

EPA OFFICE OF AIR AND RADIATION CLIMATE CHANGE ADAPTATION IMPLEMENTATION PLAN

June 26, 2014

Disclaimer

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Preface

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

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

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

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

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

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

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

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

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EPA Office of Air and Radiation Climate Change Adaptation Implementation Plan

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Background

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

Programmatic Vulnerability Assessment

I. Introduction

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

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

II. OAR Vulnerabilities to Climate Change Impacts

Tropospheric ozone pollution is likely to increase in certain regions due to the effects of climate change. The relationship between temperature changes and tropospheric ozone formation is well understood. With climate change, higher temperatures and weaker air circulation in the United States will lead to more ozone formation even with the same level of emissions of ozone forming chemicals.¹ Studies project that climate change could increase tropospheric ozone levels over broad areas of the

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Specific potential vulnerabilities of EPA stratospheric ozone programs include:

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

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

Additional areas of interest and exploration:

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

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

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

III. Conclusion

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

IV. Programmatic Vulnerability Summary Table

Goal ^a	CLIMATE CHANGE IMPACTS ^b		EPA PROGRAMMATIC IMPACTS ^c		
	Climate Change Impact ^d	Likelihood of Impact ^e	Focus of Associated EPA Program	Likelihood EPA Program will be Affected by Impact ^f	Example of Risks if Program were Impacted
Goal 1: Taking Action on Climate Change and Improving Air Quality	<ul style="list-style-type: none"> Increased tropospheric ozone pollution in certain regions 	<ul style="list-style-type: none"> Likely¹ 	<ul style="list-style-type: none"> Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards 	<ul style="list-style-type: none"> High 	<ul style="list-style-type: none"> Could become more difficult to attain NAAQS for ozone in many areas with existing ozone problems
	<ul style="list-style-type: none"> Increased frequency and intensity of wildfires 	<ul style="list-style-type: none"> Likely² 	<ul style="list-style-type: none"> Protecting public health and the environment by setting National Ambient Air Quality Standards (NAAQS) and implementing programs to help meet the standards 	<ul style="list-style-type: none"> Medium 	<ul style="list-style-type: none"> Could complicate Agency efforts to protect public health and the environment from risks posed by particulate matter (PM) pollution in areas affected by more frequent wildfires
	<ul style="list-style-type: none"> Increasing extreme temperatures Increasing heavy precipitation events 	<ul style="list-style-type: none"> Very Likely³ Likely³ 	<ul style="list-style-type: none"> Protect public health by promoting healthy indoor environments through voluntary programs and guidance 	<ul style="list-style-type: none"> Medium 	<ul style="list-style-type: none"> Could increase public health risks, including risks for the young, the elderly, the chronically ill, and socioeconomically disadvantaged populations
	<ul style="list-style-type: none"> Effects on the stratospheric ozone layer 	<ul style="list-style-type: none"> Likely⁴ 	<ul style="list-style-type: none"> Restoring the stratospheric ozone layer Preventing UV-related disease Providing a smooth transition to safer alternatives 	<ul style="list-style-type: none"> High 	<ul style="list-style-type: none"> Unable to restore ozone concentrations to benchmark levels as quickly at some latitudes
	<ul style="list-style-type: none"> Effects on response of ecosystems to atmospheric deposition of sulfur, nitrogen, and mercury 	<ul style="list-style-type: none"> Likely⁶ 	<ul style="list-style-type: none"> Ecosystem protections from Agency emissions reduction programs 	<ul style="list-style-type: none"> Low 	<ul style="list-style-type: none"> Based on evolving research, could have consequences for the effectiveness of ecosystem protections under those programs
	<ul style="list-style-type: none"> Increased frequency and severity of severe weather events 	<ul style="list-style-type: none"> Very Likely⁷ 	<ul style="list-style-type: none"> Monitoring and assessing the benefits and effectiveness of Agency emissions reduction programs Agency disaster response planning 	<ul style="list-style-type: none"> Medium 	<ul style="list-style-type: none"> Could decrease the amount and/or quality of data collected by the Agency

Footnotes for Program Vulnerability Summary Table

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

^bClimate Change Impacts are based upon peer-reviewed scientific literature

^cProgrammatic Impacts are based upon EPA best professional judgment at this time.

^dImpacts can vary by season and location.

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

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

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

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

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

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

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

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

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

Priority Actions

I. Introduction

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

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

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

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

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

II. OAR Categories of Priority Actions

Category 1: Outreach and Education

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

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

Category 2: Research and Collaboration

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

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

Category 3: Modeling and Analysis

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

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

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

III. Agency-wide Priorities

Partnerships with Tribes

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

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

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

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

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

Vulnerable Populations and Vulnerable Places

Certain parts of the population, such as children, the elderly, minorities, the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations, can be especially vulnerable to the impacts of climate change. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas or living in isolated or segregated areas.

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

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

Measuring and Evaluating Performance

I. Introduction

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

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

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

II. Measures and Evaluation

Strategic Performance Measures

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

Training

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

Outreach

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

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

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

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

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

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

III. Conclusion

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

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

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

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