and projects.	• Lessons learned are evaluated and strategies are refined. • Efforts are initiated to consider climate change in additional, or more complex, program elements. • Continue to institute institutional changes to incorporate climate change into core programs. • External communities of practice are in place to support ongoing capacity development.
6. Mainstreaming	Climate is an embedded, component of the program.	• The organization's culture and policies are aligned with responding to climate change. • All staff have a basic understanding of climate change causes and impacts. • All relevant programs, activities, and decision processes intrinsically incorporate climate change. • Methods for evaluating outcomes are in place.
7. Monitoring and Adaptive Management	Continue to monitor and integrate performance, new information, and lessons learned into programs and plans.	• Progress is evaluated and needed changes are implemented. • As impacts of climate change unfold, climate change impacts and organizational responses are reassessed.

The intention is to use this approach to follow progress related to each program as the plan is implemented. The phase identified for each program is or will be a composite summary of the overall implementation. At this time, no attempt has been made to identify the phase of each individual action and Region 4 will begin its baseline assessment once there has been additional time to consider performance measures and consult with Headquarters and other Regions on the best practices.

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Appendix A - Region 4 Summary of Region 4 Program Vulnerabilities to Climate Change Impacts by EPA Strategic Goal

5-28-2013 Draft

Goal [a]	CLIMATE CHANGE IMPACTS [b]		EPA PROGRAMMATIC IMPACTS [c]			Region 4 Programmatic Impacts	
	Climate Change Impact [d]	Likelihood of Impact [e]	Focus of Associated EPA Program	Likelihood EPA Program will be Affected by Impact [f]	Example of Risks if Program were Impacted	Likelihood of Regional Program will be Affected by Impact	Example of Risks if Program were Impacted
Goal 1 - Taking Action on Climate Change & Improving Region 4's Air Quality	•	• Likely	• Protecting public health and the environment by approving state programs to meet National Ambient Air Quality Standards (NAAQS) and implementing programs in Indian Country.	• High	• Could become more difficult to attain NAAQS for ozone in many areas with existing ozone problems.	• High	• There could be more ozone exceedances in current nonattainment areas (Atlanta, Birmingham, Memphis,etc) and new non attainment areas that were previously attaining.
	• Increased frequency or intensity of wildfires	• Likely[2, 11]	Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards	• Medium	• Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) and ozone pollution in areas affected by more frequent wildfires.	• Medium	• An increase in wildfire activity could cause more frequent elevated PM events, which would be hazardous to human health.
	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very Likely[3] • Likely[3]	• Protect public health by promoting healthy indoor environments through voluntary programs and guidance	• Medium	• Could increase public health risks, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations	• Medium	• Could see an increase in flooding which can contribute to mold and increased exposure to indoor chemicals as people stay indoors during heavy precipitation. • Could see more power outages which can lead to increases in $PM_{2.5}$ emissions from backup electricity and heat sources.
	• Effects on the stratospheric ozone layer	• Likely[4]	• Restoring the stratospheric ozone layer • Preventing UV-related disease • Providing a smooth transition to safer alternatives	• High	• Unable to restore ozone concentrations to benchmark levels as quickly at some latitudes	• Medium	• Continued decreases in ozone-depleting halocarbon emissions are expected to reduce their relative influence on climate change in the future; however potential for increased use of pesticides that contains ozone-depleting halocarbon emissions. • Climate Change may exacerbate health effects of ozone layer damage at some latitudes and mitigate them at others.

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	• Effects on response of ecosystems to atmospheric deposition of sulfur, nitrogen, and mercury	• Likely[5]	• Ecosystem protections from Agency emissions reduction programs	• Low	• Based on evolving research, could have consequences for the effectiveness of ecosystem protections under those programs	• Low	
Goal 2: Protecting Region 4's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely[9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	• High	**Watershed Management** • Higher air and water temperatures combined with nutrient pollution may result in increased growth of algae and microbes that threaten aquatic ecosystems. • Higher air and water temperatures may increase pollutant concentrations and lower dissolved oxygen levels, potentially resulting in additional water bodies not meeting water quality standards and being listed as impaired. • Areas experiencing periods of less precipitation, drought, lowe stream flow and limited ground water recharge may result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments. • Areas with increased intensity of drought or that may experience increases in events such as wildfires may see alterations in the structure and function of watersheds potentially affecting regional and state wetlands delineation and protection programs. • Increased intensity of rainfall events and storms may cause an increase in the number of sewer overflows and wastewater bypasses, fouling streams and requiring increased water quality enforcement.

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Goal 2: Protecting Region 4's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely[9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	• High • High	**Water Quality Standards** • Warmer waters and other ecological shifts will threaten aquatic habitats and aquatic species, such as cold water fisheries and potentially requiring changes in State stream classificationsSalinity changes due to seal level rise may create a need to reclassify some water bodies from fresh to salt water. Sea-level rise may also result in a shifting from fresh water communities to salt water communities, such as is happening in the Chassohowitzka River System in Florida. Increased anthropogenic use of freshwater upstream may be a significant contributor in converting fresh to salt water. **Monitoring, Assessing and Reporting** • Stream ecosystems will be affected directly, indirectly, and through interactions with other stressors. Biological responses to these changes will vary regionally and could include altered community composition, interactions, and functions. . • Monitoring locations may need to be re-located in order to effectively monitor and assess changes in stream ecology or water quality. • Timing of monitoring may need to change in order to pick up seasonal shifts and the full range of climate vulnerability, especially for recreational and aquatic life uses.

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	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely[9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	• High • High	**TMDLs** • Some areas may experience periods of less precipitation, drought, lower stream flow and limited ground water recharge resulting in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments; these considerations will need to be taken into account in the development of new TMDLs, and potentially result in the need for revision of existing TMDLs. • Some areas may experience episodes of increased intense precipitation resulting in increased runoff of pollutants; these considerations will need to be taken into account in the development of new TMDLs, and potentially result in the need for revision of existing TMDLs. **NPDES Program** • Areas experiencing periods of less precipitation, drought, lowe stream flow and limited ground water recharge will result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments. National Pollutant Discharge Elimination System (NPDES) permits wil need to take these factors into consideration during permit renewal or new permit issuance. These precipitation changes are compounded in certain areas by increased human uses of the water resources. • Increased intensity of rainfall events and storms may cause an increase in the number of sewer overflows and wastewater bypasses, fouling streams and requiring increased water qualit enforcement. • Increased aquatic temperatures may result in the need to modify existing discharge limits.

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	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely[9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	• High • High	**Wetlands** • Areas with increased intensity of drought or that may experience increases in events such as wildfires may see alterations in the structure and function of wetlands and watersheds potentially affecting regional and state wetlands delineation and protection programs. • Sea-level rise combined with coastal development will challenge the ability of coastal wetlands to migrate, potentially affecting coastal wetland protection programs. This migration will likely result in loss of coastal wetlands where developmen has encroached on natural migration pathways. • Drying out of seasonal wetlands with increased drought could affect wetland delineations and programs. • Physical damage or elimination of wetlands and dune structures that protect them due to hurricanes and other seasonal changes could affect wetland delineation and restoration efforts. **Dredging/Ocean Dumping** • Increased need and frequency of ocean dumping due to increased precipitation and rainfall intensity that cause erosion and sedimentation of rivers, channels and harbors. • Shifting sediments and forming of shoals due to higher intensity storms that impede safe navigation in harbors and channels may require increased use of emergency dredging. • Need for dredged materials to protect shorelines, beaches, dunes and marshes from sea level rise may stress existing regulatory programs.

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	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temperatures	• Likely[3] • Likely[3] • Very likely[6] • Likely[7] • Certain[8] • Very Likely [9]	• Restoring and protecting watersheds, aquatic ecosystems and wetlands	• High	• Increased number of sewer overflows and wastewater bypasses, as well increased pollutant loads in runoff, fouling streams and threatening public health. • Challenges to coastal wetlands' ability to migrate. • Reduced streamflow, altering the aquatic environments and increasing impairments. • Continued stress on coral reefs. • Shifts in aquatic habitat will threaten the economic and cultural practices of tribal communities.	• High	**National Estuary Program/South Florida** • Successful implementation of NEP Comprehensive Conservation and Management Plans may be adversely affected. Efforts to restore or enhance water quality, habitat, living resources, hydrologic alterations, and human uses may be affected. • Increased ocean temperatures and acidification resulting from the absorption of CO2 will continue to stress coral reefs potentially affecting coral reef protection programs.

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Goal 2: Protecting Region 4's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Increasing intensity of hurricanes • Increasing flood risk	• Likely[3] • Likely[3] • Very likely[6] • Likely[3] • Likely[7] • Likely	• Drinking water, wastewater and stormwater infrastructure	• High	• Water infrastructure could be rendered inoperable or damaged, needing substantial repair/replacement • Drinking water intakes and wastewater outfalls could be affected • Integrity of coastal water infrastructure systems could be put at increased risk. • Drinking water and wastewater utilities may need an 'all hazards' approach to planning for emergencies and extreme weather events. • Problems of safety as well as access to clean and safe water may be exacerbated for all communities	• High	• Higher air and water temperatures combined with nutrient pollution will result in increased growth of algae and microbes that affect drinking water treatment needs. • Increased intensity of rainfall events and storms could contribute to additional infiltration/inflow in wastewater conveyance systems, which could cause an increase in the number of sewer overflows and wastewater treatment plant overloads, requiring expensive modifications and improvements to both wastewater conveyance and treatment systems. • Increased drought will place demands on both surface and ground water resources resulting in water supply problems. • Reduction in assimilative capacity of existing surface waters due to reduced stream flows and/or increased temperatures could lead to more stringent discharge limits on existing wastewater facilities, resulting in the need for expensive improvements or upgrades to maintain permit compliance. • Sea level rise could result in: 1) saltwater intrusion into the collection system of wastewater treatment systems; 2) wet wells in pumping systems leading to increased corrosion damage to pumping equipment, and treatment plant tankage and equipment; withdrawals and 3) malfunction of gravity conveyance systems and discharges. • Increases in flooding from extreme precipitation, storm surges and loss of wetlands could cause damage to infrastructure resulting in increased needs for SRF funding. • Source water intake changes may be needed due to droughts and summertime extreme heat. Coastal aquifers may experience salt water intrusion where are outstripping recharge and increased pressure head from higher sea levels may worse this problem resulting in the need for relocation of water and wastewater facilities. •

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	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Increasing intensity of hurricanes • Increasing flood risk	• Likely[3] • Likely[3] • Very likely[6] • Likely[3] • Likely[7] • Likely	• Drinking water, wastewater and stormwater infrastructure	• High	• Water infrastructure could be rendered inoperable or damaged, needing substantial repair/replacement • Drinking water intakes and wastewater outfalls could be affected • Integrity of coastal water infrastructure systems could be put at increased risk. • Drinking water and wastewater utilities may need an 'all hazards' approach to planning for emergencies and extreme weather events. • Problems of safety as well as access to clean and safe water may be exacerbated for all communities	• High • High	• Drinking water and wastewater utilities emergency planning for extreme weather events may need to be reviewed and modified to account for climate change. Vulnerable and economically deprived communities may be particularly at risk, both for access to clean and safe water as well as for their ability to respond to emergencies during extreme events. Coastal and mountain communities will be particularly vulnerable. • Changes in rainfall patterns may lead to additional water supply infrastructure, with associated impacts on ecosystem fragmentation, aquatic life, physical stability, water quality, disruption of sediment and nutrient dynamics, downstream users, and system losses due to increased evaporation from impoundments. CWA Section 404 permit applications for reservoir creation in response to drought have increased in some states. **Nonpoint Source Management** • Increased intensity of rainfall events and storms will cause increased pollutant loads in runoff, and the velocity of runoff will scour and erode creek beds. • Accounting for greater quantities of runoff and pollutants, with more variability, from both urban and suburban stormwater and agricultural sources will stress existing nonpoint source best management programs. • Decreasing frequency of precipitation days and more concentration of runoff in intense storms, which is likely to be more damaging to aquatic habitats, and carry more erosion-related pollutants into water bodies will stress existing nonpoint source best management programs.

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Goal 2: Protecting Region 4's Waters	• Increased water temperatures • Increasing heavy precipitation events • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Loss of Snowpack	• Very Likely • Likely • Very Likely • Likely • Very likely	• The quality and availability of safe drinking water	• Medium	• High water temperatures and increased stormwater runoff will increase the need for drinking water treatment, raising costs. • May cause saltwater intrusion in surface water and ground water placing increased demands on drinking water treatment. • Water supplies may be affected, forcing communities to seek alternative sources. • Water demand may shift to underground aquifers or prompt development of reservoirs or underground storage of treated water, requiring EPA to ensure safety.	• High	• Higher air and water temperatures will promote increased growth of algae and microbes, which will increase the need for drinking water treatment and potentially affect the aesthetic quality of drinking water supplies. • Increased storm water runoff will wash sediment and other contaminants into drinking water sources, requiring additional treatment. • Sea-level rise could increase the salinity of both surface water and ground water through saltwater intrusion, encroaching upon coastal drinking water supplies. Additionally, extreme weather events such as hurricanes and extreme droughts could impact and potentially permanently affect both the availability and quality of drinking water sources. In southeastern areas with saltwater intrusion, Region 4 states may receive more permit applications and issue more permits for Class V aquifer recharge injection wells under the Underground Injection Control (UIC) program in an attempt to combat the effects of saltwater intrusion caused by sea-level rise. • Reduced annual precipitation or increased intensity and duration of drought in some regions will affect water supplies, causing drinking water providers to reassess supply plans and consider alternative pricing, allocation and water conservation options. • In areas with less precipitation, public water supply systems water demand may rely more heavily on underground aquifers or development of underground storage of treated water to supplement existing sources. Changes in the salt front of estuaries and tidal rivers due to sea level rise and over use of fresh surface and ground water resulting in flow changes may result in increased pressure to manage freshwater reservoirs to increase flows and attempt to maintain salinity regimes, in order to protect estuarine productivity and drinking water supplies.

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Goal 3: Cleaning Up America's Communities & Advancing Sustainable Development	•	• Very likely[6] • Likely[7] • Likely[7] • Very likely[3]	• Cleaning up Contaminated Sites and Waste Management	• Low	• Increased risk of contaminate release from EPA Sites • May need to alter selected remedies to ensure protection.	• Medium • High • High • Low • High • High	**Superfund** • Sea level rise may adversely impact contaminated sites in coastal areas in 6 of 8 Southeastern states through inundation, storm surge, and salt water intrusion • The Southeast is very likely to experience extreme storm events that could cause the release and affect the migration and management of contaminants through increased flooding, surface water runoff, infiltration into soils, and changes to water table levels). • Contaminated sites could experience increased wind damage and dispersal of contaminants through higher intensity hurricanes, particularly at coastal and near-coastal locations, o along major rivers. • Increased ambient temperatures could impact the design and operation of remediation systems due to extreme heat (e.g., increased pressurization of storage containers) and increased number of rain and ice storms during winter • Decreased precipitation days and increasing drought intensity could increase risk of wild fires and affect the design and operation remediation systems and restoration efforts at contaminated sites • Extreme storm events and other climate change impacts may create sudden, unexpected conditions at contaminated sites tha complicate cleanup actions, impose significant cleanup costs, and further endanger the health and safety of responders

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Goal 3: Cleaning Up America's Communities & Advancing Sustainable Development	•	• Very likely[6] • Likely[7]	• Cleaning up Contaminated Sites and Waste Management	• Low	• Increased risk of contaminate release from EPA Sites • May need to alter selected remedies to ensure protection.	• Medium • High	**RCRA** • The same climate change impacts that could affect contaminated site cleanups may also affect the management and operation of hazardous waste facilities. • Over-pressurization of tanks containing volatile wastes and the emergency venting of these wastes could occur with extreme ambient temperatures. • Buildings or other structures used for indoor storage of waste piles could be damaged or flooded in a hurricane causing the release of this material. • Region 4 has a universe of underground storage tanks which may be vulnerable to flooding events. Of particular concern is groundwater contamination from leaks from at risk tanks and damage to the supporting piping. • Failure of infrastructure (e.g. pipelines, and secondary containment) and damage or displacement of tanks due to increased intensity of hurricanes and resulting winds and storm surges. • Increased degradation and weathering of pipelines and infrastructure due to ocean acidification resulting in oil spills. • More sites may enter the brownfields inventory as natural disasters lead to release of hazardous substances and oil. EPA may begin experiencing even more competition for the already dwindling brownfields grant funding. • Flooding could disrupt or delay work at existing Brownfield sites.
	•	• Likely[7]				• High	
	•	• Very likely[3]				• Low	
	•					• High	
	•					• High	

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Goal 3: Cleaning Up America's Communities & Advancing Sustainable Development	• Increasing heavy precipitation events • Increasing risk of floods • Sea level Rise • Changes in temperature • Decreasing seasonal precipitation days/drought conditions	• Likely • Likely • Very Likely • Likely • Likely	Emergency Response	• High	• Increased need for emergency response. • Possible limitations to response capability due to staff and financial resource constraints.	• High	• Smaller entities with hazardous materials may lack resources for emergency planning, which may increase the risk of abandoned hazardous materials during a flooding or storm event. • Insufficient capacity to handle surges in treatment and disposals of hazardous and municipal waste as well as mixed waste from climatic events • Releases of hazardous materials or chemicals through high winds, flooding, and storm surge and a need for increased frequency and intensity of emergency response for both hazardous materials and oil. Current response resources, including laboratory requirements, may not be adequate for responses to extreme events. Specific impacts include o Increased number of brown/black outs will potentially lead to impacts with facility processes (i.e. runaway reactions, heat reactions, failure of chemical processes) o Coastal hazardous material and oil facilities may be impacted by extreme events and storm surge. The United States Coast Guard (USCG) has jurisdiction over hazardous material and oil spills along the coast, but the U. S. EPA has interagency agreements in place to support the USCG during responses. • Storm surge caused by coastal storms, hurricanes and sea-level rise and flooding may cause the destruction of many homes in the impacted area. This will produce an increase in the amount of household hazardous waste and white goods (i.e., refrigerators, air conditioners, etc) that may need to be collected and placed in landfills. • Storm surge caused by coastal storms, hurricanes and sea-level rise may adversely impact industrial facilities located along the coast and cause releases of chemicals, discharge of oil and spread orphan containers (i.e., above ground storage tanks, drums, totes) in the affected area.

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Goal 3: Cleaning Up America's Communities & Advancing Sustainable Development	• Increasing heavy precipitation events • Increasing risk of floods • Sea level Rise • Changes in temperature • Decreasing seasonal precipitation days/drought conditions	• Likely • Likely • Very Likely • Likely • Likely	Emergency Response	• High	• Increased need for emergency response. • Possible limitations to response capability due to staff and financial resource constraints.	• High	• Twenty-seven percent of the major roads, 9 percent of the rail lines, and 72 percent of the ports in the Region 4 area are built on land at or below 4 feet in elevation, a level within the range of projections for relative sea-level rise in this region in this century. Increased storm intensity may lead to increased service disruption and infrastructure damage. More than half of the area's major highways (64 percent of interstates, 57 percent of arterials), almost half of the rail miles, 29 airports, and virtually all of the ports, are below 23 feet in elevation and subject to flooding and damage due to hurricane storm surge. • Additional planning for emergency response may be needed: o Brown and black-outs may cause releases and the frequency and intensity of storms may need to be incorporated into current national and area contingency plans. o Facility Response Plans (FRP) and Spill Prevention and Control Countermeasures (SPCC) plans may not consider climate change impacts. o Current regional debris management plans rely on historical climate assumptions and do not address the increasing uncertainty in climatic extreme events. o Additional planning may be needed as Stafford Act declaration (federal emergency declaration) may be more frequent with a changing climate. o Current energy infrastructure (oil, natural gas, nuclear) in Southeast may not include climate change assumptions for emergency planning.

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Goal 4: Ensuring Safety of Chemicals & Preventing Pollution	• Increasing extreme temperatures • Increasing heavy precipitation events	• Very likely[3] • Likely[3]	• Protecting human health and ecosystems from chemical risks. • Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Section 18 emergency exemptions • FIFRA compliance monitoring • Integrated Pest Management (IPM) programs	• Low • Low	• Assure that chemical exposure models reflect changes in the environment • Changing in planting timing or location may affect the volume and timing of agricultural chemical use which could impact the appropriate risk management decisions.	• Low • High	• Region 4 may experience new pest problems, many of which will be from exotic invasive species. • Changes in pests and pest pressures due to increases in temperatures and variations in rainfall patterns. • There would be a potential increase in the need for emergency exemptions (FIFRA Section 18). These FIFRA exemptions ar granted when an emergency pest problem appears which cannot be controlled effectively by the current pesticides registered for that pest or commodity, allowing temporary use of chemicals which are not registered for that use • Increasing pesticides usage to control pests could also lead to increased resistance of the pest to the chemical being used. Resistance management will therefore become increasingly important. • The increase in amount and variability of precipitation projected for Region 4 can create an expanded mosquito habitat, which could increase exposure to more diseases like dengue fever and malaria. • Emergency exemptions for mosquito control may increase, especially after major weather events such as floods and hurricanes, which tend to spur populations of *A. aegypti* and *A. albopictus*. • Increase in fungal organisms in agricultural and non-agricultural settings due to extreme rainfall. • Increase in dry condition pests due to drought (e.g. mites that feed on a variety of field, vegetable and fruit crops). • These changes in pesticide choices and quantities will require changes to the pesticide applicator certification and training programs. Changes in chemical selection could result in new and increased chemical exposures especially for indoor applications.

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	Climate Change Impact [d]	Likelihood of Impact [e]	Focus of Associated EPA Program	Likelihood EPA Program will be Affected by Impact [f]	Example of Risks if Program were Impacted	Likelihood of Regional Program will be Affected by Impact	Example of Risks if Program were Impacted
Facilities and Operations	• Increased Water Temperatures • Decreasing precipitation days and increasing drought intensity • Increased high wind event intensity, e.g., tornado	• Very likely[9] • Likely [7]	• Water usage at EPA facilities • Office building inaccessible due to tornado damage	• High	• Water temperatures impact research activities or cooling requirements. • Facilities could be located in areas with water shortages	• High	• Droughts could affect energy use – may experience periods of "brown outs" • Air temperatures impact cooling/energy demand, water temperature impact cooling equipment efficiency.
	• Increasing risk of floods • Increasing intensity of hurricanes • Sea level rise • Increasing extreme temperatures	• Likely [7] • Likely[3] • Very likely[6] • Very likely[3]	• Operations of Agency facilities, personnel safety, physical security, and emergency communications • Emergency management mission support (protective gear and acquisition)	• Medium	• Facilities in coastal or flood-prone areas • Personnel engaged in field work and vulnerable to extreme temperatures or events • Security, lighting and communication systems without backup power • Personnel and real property supporting emergency response and management	• High	• Region 4's Gulf Breeze Lab is located on Sabine Island on Florida Panhandle • The Region has the largest coastal population exposure.

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

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

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

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

[d] Impacts can vary by season and location.

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

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

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

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

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

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

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

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

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

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

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

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

11) Ingram, K.T., K. Dow, L. Carter (2012): Southeast Regional Technical Report to the National Climate Assessment.

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Appendix B

Region 4 Priority Actions Matrix

	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
Regional Crosscutting Actions	The Region 4 will assist its state, local, and tribal governments and Federal resource managers to prepare for and respond to climate-related changes.	Region will work with its stakeholders to develop and implement strategies to respond to local concerns and to share these methods with other communities	As budgets allow: Promote EPA's Clean Energy-Environment State Partnership. Promote the Southeastern Ecological Framework as a tool for evaluating and adapting to climate change impacts on important ecosystems and services across eight Southeastern states. Implement activities that support national Climate for Action Education and Outreach Campaign. Promote EPA's Smart Growth program to help communities grow in ways that expand economic opportunity, protect public health and the environment, and create and enhance the places that people want to live and work.	B R B B	Y N N U
Goal 1: Taking Action on Climate Change & Improving Air Quality	Increased tropospheric ozone pollution	Protecting the public health and the environment by approving state programs to meet NAAQS and implementing programs in Indian Country	Work with other Regions and HQ air program managers to develop a strategy, in context to other programmatic priorities, on how to incorporate climate adaptation into air quality programs (e.g., SIP, permits).	B	Y
	Increased frequency or intensity of wildfires	Protecting the public health and the environment by approving state programs to meet NAAQS and implementing programs in Indian Country	Promote awareness of the use of prescribed fires or alternative treatment options to reduce build-up of fuel loads in areas prone to wildfires Broaden Smoke Management Recommendations for prescribed fires developed by SERPPAS	R R	Y N
	Increasing extreme temperatures	Protecting the public health	Promote SunWise Program to teach public how to protect themselves from overexposure to the sun.	B	N

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	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
Goal 2: Protecting America's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Watershed Planning**	Encourage green infrastructure and low-impact development to protect water quality, to make watersheds more resilient and to reduce the demand for additional water resources. Work with USGS to become knowledgeable in the best methods to model for current and projected low flow and high flow conditions in gauged and ungauged rivers and streams.		Y Y
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Water Quality Standards**	Use the Triennial Review of state water quality standards to work with states and tribes on changes in stream use classification or standards, where necessary due to climate change induced increasing temperatures or changes in stream flow.. Encourage states and tribes to develop appropriate coordination processes between water quality and water supply decisions to ensure proper implementation of state water quality standards.		Y N
Goal 2: Protecting America's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Monitoring, Assessing and Reporting**	Evaluate Region 4 states' and tribes' current monitoring and assessment practices to encourage the capturing of extreme low flow or other climate related conditions, including: 1) appropriate biological monitoring and assessment techniques, and 2) water monitoring system design. Work with states, tribes, and other water monitoring partners to help establish a long term monitoring program to track potential changes in temperature, flow, aquatic biological communities, habitat, and chemical constituents that are occurring over time at important sentinel reference sites in the SE Region.	R B	Y Y

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	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **TMDLs**	Guidance from the Office of Water on methods and approaches is needed prior to the Region identifying specific regional actions.	N	Y
	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **NPDES**	Encourage States to update fact sheets at permit reissuance to include the most up-to-date critical low flow as possible and to calculate reasonable potential based on those values. Continue to work with states on the incorporation of green infrastructure components in MS4 permitting.		N N
Goal 2: Protecting America's Waters	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Non-Point Source (NPS)**	Work with states and tribes to include climate change adaptation provisions in revised Nonpoint Source Management Plans to provide flexibility to fund programs and projects to assess, evaluate, plan and implement climate change adaptations.		Y

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	• Increasing heavy precipitation events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Wetlands**	Consider the effects of climate change as appropriate when evaluating Least Environmentally Damaging Practicable Alternatives (LEDPA) in the context of CWA Section 404 Wetlands Permitting. Ensure water conservation and efficiency measures are considered, where appropriate, as part of wetlands 404 permitting before new water resource projects are approved.	B B	Y N
	• Increasing heavy precip. events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **Dredging/Ocean Dumping**	Promote the beneficial use of suitable dredged material to protect from sea level rise and storm surge. Develop protocols to address the likely increase in emergency dredging from hurricanes of increased intensity and other extreme events that may cause unexpected sedimentation and shoaling.	B B	U Y

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				National = N Regional = R Both = B	Yes = Y No = N Unknown = U
Goal 2: Protecting America's Waters	• Increasing heavy precip. events • Increasing intensity of hurricanes • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Ocean acidification • Increased water temp.	Restoring and protecting watersheds, aquatic ecosystems and wetlands **National Estuary Program/South Florida**	Promote the Climate Ready Estuary program in Region 4 National Estuary Programs (NEPs). Promote the development of NEP coastal watershed management plans that consider climate change. Promote the development of vulnerability assessments by Region 4 NEPs. Work with the NEP's to revise and update the NEP Comprehensive Conservation and Management Plans (CCMPs) to address vulnerabilities to climate change. Work with the gulf of Mexico Alliance to include climate change considerations in projects and programs under the BP Deepwater Horizon Natural Resource Damage Assessment and Restore Act procedures. Work with the Governor's South Atlantic Alliance to include climate change into South Atlantic Alliance efforts. Continue to work with Monroe County Florida, (Florida Keys) to implement climate change in water quality management planning for protection of the Florida Keys National Marine Sanctuary.	R R R R B R R	Y Y Y Y Y Y U
	• Increasing heavy precip. events • Increasing intensity of hurricanes • Sea-level rise • Increase flood risk	**Drinking water, wastewater and stormwater infrastructure**	Guidance from the Office of Water on methods and approaches is needed prior to the Region identifying specific regional actions.	N	Y

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	Climate Change Impact	Focus of Associated Region 4 Program	Priority Actions	National or Regional Action	Action requires National Guidance or HQ Coordination
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	• Increasing heavy precip. events • Sea-level rise • Decreasing precipitation days and increasing drought intensity • Increased water temp.	The quality and availability of safe drinking water **Drinking Water Quality**	Work with tribes on efforts towards sustainable infrastructure and participate on national workgroups aimed at directing tribal water systems towards sustainable operation/maintenance of tribal water systems.Include assistance to the utilities in developing vulnerability assessments to the anticipated effects of climate changes through the Region's Energy Management Initiative to reduce energy consumption at wastewater and drinking water utilities.	B	N
Goal 3: Cleaning Up America's	Increasing heavy precipitation events Changes in temperature	Cleaning up contaminated sites and waste **Longer-term Cleanups**	Identify and assess the potential vulnerability of NPL sites within delineated GIS-mapped zones based on a consideration of site-specific factors. Develop an action plan to evaluate the vulnerability of other contaminated sites (e.g., brownfields, Superfund Time-Critical Removal, RCRA corrective action) and RCRA Hazardous Waste Management Facilities. In conjunction with tribes and state agencies, initiate an interagency dialog to plan and coordinate efforts to consider climate change impacts. Incorporate energy efficiency and conservation into green site remediation practices funded by EPA, and encourage efficiency and conservation in actions conducted by responsible parties.		Y Y U N

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	Increasing heavy precipitation events Changes in temperature	Cleaning up contaminated sites and waste **Emergency Response**	Utilize GIS-based tools to locate potentially vulnerable critical public infrastructure and sources of potential hazardous material releases to aid in planning for and responding to emergency events. Conduct an assessment of the hazardous waste disposal infrastructure to determine whether it can manage potential disposal needs during a changing climate and whether facility operations will be impacted. Work with local/state/federal emergency preparedness and response counterparts and businesses to develop and implement strategies to address adaptive measures needed for climate-related changes and work with state and industry to add enhanced emergency planning in operating permits.		Y N U
	Increasing heavy precipitation events Changes in temperature	Cleaning up contaminated sites and waste **RCRA/Brownfields**	Expand green remediation practices. Promote revitalization of contaminated land to productive environmental and economic reuse, with an emphasis on green technologies. Integrate materials recovery principles, practices and programs into the Region's Brownfields and Revitalization program and projects.		N N N
	Increasing heavy precipitation events Changes in temperature	Cleaning up contaminated sites and waste **Oil Program**	Create layers in GIS to enhance existing mapping tools demonstrating potential impact areas, flood zones, storm surge areas etc. Identify SPCC and FRP facilities within EPA Region 4 and include in updated mapping tools. Include consideration of climate change impacts in EPA Region 4 management reviews of current and future SPCC and FRP facilities.		U N N
Goal 4: Ensuring the Safety of Chemicals	Increasing extreme temperatures	Protecting human health and ecosystems from chemical risks	Promote EPA's Green Building and Sustainable Materials Management challenge programs to encourage healthier and more resource-efficient models of construction, renovation, operation, maintenance and demolition of buildings.	R	N

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Goal 5: Enforcing Environmental Laws	Earlier timing of spring events Increasing heavy precipitation events and risk of floods Increased frequency and intensity of wildfires		Work with NEPA to appropriately incorporate climate change into their environmental assessments and that NEPA analysis is consistent with respective Climate Change Adaptation plans. Region will work with other federal agencies to appropriately address vulnerable people and places as they are impacted by climate change.		U N
Facilities & Operations	Decreasing precipitation days and increasing drought intensity	Water and energy usage at EPA facilities	Continue to use the Region's EMS to promote sustainable business practices, energy efficiency, renewable energy strategies, and maintain LEED certification As a GSA building occupant, EPA Region 4 will promote facility efficiencies. .		N N
	Increasing extreme weather events	Operations of Agency facilities, personnel safety, physical security and emergency communications	Investigate alternative lodging availability at the Alternate COOP Site. Maintain the staff's capacity to work remotely	R R	N N
Facilities and Operations	Decreasing climate change impacts	Encouraging sustainability practices within the region 4 offices and surrounding area.	Develop interagency federal sustainability team to promote greening federal facilities in Atlanta. Recruit Federal Green Challenge partners from federal departments to reduce their climate change impacts Support the development of sustainable recycling infrastructure and commodities markets through partnerships with state and regional recycling coalitions, by developing and supporting product stewardship and extended producer responsibility models, and through efforts to encourage the recovery and recycling of organic waste streams. Recruit partners to implement the SMM Food Recovery Challenge to increase economically valuable and environmentally responsible use and diversion of organic waste away from land-filling to minimize the creation and release of methane		N N N

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EPA Staff Training	Cumulative	Increase employee knowledge regarding climate change adaptation and encourage consideration while performing job duties	Encourage regional employees to take EPA Headquarters created training regarding climate change adaptation. Utilize Region 4's Energy and Climate Change Steering Committee and Workgroups to monitor opportunities to educate and outreach to employees and look for areas where climate change adaptation can be incorporated. Look for opportunities to bring in guest speakers to lecture employees about climate change and potentially how other agencies are tackling adaptation.		Y N N
Vulnerable Populations	Climate Change Impacts to Tribes	Region 4's will coordinate with its six-federally recognized Tribes and support Tribal climate change adaptation efforts consistent with the Agency's statutory and regulatory authorities, program office guidance, and resources.	Coordinate with the Regional Tribal Operations Committee (RTOC) and individual Tribes to identify climate change priorities, assess Tribes' climate change adaptation readiness and determine training, technical assistance and/or resource needs. Request clear guidelines from National Program Managers to Project Officers and Tribes about the management of available funds to grant awards addressing climate change adaptation activities. Facilitate a workshop or training for Tribal environmental staff on climate change impacts and priorities. Collaborate with R4 Tribal component(s) in energy and climate change website. Incorporate Tribal climate change priorities, Traditional Ecological Knowledge, and related information into training opportunities for Region 4 staff. Coordinate with federal partners on a regular basis to share climate change related efforts, and to streamline education, outreach and consultation with Tribes, where appropriate. Enhance interagency cross-program coordination and collaboration opportunities to inform, discuss and consult with Tribes on EPA climate change actions and decisions.	R N R R B R B	N Y N N Y N N

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Vulnerable Populations	Climate Change Impacts to Children's Health		Conduct an inventory of tools and materials available to address issues faced by children and pregnant women. Promote and disseminate of tools and materials to address issues targeting children and pregnant women. Educate and conducnt outreach directed to pediatric health care professionals to enhance their understanding of the threats on children's health. Consult with the Southeast Pediatric Health Specialty Unit (PEHSU) as a resource to address environmental health medical conditions that may be exacerbated by climate change.		Y Y N N
Vulnerable Populations	Climate Change Impacts to Environmental Justice Communities		Host climate change and adaptation educational workshops for environmental justice communities. Partner with other federal and state agencies and non-profit organizations to inform environmental justice communities of various activities and programs. Promote and distribute climate change and adaptation tools and materials via emails, listserv, and mailings. Create a train-the-trainer climate change and adaptation workshop where community partners are able to lead climate change and environmental justice workshops.		N Y Y N

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