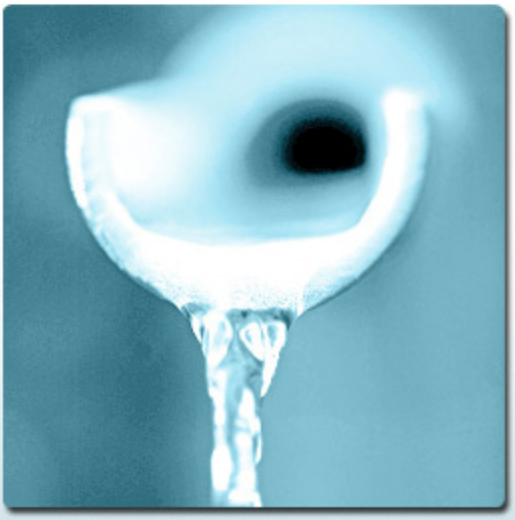
Climate Ready Water Utilities



Final Report of the National Drinking Water Advisory Council

December 9, 2010

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EPA NATIONAL DRINKING WATER ADVISORY COUNCIL

Together We Can Protect Drinking Water

January 11, 2011

Ms. Lisa Perez Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington D. C. 20460

Dear Administrator Jackson:

On behalf of the National Drinking Water Advisory Council (NDWAC), I am pleased to submit the Climate Ready Water Utilities report containing recommendations that will assist drinking water, wastewater, and stormwater systems across the nation to increase their resilience to climate change impacts. Although previous national forums on climate change and its effects on water systems have focused on achieving a common understanding of the problem and general steps forward, this report contains many practical steps which the water sector could undertake to become more climate ready, and as such, it represents an important advance in our nation's efforts to adapt to and mitigate climate change. The report also recognizes that the responsibility for becoming climate ready lies not only within the water utility sector, but with federal, state, and local governments, in addition to interdependent sectors (e.g., energy) that through their regulations or actions can impede or facilitate a water system's striving for climate readiness.

We applaud the fact that Taking Action on Climate Change is one of your highest priorities. The Council believes that our recommendations will assist in advancing this important priority with respect to the water sector, especially in those communities that are disadvantaged and underserved. It is important to note that the recommendations in this report often do not represent additional program costs for the U.S. Environmental Protection Agency (EPA or Agency), but instead emphasize the need for EPA's leadership to integrate climate change considerations into

existing activities to more efficiently and effectively lead the utility sector towards climate readiness.

The NDWAC recognizes the economic, social, and political challenges associated with the nation's efforts to emerge from an unprecedented severe economic recession. The Council urges that such concerns serve to guide a more efficient, coordinated response to climate change for the water sector rather than forestall or preempt immediate, appropriate action. The Council maintains that the human health, quality of life, and economic costs of *inaction* can be readily underestimated. NDWAC calls on EPA to accelerate and support efforts to estimate the national and local costs of inaction to inform and motivate water utilities as well as key decision makers at the federal, state, and local levels to take appropriate actions.

One important but historically neglected cost to consider relates to the potential for climate change to exacerbate already existing health inequities and environmental/economic injustices. This statement might become evident in wealthier countries such as the United States during natural disasters, the frequency and intensity of which could increase as a result of global warming. For example, the weaker resilience of infrastructure and inadequate preparedness planning in some poor communities could translate into a lack of access to transport during mass evacuations. Consequently, EPA should develop policies and tools for climate change adaptation and mitigation that focus attention on underserved and disadvantaged communities. The NDWAC wants to emphasize that the recommendations in this report fundamentally address the need for EPA and others to enhance their approach for addressing the environmental, public health, and social challenges often associated with disadvantaged communities. As stated in the report, climate ready water utility initiatives require the meaningful and timely involvement and input from all such affected populations "to better ensure environmental justice concerns are proactively addressed."

The NDWAC would like to commend the working group that prepared this report and underscore that this group reflected a diverse cross-section of the water sector including small, large, public and investor-owned utilities, state and local governments, and academic, environmental, and other affected organizations. This working group was supported by key federal partners from EPA, the US Army Corps of Engineers (USACE), the Centers for Disease Control and Prevention (CDC), the National Oceanic and Atmospheric Administration (NOAA), and the Federal Emergency Management Agency (FEMA). The fact that this diverse group reached consensus on such a complex and potentially divisive topic, illustrates the extraordinary imperative associated with the need for immediate action to address climate change impacts. The extremely broad-based water sector support evident in the group's consensus implies a critical need for strong, focused leadership and direction. EPA, along with other federal, state, and local entities, is an important steward of the nation's water resources. This report is intended to underscore the pressing need for our stewards to take action against any current or impending threat to our water resources.

In considering the report, we ask that EPA approach its implementation in a holistic, integrated, and sustainable manner. For instance, the report encourages EPA to work collaboratively with federal, state, and local governments to integrate climate change considerations into business-as-usual activities. Instead of creating a separate program with

potentially significant resource demands, the Climate Ready approach of the report recognizes that effective programs already exist on the federal, state, and local levels which, if properly leveraged, can provide the most efficient means to adapt to and mitigate climate change impacts. The NDWAC, therefore, recommends that the report's recommendations be implemented through a cross-office effort, linking several important activities already underway within the National Water Program, including water security/preparedness, sustainable infrastructure, and capacity development. A positive example of this approach is Climate Ready Estuaries, which has introduced climate change concepts relating to impacts and adaptation into the long-established National Estuaries Program.

This report has the potential to inform multiple aspects of EPA's climate change efforts, not only the water program. Given this breadth of application, NDWAC also strongly recommends that you share it not only within EPA's National Water Program, but also with other programs where climate change efforts are underway, such as the Office of Air and Radiation, Office of Policy, and the Office of Research and Development. Also, consistent with the report's call for improved coordination across the federal government, EPA should disseminate the report to other key agencies with climate change programs, most notably NOAA, CDC, USACE, U.S. Department of Agriculture (USDA), and Department of Interior (DOI).

The attachment to this letter provides an overview of the NDWAC's report, which was generated in response to a three-point charge: (1) to develop the attributes of a climate ready water utility, (2) to conduct an assessment of tools, training and assistance necessary to promote climate readiness, and (3) to identify incentives to promote adoption of climate readiness. With respect to the first part of the charge, the NDWAC developed the concept of a Climate Ready Adaptive Response Framework which supports immediate water utility attention to climate challenges and reflects the flexible, practical response strategy that will be required to address climate change impacts. The attachment provides a summary of the other two parts of the charge.

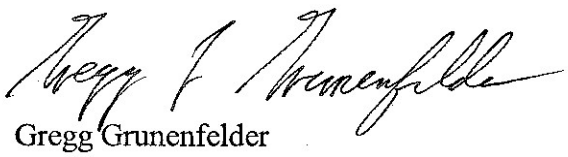
I would like to conclude this letter by highlighting the key recommendations from our report:

1. EPA should develop a well-coordinated program to articulate and support the adoption of climate ready activities by utilities.
2. EPA should build out the concept of "climate ready" utilities based on the Findings and [Climate Ready Water Utilities] CRWU Adaptive Response Framework in this report.
3. Establish for utility staff, a climate change continuing education and training program.
4. Build on and strengthen advanced decision making support models and tools to support utility climate change efforts.
5. Increase interdependent sector knowledge of water sector climate-related challenges and needs.
6. Improve and better integrate watershed planning and management in response to climate uncertainty and impacts.

7. Improve access to and dissemination of easy-to-understand and locally relevant climate information.
8. Better integrate climate change information into existing utility technical assistance initiatives.
9. Develop an adaptive regulatory capacity in response to potential climate change alteration of underlying ecological conditions and systems.
10. Develop a comprehensive water sector, climate change research strategy.
11. Advocate for better coordination of federal agency climate change programs and services.

The NDWAC welcomed the opportunity to provide these recommendations to EPA on so important an issue. We look forward to providing further assistance as EPA considers this report and, hopefully, as the Agency implements a Climate Ready program to improve the resilience of the nation's water sector in the face of climate change.

Sincerely,



Gregg Grunenfelder
Chair
National Drinking Water Advisory Council

Attachment

cc:
Peter Silva, Assistant Administrator for Water
Cynthia C. Dougherty, Director, Office of Ground Water and Drinking Water

Climate Ready Water Utilities

Final Report

CONTENTS

List of Acronyms

AMWA – Association of Metropolitan Water Agencies

AWWA – American Water Works Association

BASINS – Better Assessment Science Integrating point and Nonpoint Sources

CRE – Climate Ready Estuaries

CREAT – Climate Resilience Evaluation and Awareness Tool

CRWU – Climate Ready Water Utilities

CWA – Clean Water Act

DOI – Department of Interior

DOT – Department of Transportation

EPA – Environmental Protection Agency

ESA – Endangered Species Act

EUM – Effective Utility Management

FEMA – Federal Emergency Management Association

GVC – Green Value Calculator

HEC-HMS – Hydrologic Modeling System

HUD – (United States Department of) Housing and Urban Development

LEED – Leadership in Energy and Environmental Design

NACWA – National Association of Clean Water Agencies

NDWAC – National Drinking Water Advisory Council

NEP – National Estuary Programs

NGO - non-governmental organization

NOAA – National Oceanic and Atmospheric Administration

SCADA – Supervisory Control And Data Acquisition

SDWA – Safe Drinking Water Act

SRF – State Revolving (Loan) Fund

TMDL – Total Maximum Daily Load

TTX – Table Top Exercise

UKCIP – United Kingdom Climate Impacts Programme

USACE – United States Army Corps of Engineers

USGS – United States Geological Survey

VSAT – Vulnerability Self Assessment Tool

WEAP – Water Evaluation And Planning

WEF – Water Environment Federation

WERF – Water Environment Research Foundation

WUCA – Water Utility Climate Alliance

Executive Summary

The National Drinking Water Advisory Council (NDWAC) established the Climate Ready Water Utilities (CRWU) Working Group to evaluate the concept of "climate ready water utilities." The evaluation was to provide findings and recommendations relating to the development of a program enabling water and wastewater utilities to prepare long-range plans that account for climate change impacts. Consistent with the NDWAC charge to the CRWU Working Group, the working premise for all deliberations was that climate change represents an important challenge for the water sector necessitating its consideration in all aspects of utility planning. NDWAC specifically requested that the Working Group's findings and recommendations cover three topics: identify the behaviors that will characterize a climate ready utility; identify climate change-related tools, training, and products needed to enable climate ready utility behaviors; and explore ways to encourage broad adoption through recognition or incentives incorporated into existing United States Environmental Protection Agency (EPA) Office of Water recognition and awards programs or new recognition programs.

This report presents the CRWU Working Group's findings and recommendations to the NDWAC. While recognizing that EPA, other federal agencies, water sector professional associations, many utilities, and non-governmental organizations have taken important steps to improve the water sector's understanding of and response to climate change challenges, the Working Group's findings and recommendations point to the need for further support to motivate and enable water sector utilities to become more climate ready. The Group's discussions have explored the fact that climate science is evolving and uncertainty regarding the timing, nature, direction, and magnitude of localized climate change impacts (weather, ecological, and other) is, and is expected to remain, high. At the same time, because utility investments are often capital intensive, long-lived, and can require long lead times to ensure system reliability and maintenance of desired service levels, building climate considerations into utility decision making is a current necessity.

EPA, in close coordination and cooperation with other federal and state agencies, water sector associations, non-governmental organizations, and tribes needs to take action that helps utility managers: a) better understand the evolving nature of climate change challenges; b) improve knowledge of no and low cost "no regrets" operational, infrastructure, and non-structural choices; c) better incorporate and address climate-related uncertainty in long-range planning; d) understand the costs and benefits of adaptation and mitigation options; and e) attract and establish effective collaborative partnerships with interdependent sectors. At the same time, the Working Group understands, and this report clearly acknowledges, that expectations for utility climate readiness must be managed in the context of several factors. These factors include the struggle many utilities face to meet current obligations, the uncertainty of localized climate change impacts, and the lack, for certain utilities, of technical, financial, and managerial capacity. The Working Group's recommendations focus substantially on the actions necessary to overcome these obstacles.

CRWU Working Group Findings – Highlights

Finding 1: The water sector faces important and potentially substantial climate change adaptation challenges, but also opportunities. Present understanding of water sector-related climate change challenges, and of the opportunities for response, signals a need for the water sector to enhance climate change education, adaptation and mitigation planning, and utility-specific, locally-appropriate action. Furthermore, individual utilities will be exposed to greater variability and less predictability in the hydrological and meteorological (weather, ecological, and other system) conditions that underlie water sector utility systems planning, design, financing, and operations at all scales. This indicates a need to examine "stationarity" assumptions that underlie much water sector planning. *(See Recommendations 1 and 12)*

Finding 2: Proactive, climate ready actions will enhance water sector utility resilience. Utilities, through proactive, climate-related engagement, have the opportunity to build resilience into their systems through the use of no- and low-cost operational changes and multiple-benefit investments, such as flexible treatment technologies, alternative water storage management, water supply diversification, integrated water management, and a wide range of non-conventional alternatives such as green infrastructure and water efficiency. These investments can serve as effective management practices in response to difficult-to-predict, but potentially high consequence, weather and ecological impacts, as well as planned and unplanned events. *(See Recommendation 1)*

Finding 3: Different local conditions will dictate different climate ready responses. It is critical to recognize that different local conditions – including the immediacy and certainty of actual or projected climate impacts and community understanding and support – will, understandably, lead to different climate adaptation and mitigation responses and intensity of engagement. A one-size-fits-all approach to climate readiness will not be effective. *(See Recommendation 2)*

Finding 4: Utility "climate readiness" is an emerging concept that must therefore reflect an adaptive learning and management framework. Climate change knowledge and experience in the water sector are evolving, and have not yet translated into the specificity water utilities typically use to make near-term operational decisions or long-term infrastructure investments. At the same time, the sector has generally made important advances in understanding climate challenges and has begun translating this knowledge into planning and operational approaches that provide opportunities for proactive utility engagement. A climate ready adaptive management framework supports the need for immediate water sector utility attention to climate challenges, while enabling measured action that responds to evolving climate science, actual and/or projected local weather and ecological conditions, and adaptation and mitigation opportunities and techniques. *(See Recommendations 2 and 3)*

Finding 5: An expanded concept of "water system infrastructure" is a key element of utility climate readiness. Experience from water sector climate adaptation and mitigation to date indicates utilities should anticipate the need for balanced, upfront consideration of conventional and non-conventional infrastructure, operational, legal, financial, and institutional alternatives to ensure robust utility climate

readiness can emerge. In response, utilities will need to expand their communities' understanding of the value of the level of water services, as well as the concept of water infrastructure to include re-purposing of existing infrastructure, integrated management of currently independent infrastructure components, and the use of distributed and green technologies. *(See Recommendations 4 and 6)*

Finding 6: To succeed, individual utilities need a robust enabling environment. Utility experience to date indicates that successful climate change adaptation efforts require effective partnerships and enhanced watershed or basin-level water resources coordination and management. This requires a water management institutional framework that supports cross-jurisdictional coordination and integration, effective priority setting and integrated water resource management, and the establishment of effective risk management partnerships with critical interdependent actors. There is thus a critical need for federal and state water resource management and protection agencies to support the development of improved water resource management frameworks, as well as to support utilities in their efforts to establish partnerships with other interdependent sectors (such as energy and agriculture) as an essential foundation for climate change adaptation and mitigation efforts. *(See Recommendations 5 and 6)*

Finding 7: Many utilities do not have the capacity to become climate ready. Many utilities are faced with immediate, essential, concrete needs (e.g., security, regulatory, aging infrastructure, environmental and public health protection, and workforce succession requirements) that will by necessity remain priorities that absorb most, if not all, of their available technical, financial, and managerial capacity. This is especially true for small and rural systems, as well as systems with deteriorated infrastructure, struggling to meet existing regulatory requirements and level of service expectations. In the absence of focused support for long-range climate change adaptation and mitigation planning and implementation (balanced with the need to maintain support to existing utility capacity and infrastructure development efforts), these utilities will face great challenges to become climate ready. *(See Recommendations 8 and 12)*

Finding 8: Climate change impacts create challenges for current "regulatory stationarity." Just as questions have emerged regarding hydrological and meteorological stationarity as a basis for utility planning, there is increasing concern regarding the future validity of the natural systems assumptions upon which current standards, permit conditions, and water use and delivery obligations are based (i.e., regulatory stationarity). EPA has acknowledged these challenges in its *National Water Program Strategy: Response to Climate Change*. These changing conditions hold the potential to require a substantial shift in existing and future utility investments in water resource protection and management. This highlights the need to incorporate climate considerations in utility planning and management and the evaluation of regulatory frameworks to ensure the continued progress in meeting clean and safe water goals. To support incorporation, there is a need to establish regulatory and non-regulatory agency, utility, tribal, and non-governmental organization (NGO) partnerships to explore these challenges and ensure an adaptive, problem-solving framework and approach underlies implementation of regulatory frameworks. *(See Recommendation 9)*

Finding 9: Water sector utilities are overwhelmed with climate change information and lack of coordination by federal agencies, state agencies, and other water sector actors. Water utility officials are struggling with the number and volume of climate change studies being produced by many different federal and state agencies, water associations, universities, and other organizations. Moreover, there is a current lack of horizontal coordination and alignment amongst the various federal agencies that are engaged in climate adaptation and mitigation activities as well as vertical coordination among the federal, state, and local levels of government. This lack of coordination creates significant challenges for the water sector in deciding how to allocate time, attention, and other resources to the myriad initiatives, and runs the risk of duplicating efforts. *(See Recommendations 7 and 11)*

Finding 10: The water sector is underserved by available climate science and by information regarding adaptation and mitigation costs and benefits. Concurrent with individual utilities proactively moving forward to address climate change challenges, there is a strong need for continued investment in advancing the research and understanding of climate impacts, adaptation, and mitigation. Needed research and support includes long-term data collection, locally refined understanding of projected impacts, decision support models, information on adaptation (including adaptation to both gradual, continuous change and response options to non-continuous events and emergencies such as floods and droughts) and mitigation options from other sources and sectors, and translation of research and analytical findings in a manner useful to the full range of systems and for general education. *(See Recommendation 1)*

Finding 11: Water sector utility greenhouse gas (GHG) mitigation efforts are an important aspect of the sector's climate-related strategy. Water sector utilities have begun to develop GHG emission reduction programs in response to energy cost saving opportunities, a desire to take proactive climate change steps, and/or in anticipation of federal, regional, and state GHG reduction programs. Improved energy management measures will have important GHG reduction benefits. Efforts focused specifically on GHG mitigation hold the potential to insulate utilities from energy price increases and supply disruption, and practices relating to water conservation, efficiency, and reuse can also reduce energy demand and GHG emissions. By including GHG reduction efforts as a component of their climate readiness program, utilities can demonstrate leadership in addressing climate concerns. *(See Recommendations 7 and 10)*

CRWU Working Group Recommendations - Highlights

The CRWU Working Group has prepared 12 recommendations in response to its findings, its determination of what it means to be a climate ready utility, and its understanding of the incentives, tools, training, and program integration needed to motivate and enable utilities to become climate ready. Recommendation 1 addresses the overall concept of supporting climate readiness by utilities, while Recommendations 2 through 12 address the key building blocks of such an effort.

Recommendation 1: EPA should develop a well-coordinated program to articulate and support the adoption of climate ready activities by utilities. In coordination with other federal partners and in close

cooperation with water sector professional associations and others, EPA can substantially aid the water sector by: a) supporting water sector climate adaptation and mitigation strategy evaluation, planning, and response; b) working with others to build out the concept of "climate ready" articulated in this report; and c) preparing guidance, case studies, and other reference materials that inform utilities of the adaptation and mitigation options they have and how best to evaluate and implement these choices. While climate ready water utility programs should not be viewed by utilities or EPA as a separate, stand-alone initiative, at the initial stages, climate ready programs may necessitate focused attention and resources given the emerging challenges, opportunities, and needs articulated in the finding statements. Ultimately, however, climate readiness must be folded into a comprehensive utility management and operations strategy (including making clear how an expanded concept of water infrastructure fits into climate readiness), as well as a comprehensive EPA climate change strategy that is integrated with other utility sector management programs and other EPA media offices. Recommendations 2 through 12 are designed to provide the basic building blocks for utilities and the EPA strategy, as well as focus and guide the efforts of all water sector actors.

Recommendation 2: EPA should build out the concept of "climate ready" utilities based on the Findings and CRWU Adaptive Response Framework in this report. As EPA develops a climate ready utilities program, it should adopt an approach that recognizes the diversity of conditions faced by individual utilities and the substantial uncertainty that exists regarding the nature, timing, and magnitude of localized climate impacts. The Adaptive Response Framework articulated in this report is designed to address these challenges while encouraging all utilities to become more climate ready. In light of the expectation that climate change impact uncertainty will remain high for the foreseeable future, the Working Group believes the adaptive framework approach to climate readiness is very appropriate and practical for providing utilities with a balanced approach for improving water utility climate resiliency.

Recommendation 3: Establish for utility staff a climate change continuing education and training program. Utilities will need well informed and supportive staff to identify, assess, and prioritize climate considerations and integrate them successfully into utility planning, managerial, and operational processes. In response, utilities will need to educate staff at all levels on the water management implications of climate change. EPA, in close partnership with other water sector organizations, could offer training through existing in-house programs, new programs, and water sector continuing education.

Recommendation 4: Build on and strengthen advanced decision support models and tools to support utility climate change efforts. Effective adaptation requires utility managers to address the complex challenges associated with an uncertain climate and the need to reach beyond conventional infrastructure approaches. In response, utilities need a more locally refined understanding of climate change implications and the benefits and costs of alternative adaptation and mitigation strategies. Advanced decision support models and tools that aid utility managers in evaluating management strategies under different, local climate change scenarios are needed. Work has been done in this area,

and EPA should partner with other federal and state agencies and other water sector organizations to further develop, disseminate, and provide training on these tools.

Recommendation 5: Increase interdependent sector knowledge of water sector climate-related challenges and needs. Large volume water users such as agriculture, industrial, energy, and maritime/navigation interests and state and local economic development, land use planning, and other departments can strongly influence water quality, quantity, availability, and access, and can mitigate or exacerbate the water resource management challenges water utilities face. Enhanced cooperation and integration with these organizations are needed to ensure local utility adaptation and mitigation needs and interests are clearly understood and addressed. In response, EPA, in partnership with national and regional water sector associations, should enhance interdependent sector knowledge and appreciation of shared water management responsibilities, as well as opportunities for shared risk partnerships.

Recommendation 6: Improve and better integrate watershed planning and management in response to climate uncertainty and impacts. Participation among all invested partners in a watershed is needed to focus on a comprehensive strategy that characterizes potential climate change effects on local hydrology/water resources and identifies collective actions necessary to adapt to those effects. Utilities, however, must be better enabled to make more effective climate change adaptation investments in source water protection and distributed and green infrastructure, join in partnerships with other watershed actors, and collect and provide watershed planners better data. In response, EPA, in partnership with other federal, state, and local water sector actors, needs to enhance the watershed approach by:

- Encouraging continued adoption of integrated water resources management by utilities;
- Improving the efficacy of current watershed-based planning and permitting approaches to enable more complete consideration of non-traditional approaches to achieve watershed objectives in land-use planning, watershed based permits, habitat and natural resource protection, and Total Maximum Daily Loads (TMDLs);
- Clarifying and ensuring consistent implementation of existing investment flexibilities and expanding on these flexibilities as needed to support investments in source water protection, distributed and green infrastructure, and joint partnerships; and
- Integrating and reconciling in the local watershed planning and permitting context the requirements of key statutes such as the Endangered Species Act (ESA), Clean Water Act (CWA), and Safe Drinking Water Act (SDWA).

Recommendation 7: Improve access to and dissemination of easy-to-understand and locally relevant climate information. Climate science is complex and often expressed in technical, ambiguous, and scientific form that can be difficult for utilities to understand, communicate to their local community, and translate into action. Furthermore, there is a need to establish utility level awareness of climate

change science and impacts, planning methods, tools, resources, and approaches for evaluating and responding to climate change challenges. In response, EPA should partner with other federal and state agencies, professional associations, and the scientific community to translate climate impact findings and projections into more synthesized, water-sector specific, and less technical material that is specifically tailored to at least regional, if not local, conditions, and to prepare targeted, synthesized information offerings (e.g., fact sheets, brochures, web casts). This information should speak directly to the climate change information needs of utility managers and inform community decision makers and the public about the potential impacts of climate change to water systems, the benefits of enhancing local vulnerability assessment and planning to address climate change, and the opportunities for proactive, "no regrets" actions to buffer against such threats. Additionally, establishing a focused set of channels through which this information will flow can reduce the burden of gaining information access.

Recommendation 8: Better integrate climate change information into existing utility technical assistance initiatives. EPA and its federal partners addressing climate change, along with professional associations and others, need to leverage and adapt existing partnership programs (such as those offered through National Rural Water Association, the Rural Community Assistance Partnership, Effective Utility Management (EUM), and state capacity building programs) to identify and design specific, focused efforts that integrate climate change adaptation considerations and opportunities into existing assistance modules such as capital planning, financial planning, and emergency response planning. Effective planning, including building in climate impact assessments, is an important aspect of improving overall utility management and can play an important role in responding to the capacity concerns described in Finding 7. Capacity building topics would include: understanding and applying local climate science information; vulnerability assessment techniques; long-range planning approaches; flexible operating strategies and mitigation options; and operational partnerships. Additionally, recruiting "sentinel" utilities and associations to share experiences about adaptation and mitigation experiences in structured forums could help disseminate the latest information available and potentially support development of on-going mentoring relationships and/or regional collaborations.

Recommendation 9: Develop an adaptive regulatory capacity in response to potential climate change alteration of underlying ecological conditions and systems. Climate change continues and is projected to place substantial pressure on the pre-existing hydrological, meteorological, and ecological conditions that form the basis for federal and state water resources protection and management regulatory framework. To sustain past progress and avoid new risk to human health and aquatic ecosystems, EPA, in partnership with the states, water sector, tribes, and NGOs, must:

- Improve the assessment of projected climate changes nationally and regionally, including enhancing tools and data collection systems, as needed;
- Identify current areas and programs where existing water quality and quantity conditions or projected changes in those conditions can create significant new regulatory, public health, or environmental challenges;

- Integrate, as necessary, the implications of the changes into standard setting, permitting, and modeling efforts to ensure that clean and safe water and ecosystem goals are met;

- Ensure that cross media impacts and associated costs are clearly identified; and

- Establish pilot projects responding to these challenges and use the experience to recommend more proactive approaches within the existing regulatory framework.

Recommendation 10: Develop a comprehensive water sector, climate change research strategy. The water sector is currently underserved by available climate science, expertise, and resources, as well as information regarding the costs and benefits of alternative adaptation and mitigation strategies. In response, it is vital that EPA, other federal agencies, and Congress place the needs of the water sector high on the national agenda. EPA and other federal agencies should involve the water sector and all applicable professional associations in considering what climate research to prioritize, while placing a special emphasis on the need to develop a more locally refined understanding of the risks posed by climate change to water systems and the need for additional information regarding the costs and benefits of adaptation and mitigation options. The strategy should also identify the applicable roles and responsibilities of federal agencies, research organizations, and the climate research community.

Recommendation 11: Advocate for better coordination of federal agency climate change programs and services. EPA, through its participation in the federal Interagency Climate Change Task Force, should advocate for stronger and more effective federal interagency coordination and the establishment of a national-level framework through which the water sector can engage the federal government. Advocacy should include: articulation of guidance for how federal agencies should work together to strengthen coordination across the federal government and collaborate with the water sector; preparation of a coordinated, collaborative, technical assistance and information strategy that is supported by the key agencies and organizations; and coordination on the development of the National Climate Service, particularly between the National Oceanic and Atmospheric Administration (NOAA) and Department of Interior (DOI).

Recommendation 12: EPA should take the following early action steps in close cooperation with applicable federal agencies, NGOs, and water sector professional associations.

- More fully articulate the elements of the adaptive response framework.

- Develop and articulate strategies for integrating climate change adaptation and mitigation approaches into existing utility priorities, on-going asset management and infrastructure repair and replacement efforts, and emergency response, capacity, and capital planning.

- Assure funding and other resources currently available for climate change is well coordinated, aligned to water sector needs, and available for a full range of adaptation strategies.

- Inform other federal agencies about federally funded project design opportunities that will support water sector climate resilience and stress the importance of ensuring federally funded projects account for climate change considerations.

- Link climate ready adaptive response framework activities with EPA's EUM and Climate Ready Estuaries (CRE) programs to ensure climate readiness becomes part of on-going utility planning and management efforts, and post this report on the EUM website.

- Establish a climate ready information sharing community and include climate ready criteria in current awards programs to spotlight current and incentivize future utility activity.

A Climate Ready Utility

The Working Group has developed the concept of a climate ready adaptive response framework to illustrate the types of activities that a climate ready utility will undertake as its level of engagement changes in response to evolving climate science, local hydrological and meteorological conditions, and adaptation and mitigation opportunities and techniques. The Climate Ready Adaptive Response Framework divides utility engagement into two stages: Stage 1 – Assess and Plan and Stage 2 – Implement and Evaluate. Climate ready activities within both of these stages reflect a continuum from basic to focused engagement.

Basic engagement reflects the expectation that certain utilities today do not view climate impacts as immediately relevant, or do not have adequate knowledge regarding the impacts of climate change on system reliability and maintenance of service levels. It also reflects the belief that individual utility and water sector resilience is dependent on the integration of general climate impact awareness into typical utility management activities such as emergency response, capacity, and capital planning. *Focused engagement* is an extension of basic engagement that comes in response to a utility's determination that local climate change challenges pose a direct threat to system reliability and associated service levels. With focused engagement, a utility undertakes a structured, systematic climate vulnerability assessment, utilizes long-range planning methods that account for greater uncertainty and variability, and seeks "robust" project alternatives (those that perform well under a range of potential future conditions and events) rather than those optimized for a single, specific design condition. To support integration of climate ready activity areas into on-going utility management, the Working Group specifically identified EPA's EUM initiative and the CRE Program as important areas for coordination.

Resources and Incentives

In developing the climate ready adaptive response framework and associated activity areas, the Working Group identified needed resources (tools, training, and products) to support, and incentives to promote, successful implementation. Resource needs are organized by five categories: Internal Understanding and Education; Partnership Building; Climate Impact Assessment; Climate Adaptation Support; and Stakeholder Communication. Each need is linked to the specific recommendation(s) it supports, and is

identified as short-term (within the next three years) or long-term (beyond three years) to help with prioritization. Along with needed tools, trainings, and products, each category contains a list of example existing resources that could be immediately useful in supporting implementation of climate ready actions. In addition to resources, the Working Group outlined potential incentives to support climate ready activities. Initially, while the concept of climate ready is evolving, incentives should focus on a) spotlighting early adopters via integration of climate ready concepts into existing award programs, and b) promoting membership in a community of practice and information sharing. Over time, as climate readiness matures, EPA could consider developing a new leadership or recognition program, but only after completing a gap analysis to determine whether a new program is needed, coupled with an examination of similar programs to determine their success in changing behavior and motivating action. In addition to leadership and recognition programs, the Working Group explored two additional incentive areas: highlighting and promoting existing sources of funding, and encouraging breakthrough technological innovations. The Working Group encourages full consideration of these additional incentive areas as a means to entice and facilitate utility implementation of climate ready actions.

Introduction

The National Drinking Water Advisory Council (NDWAC) established the Climate Ready Water Utilities (CRWU) Working Group to evaluate the concept of "climate ready water utilities." The Working Group was composed of 21 members representing a broad range of perspectives related to water utilities, including participants from large and small, private and public, drinking water and wastewater treatment providers; state and local government; academia; and environmental interests. The Working Group was supported by a number of resource personnel from federal agencies with interest and expertise in water utilities and climate change. These included representatives from United States Environmental Protection Agency (EPA), Centers for Disease Control and Prevention (CDC), Federal Emergency Management Agency (FEMA), National Oceanic and Atmospheric Administration (NOAA), and the United States Army Corps of Engineers (USACE).

The Working Group met five times in person and by conference call between November 2009 and September 2010. Notices of meetings were published in the Federal Register in advance of meetings and calls. Meetings were open to the public, and opportunities for public comment were provided at each meeting. A total of 16 outside presenters spoke on a variety of related topics to provide the Working Group with additional background information and technical insight. The complete list of these presenters can be found in Appendix B. The Working Group used a consensus-based, collaborative problem-solving approach to develop the report.

As directed by NDWAC, the evaluation was to provide findings and recommendations on the development of an effective program that will enable water and wastewater utilities to develop and implement long-range plans that account for climate change impacts. The CRWU Working Group was to interpret the scope of its deliberations to include all water and wastewater operations, from source water to tap, and collection system to discharge. The Working Group has interpreted the term "water utilities" to also include stormwater management utility services because of the direct relationships among stormwater, water supply, and wastewater treatment planning and management.

NDWAC specifically requested that the findings and recommendations cover the following topics:

1. Define and develop a baseline understanding of how to use available information to develop climate change adaptation and mitigation strategies (i.e., identify the behaviors that characterize a "climate ready utility" for purposes of both adaptation and mitigation), including ways to integrate this information into existing complementary programs such as the Effective Utility Management (EUM) and Climate Ready Estuaries (CRE) Program;

2. Identify climate change-related tools, training, and products that address short -term and long-term needs of water and wastewater utility managers, decision makers, and engineers (i.e., explore how to best enable climate ready utility behaviors), including ways to integrate these tools and training into existing programs; and

3. Explore mechanisms to provide recognition or incentives that facilitate broad adoption of climate change adaptation and mitigation strategies by the water sector for incorporation into existing EPA Office of Water recognition and awards programs or new recognition programs.

This report presents the CRWU Working Group's findings and recommendations to NDWAC. CRWU Working Group members understand that NDWAC will consider these findings and may provide them to EPA unchanged, may amend them to reflect their own views, or may choose not to forward findings and recommendations to EPA.

The report captures, organizes, and synthesizes the Working Group's deliberations. The findings and recommendations emerged from a carefully conducted deliberative process carried out over the course of five meetings spanning a ten-month period. Working Group members have acted as a "consensus seeking" body, striving to find common ground on the specifics of, and needs related to, the concept of climate ready water utilities. Consensus is defined as findings and recommendations which, at a minimum, all group members can live with, but for any given topic individual support can range from basic acceptance to strong support. Per the NDWAC charter, Working Group members did not formally represent their specific affiliated organization, but rather sought to provide input reflective of their individual expertise and their broad understanding of water sector needs and interests.

The Working Group recognizes that EPA, water sector professional associations, many utilities, non-governmental organizations (NGOs), and others have taken important steps to improve the water sector's understanding of and response to climate change challenges. As evidenced by the EPA – United States Department of Housing and Urban Development (HUD) – Department of Transportation (DOT) Interagency Partnership for Sustainable Communities, there are very positive examples of federal agency collaboration to address climate change challenges. As reflected in this report, however, there remains a need for better coordinated and more comprehensive efforts across all levels to help utilities address climate change challenges, while making the most efficient and effective use of their available technical and financial resources.

Overall, the Working Group believes the concept of water utility climate readiness as articulated in this report requires support by EPA in very close partnership with the water sector, including state water management agencies, professional water associations, and NGOs. Climate readiness is a critical aspect of overall water sector utility resilience. Moreover, "no-regrets," "multiple benefits" opportunities exist to integrate climate considerations into utility planning, operations, management, and capital investments on a no or low cost basis.

At the same time, the Working Group understands, and this report clearly acknowledges, that expectations for utility climate readiness must be managed in the context of several factors. These factors include the struggle certain utilities face to meet current obligations, maintain service affordability, the uncertainty of localized climate change impacts, and the lack of financial, managerial, and technical capacity to support implementation. The Working Group's recommendations focus substantially on the actions necessary to overcome these obstacles. Additionally the Working Group

recognizes that climate change impacts have the potential to disproportionally affect disadvantaged populations, thereby exacerbating environmental justice issues in certain communities. Climate ready water utility initiatives at all levels should include opportunities for timely and meaningful involvement and input from all affected populations to better ensure environmental justice concerns are proactively addressed.

This report is divided into the following five sections.

Section 1: Findings, presents 11 key findings resulting from the Working Group's discussions. These findings provide the overall context for the remainder of the report.

Section 2: Recommendations, presents the Working Group's 12 key recommendations regarding actions that EPA, in cooperation and collaboration with other water sector participants, should consider taking to promote and enable climate ready utilities.

Section 3: Climate Ready Adaptive Response Framework, provides an in-depth description of an illustrative adaptive response framework by which utilities can become climate ready and maintain climate readiness. It also briefly discusses the need for integration of the report's findings, recommendations, and adaptive response framework with other existing programs.

Section 4: Needed Resources, provides a list of tools, training, and products needed by utilities to help achieve climate readiness and identifies existing tools, training, and products which would support implementation of climate ready actions.

Section 5: Incentives, covers two early leadership actions, new recognition program development considerations, and a number of other incentive-related approaches that could help to support broad implementation of water sector utility climate readiness.

Section 1: Findings

This section presents CRWU Working Group Findings. These 11 findings emerge from deliberations conducted throughout the Working Group process, and they provide the critical context and key considerations for understanding Working Group recommendations and the Climate Ready Adaptive Response Framework presented in Section 3. Table 2, at the end of this section, provides a cross walk between these findings and the CRWU recommendations.

Finding 1: The water sector faces important and potentially substantial climate change adaptation challenges, but also opportunities. A range of scientific work and current utility experience indicates that a changing climate holds the potential to impact water resources management by increasing temperatures and the variability of precipitation, increasing the frequency and severity of storm events, raising sea levels, and setting off secondary effects such as changing utility customer demands, increasing use of water for energy and agricultural production, and shifts in population and economic

activity throughout the country. Several recent reports (e.g., Association of Metropolitan Water Agencies' *Implications of Climate Change for Urban Water Utilities* and National Association of Clean Water Agencies' *Climate Change: Emerging Issues for Clean Water Agencies*) have explored and articulated the implications of these climate challenges for water sector utilities. These reports indicate that, while the specific local nature, timing, severity, and scope of climate-related water resource and infrastructure impacts remains uncertain, individual utilities will be exposed to greater variability and less predictability in the hydrological and meteorological (weather, ecological, and other system) conditions that underlie water sector utility systems planning, design, financing, and operations at all scales. This indicates a need to examine "stationarity" assumptions that underlie much water sector planning. Furthermore, current and projected changes in climate are seen to hold the potential to reduce water management system flexibility, reliability, and sustainability. Those changes will also place increasing pressure on emergency response programs and capabilities, and will likely increase the cost of capital improvements, operations, and maintenance. Climate change will likely generate additional challenges for the water sector, thereby complicating (and potentially compromising) the ability to strike a balance among key water management system objectives including delivering adequate, reliable, and sustainable water supplies, providing effective flood management, ensuring adequate quality and quantity of in-stream flows for environmental purposes, and maintaining water, sewer, and stormwater utility rates at affordable levels.

Stationarity – The presumption that conditions vary within a generally predictable range based on historic data.

While the challenges of climate change will likely dominate the discussion in the water sector, it is important to also consider how thoughtful, proactive adaptation can be a means to pursue beneficial opportunities as illustrated by the following examples:

- Integrating such features as green roofs, street trees, and porous paving to reduce stormwater runoff and flooding affords a visible means to further engage the public in water issues and mitigates impacts to water quality for a community;
- Creating a coordinated regional water shortage plan, including shared customer monitoring, outreach, and messaging to enhance overall water system resilience; and
- Proactive development of finished water system interconnections to diversify and increase water supply capacity, as well as water efficiency initiatives can enable deferral of expansion of water system infrastructure improvements, thereby reducing costs.

Understanding of climate change challenges sends a message to, and signals the need for, water sector utilities to engage in adaptation thinking and locally-appropriate action.

Finding 2: Proactive, climate ready actions will enhance water sector utility resilience. Adaptation actions already taken by water utilities fall along a continuum of engagement, generally commensurate with the respective utility's awareness of the immediacy and certainty of actual or projected climate impacts and of the opportunities for taking proactive action. Some utilities have engaged in substantial

adaptation efforts, including vulnerability assessments, long-range planning modifications, operational alterations, and investments in more flexible infrastructure. Utilities, through proactive, climate-related engagement, have the opportunity to build resilience into their systems through the use of no and low cost operational changes and multiple-benefit investments, such as flexible treatment technologies, alternative water storage management, water supply diversification, and integrated water management. These investments can act as insurance (in the form of added system resiliency) against difficult-to-predict, but potentially high impact, hydrological and meteorological changes, as well as other planned and unplanned events. Certain strategies needed to adapt effectively to climate challenges – particularly forming collaborative, shared-risk partnerships with interdependent actors – will take time to develop, while experience indicates severe climate impacts such as droughts can emerge quite quickly. This further reinforces the need for proactive engagement and preparedness.

Shared Risk Partnership – Establishment of a cooperative relationship by organizations subject to similar threats, such as water scarcity, to pool resources and coordinate strategy to more cost effectively and adequately respond to these threats.

Finding 3: Different local conditions will dictate different climate ready responses. As the water sector engages in climate-related adaptation thinking, it is critical to recognize that different local conditions – including immediacy and certainty of actual or projected impacts and consistency of climate modeling results – will, quite appropriately, lead to different responses and intensity of engagement. Furthermore, the level of community interest, varying public opinion, and local decision makers' understanding and commitment will significantly affect a water utility's ability to respond and adapt to climate challenges. Concerns about uncertainty related to the hydrological and meteorological historical record as a good predictor of future conditions has led some utilities to alter their planning, design, and/or operational practices. Where climate-related impacts are already discernable and/or climate model projections are sending stronger and more consistent signals about future expectations (e.g., severe and extended drought conditions in the American Southwest and coastal communities attuned to potential sea level rise) utilities will have a stronger basis for engaging in adaptation planning, infrastructure investments, and operational changes. Other utilities, seeing the uncertainties of future climate conditions as a threat to system reliability, will undertake climate assessments and find "no regrets" opportunities to proactively increase the climate impact resiliency of their systems. On the other hand, decision makers will likely conclude there is a weak basis for action when impacts remain muted, climate projections vary about the direction and severity of impacts, community resources by necessity are focused on more immediate priorities, and they have limited awareness of the opportunities provided by no regrets actions (some of which can save money for a utility). Importantly, while addressing and maintaining a focus on other pressing priorities, all utilities have the opportunity to integrate no regrets approaches to build resilience to climate impacts into their systems.

No Regrets – Adaptation options that produce multiple, cost-effective benefits to existing and future problems and would be justified under a wide range of future scenarios.

Finding 4: Utility "climate readiness" is an emerging concept that must therefore reflect an adaptive learning and management framework. Climate change knowledge and experience within the water sector (including local impact projections, tools for managing uncertainty, and efficacy of project alternatives) is evolving. This knowledge and experience, however, has not yet translated into the specificity water utilities typically use to make near-term operational decisions or long-term infrastructure investments. At the same time, the sector has generally made important advances in understanding climate challenges and translating them into planning and operational approaches, particularly where alterations in underlying hydrological and meteorological conditions have supported action. Water utilities have an opportunity and, under certain conditions, a compelling need to alter their water systems planning, design, expansion, operations, and financial planning and management in response to more uncertain, future hydrological and meteorological conditions. Accordingly, water sector adaptation and mitigation efforts will reflect a continuum of engagement best supported by an adaptive learning and management framework (see Section 3 for the articulation of this concept). Engagement will start with anticipatory actions such as maintaining climate impact awareness and undertaking no regrets operational changes before impacts are observed. Engagement will evolve in response to specific emerging and changing local conditions. These new planning and operational activities will require effective training for staff and decision makers on climate science, climate change impacts, tools to support assessment and planning, and managerial, operational, and traditional and non-traditional infrastructure responses.

Finding 5: An expanded concept of "water system infrastructure" is a key element of utility climate readiness. Experience from water sector climate adaptation and mitigation to date indicates utilities should anticipate the need for balanced, upfront consideration of conventional and non-conventional infrastructure, and operational, legal, financial, and institutional alternatives to ensure robust climate change adaptation and mitigation strategies are identified. Conventional, centralized systems can provide economies of scale in terms of cost, staffing, energy, and operations/maintenance, however, by their traditionally capital intensive and long-lived nature, can be less flexible and potentially more vulnerable to uncertain climate impacts. In response, utilities will need to engage stakeholders and other responsible parties to expand the community's understanding of the value of the level of water services, as well as the concept of infrastructure to include repurposing of existing infrastructure, integrated management of currently independent infrastructure components, and distributed and green technologies.

Robust – Strategies that perform well not only under the normal range of conditions but also under unusual conditions that stress underlying assumptions.

Re-purposing and more integrated management of a community's infrastructure hold the potential to increase resilience and maintain reliability in the face of climate change challenges. For example, when relevant to a particular community's infrastructure needs and conditions, using decommissioned tanks (such as clarifiers, basins, trickling filter boxes, etc.) at wastewater treatment plants to equalize influent flows can increase wet weather capacity and allow for shifting energy load from peak to off-peak periods. The particular asset configuration and potential for their re-purposing must be evaluated on a

case-by-case basis as no one-size-fits-all approach will be applicable. Climate change will also challenge existing institutional frameworks, especially in the face of increasing financial and natural resource constraints and conflicts, and because some utilities are already having difficulty meeting basic responsibilities even under current climate conditions. Alternative solutions, such as utility-to-utility collaboration or consolidation and collaboration among water sector utilities and stormwater and flood control agencies, may enable more effective use of the limited technical and financial resources.

Green infrastructure and low impact development can provide no regrets solutions that can benefit water utilities and surrounding communities by helping reduce vulnerability to climate-induced changes regardless of exactly what changes occur. Green infrastructure examples include wetlands, parks, rain gardens, trees, infiltration planters, green roofs, and porous paving (which reflect the protection, restoration, and replication of natural systems). Similarly, distributed technologies such as advanced decentralized sewage treatment, gray water reuse systems, and cisterns, are important to consider as part of the planning process. These technologies, if properly designed and operated, may be a better choice in some circumstances as they can cost less, use less energy (and reduce associated greenhouse gases (GHGs)), contribute to reduced demand for highly treated water, and help maintain hydrologic balance at the site and local level. Green infrastructure can buffer and alleviate the impact of stormwater on traditional infrastructure and treatment systems by reducing the rate, volume, and temperature of runoff and preventing or controlling the introduction of pollutant loads into fresh water supplies. Green infrastructure can also help restore or mimic the functions of natural systems (e.g., temperature moderation through shading and evapotranspiration, GHG removal by vegetative systems, flood risk reduction through decreased runoff volumes and velocities) and contribute to aquifer recharge and surface water base flows. Distributed systems, where they can be cost-effectively and sustainably operated and managed at smaller scales, may provide more flexibility than centralized systems that have large fixed capital investments that are potentially more vulnerable to a changing climate.

Importantly, these potentially more robust approaches can be challenging to implement in already developed, highly urban areas and require the active participation and cooperation of multiple entities, including local governments, land use planners, private developers, and regulators. New skill sets and programmatic functions, such as vegetative cover design and maintenance, will be required within the water sector as well. A water utility alone cannot deliver on this expanded concept of water infrastructure. Utilities can, however, integrate these concepts into their strategies through balanced and upfront consideration in planning activities and by engaging stakeholders and other responsible parties.

Finding 6: To succeed, individual utilities need a robust enabling environment. The ability of individual utilities to address climate change challenges will rely substantially on the sustained support of key water sector interests, including major water associations, federal and state water resource agencies, utility rate decision makers, and the scientific community involved in climate change modeling, impact assessment, adaptation and mitigation planning. Water utilities operate in a management context

created, implemented, and influenced by federal, state, local, and regional actors (including local land use and economic development planners, the public health sector, other water utility service providers, the energy sector, and regional water and natural resource managers). Utility experience to-date indicates that successful climate change adaptation efforts require effective partnerships and enhanced watershed or basin-level water resources coordination and management. This requires a water management institutional framework that supports cross-jurisdictional coordination and integration, effective priority setting and integrated water resource management, and the establishment of effective risk management partnerships with critical interdependent actors. Utilities that do not form such partnerships will likely achieve only limited adaptive success. This points to the critical need for and role of federal and state water resource management and protection agencies in supporting the development of improved water resource management frameworks, as well as in supporting utilities in their efforts to establish partnerships with other interdependent sectors (such as energy and agriculture) as an essential foundation for climate change adaptation and mitigation efforts. Utilities will need these entities to take action that supports and/or creates an environment in which utility managers can understand the evolving nature of climate change challenges, better incorporate and address climate-related uncertainty in long-range planning, understand the costs and benefits of adaptation options, attract and establish effective collaborative partnerships with interdependent actors, and actually implement environmentally, technically, and financially feasible adaptation strategies.

Finding 7: Many utilities do not have the capacity to become climate ready. In the absence of focused support for long-range climate change adaptation planning and implementation, water sector utilities will need to focus their existing technical, managerial, and financial capacity to respond to more traditional and immediate operational priorities. Many utilities are faced with other immediate, essential, concrete needs (e.g., security, regulatory requirements, aging infrastructure, environmental protection, and workforce succession) that will by necessity remain priorities that absorb most, if not all, of their available technical and financial capacity. For many utilities, current funding is simply inadequate to finance and implement climate adaptation and mitigation actions such as enhanced long-range planning and a variety of water supply, collection system, and treatment options – especially considering that many such measures have the potential to increase both operating and long-term fixed costs.

This will likely be the case, especially for small and rural systems, as well as systems with deteriorated infrastructure, struggling to meet existing regulatory requirements and level-of-service expectations. Furthermore, community awareness and willingness to support action regarding climate change remains mixed and highly variable, thus creating a challenge for local decision makers to allocate resources to address climate change adaptation and mitigation efforts. Importantly, efforts to provide focused support for climate change planning and implementation must be balanced with the continuing need to maintain support to, for example, small and disadvantaged utility capacity development efforts, including maintaining a balance with the public health and environmental objectives of the Clean Water and Drinking Water State Revolving Loan Funds (SRFs). A critical strategy for addressing these challenges

will be ensuring climate ready water utility programs are folded into comprehensive utility management and operations strategies.

Finding 8: Climate change impacts create challenges for current "regulatory stationarity." The current federal and state water resources protection and management regulatory framework (including those related to the Clean Water Act (CWA), Safe Drinking Water Act (SDWA), Endangered Species Act (ESA), and a wide range of federal and state water quantity, quality, and rights-related rules) is grounded in baseline assumptions, experience, and expectations based on pre-existing hydrological, meteorological, and ecological conditions. Climate change is projected to substantially change these conditions and stress vulnerable ecosystems. Climate impact planning conducted by the water sector indicates current and emergent regulatory obligations can come under substantial pressure in this context. Just as questions have emerged regarding hydrological and meteorological stationarity as a basis for utility planning, there is increasing concern regarding the future validity of the natural systems assumptions upon which current standards, permit conditions, and water use and delivery obligations are based (i.e., regulatory stationarity). These changing conditions hold the potential to require a substantial shift in existing and future utility investments in water resource protection and management. For example, current permit requirements or water rights obligations tied to historic stream flow, water temperature, water quality, or ecological data may become outdated as ecological conditions shift (e.g., background average surface water temperatures rise, salt water intrusion risks to coastal freshwater increase, average in-stream flows decline), highlighting the need to incorporate climate considerations in utility planning and management and the evaluation of regulatory frameworks. EPA has clearly acknowledged these challenges in its *National Water Program Strategy: Response to Climate Change*, where it states:

> "EPA, States, and Tribes implementing core water programs will need to continue to meet drinking water, clean water, and wetlands protection goals as the climate changes. Warmer air and water, changes in weather patterns, and rising sea levels will create challenges that may require modifications to programs and new tools in order to sustain past progress and avoid new risk to human health and aquatic ecosystems."

The *National Water Program Strategy: Response to Climate Change* identifies potential impacts on specific water programs as summarized in Table 1. EPA should continue to expand, refine, and update its strategies to address these challenges.

In addition, there is a need to establish regulatory and non-regulatory agency (e.g., United States Geological Survey (USGS)), utility, tribal, and NGO partnerships to explore the nature of these challenges and ensure an adaptive, problem-solving framework and approach underlies implementation of regulatory frameworks. This will ensure continued progress in meeting the goals of the CWA, SDWA, and ESA, and other water allocation, water quality, and in-stream flow protection requirements/goals.

Table 1: *National Water Program Strategy* Potential Climate Change Impacts on Water Programs

Climate Change Impacts on Water Program (shaded area indicates program most impacted by climate change)	Air and Water Temperature Increase	Rainfall and Snowfall Levels/Distribution	Storm Intensity	Sea Level Rise	Changing Ocean Characteristics	Energy Generation Shifts
Drinking Water Standards	✓					
Drinking Water Planning		✓	✓	✓		✓
Underground Injection Control Permits		✓		✓		✓
Source Water Protection	✓	✓				✓
Drinking Water SRF	✓	✓	✓	✓		
Surface Water Standards	✓					✓
Clean Water Planning	✓			✓		
Discharge Permits	✓	✓	✓			
Nonpoint Pollution Control	✓	✓	✓			✓
Clean Water SRF	✓	✓	✓	✓		
Technology Based Standards						✓
Water Monitoring			✓		✓	
Stormwater Permits		✓	✓			
Coastal Zone			✓	✓	✓	
Ocean Protection			✓	✓	✓	✓
Emergency Planning			✓	✓		
Water Restoration/TMDLs	✓	✓	✓			
Wetlands Permits	✓		✓	✓	✓	
National Estuaries Program			✓	✓	✓	
Combined Sewer Overflow Plans		✓	✓			

Finding 9: Water sector utilities are overwhelmed with climate change information and lack of coordination by federal agencies, state agencies, and other water sector actors. Water utility officials are overwhelmed with the number and volume of climate change studies being produced by many different federal and state agencies, water associations, universities, and other organizations. In some cases, there has been substantial duplication of effort and information. Both quantity and quality aspects of source water are important for water utility; therefore the climate research led by federal entities on water quantity should be augmented with a complementary focus on water quality. Moreover, there is a current lack of horizontal coordination and alignment amongst the various federal agencies that are engaged in climate adaptation and mitigation activities as well as vertical coordination between the federal, state, and local levels of government. The past few years have seen a welcome increase in federal attention and resources being directed at the issue of climate adaptation. The proliferation of what appear to be uncoordinated federal initiatives, however, create significant challenges for the water sector in deciding how to allocate time, attention, and other resources to the myriad initiatives, and runs the risk of duplicating efforts. In addition, the apparent lack of coordination at the federal level also hinders vertical coordination between the federal government and local and state governments, as well as NGOs, water associations, universities, and other organizations. The lack of vertical coordination hinders the opportunity to leverage more fully the good work that is happening at multiple levels of government and in different sectors of society.

Finding 10: The water sector is underserved by available climate science and by information regarding adaptation and mitigation costs and benefits. Current climate change projections indicate water resources will be substantially affected by climate change. These findings have critical implications for adaptation planning and investments for drinking water and wastewater utilities. Currently, the water sector is underserved by available climate science and information regarding adaptation costs and benefits. In the absence of focused efforts to keep water sector needs high on the national agenda (including EPA and Congress), the sector will be at risk of not having the tools and information necessary to understand risks and consequences adequately, to identify and evaluate the benefits and costs of alternative response strategies, and to make quality, timely, and cost-effective adaptation decisions. Concurrent with individual utilities proactively moving forward to address climate change challenges, there is a strong need for continued investment in advancing the research and understanding of climate impacts, adaptation, and mitigation. Needed research and support includes long-term data collection, locally refined understanding of projected impacts, decision support models, information on adaptation (including adaptation to both gradual, continuous change and response options to non-continuous events and emergencies such as floods and droughts) and mitigation options from other sources and sectors (international and domestic), and translation of research and analytical findings in a manner useful to the full range of systems and for general education.

Moreover, the scientific community must be a strong partner in providing technical assistance to the sector. In this context, water utilities need to be viewed as both a user and shaper of climate research, and federal agencies need to include them and related professional organizations/associations in the

development of research agendas. Through such partnerships, the water sector can be assured its climate adaptation and mitigation research needs are well represented, understood, and addressed.

Finding 11: Water sector utility greenhouse gas (GHG) mitigation efforts are an important aspect of the sector's climate-related strategy. Water and wastewater utilities use a substantial amount of energy to transport, treat, and distribute water and wastewater. Therefore, the water utility sector is an important source of indirect GHG emissions. (Direct emissions can be associated with these activities when utilities use on-site generators as a source of backup power, as well as fuel used for utility vehicle fleets.) EPA has estimated that drinking water and wastewater services account for three percent of national energy consumption, with associated GHG emissions at about 45 million tons annually. Water sector utility vehicle fleets directly emit GHGs, while the transportation of supplies such as chemicals to utilities also produces direct GHG emissions. Additionally, wastewater treatment activities are direct emitters of methane, nitrous oxide, and other GHGs. EPA's 2008 GHG Inventory indicated that wastewater treatment ranks seventh in methane emissions and sixth in nitrous oxide emissions nationally, with wastewater treatment accounting for approximately five percent of national methane emissions. Wastewater treatment carbon dioxide emissions, for emissions inventory purposes, are considered a biogenic gas and are therefore not estimated.

Water sector utilities have begun to develop GHG emission reduction programs in response to energy cost saving opportunities, a desire to take proactive climate change steps, and/or in anticipation of federal, regional, and state GHG reduction programs. Most current utility activity is focused on energy efficiency and related cost savings, rather than GHG mitigation per se, with utilities implementing energy management programs and incorporating more efficient and renewable energy technologies and strategies into repair, replacement, and new construction efforts. In addition to energy management focused efforts, some utilities have undertaken focused GHG reduction efforts with such programs reflecting a range of mitigation practices. Improved energy management measures will have important GHG reduction benefits. More intensive efforts focused specifically on GHG mitigation hold the potential to insulate utilities from energy price increases and supply disruption. Moreover, water conservation and water use efficiency practices can also reduce energy demand and GHG emissions. By including GHG reduction efforts as a component of their climate readiness program, utilities will further demonstrate leadership in addressing climate concerns. Utilities will, however, face a range of GHG management challenges including the energy and GHG intensity of some enhanced treatment technologies, the energy intensity of certain adaptation options, and the increased water intensity of some energy alternatives.

Table 2: CRWU Report Findings and Recommendations Cross-Walk

CRWU Finding	CRWU Recommendation(s) the Finding Supports
Finding 1: The water sector faces important and potentially substantial climate change adaptation challenges, but also opportunities	**Recommendation 1:** EPA should develop a well-coordinated program to articulate and support the adoption of climate ready activities by utilities **Recommendation 12:** EPA should take early action steps in close cooperation with applicable federal agencies, NGOs, and water sector professional associations
Finding 2: Proactive, climate ready actions will enhance water sector utility resilience	**Recommendation 1:** EPA should develop a well-coordinated program to articulate and support the adoption of climate ready activities by utilities
Finding 3: Different local conditions will dictate different climate ready responses	**Recommendation 2:** EPA should build out the concept of "climate ready" utilities based on the Findings and CRWU Adaptive Response Framework in this report
Finding 4: Utility "climate readiness" is an emerging concept that must therefore reflect an adaptive learning and management framework	**Recommendation 2:** EPA should build out the concept of "climate ready" utilities based on the Findings and CRWU Adaptive Response Framework in this report **Recommendation 3:** Establish for utility staff a climate change continuing education and training program
Finding 5: An expanded concept of "water system infrastructure" is a key element of utility climate readiness	**Recommendation 4:** Build on and strengthen advanced decision support models and tools to support utility climate change efforts **Recommendation 6:** Improve and better integrate watershed planning and management in response to climate uncertainty and impacts
Finding 6: To succeed, individual utilities need a robust enabling environment	**Recommendation 5:** Increase interdependent sector knowledge of water sector climate-related challenges and needs **Recommendation 6:** Improve and better integrate watershed planning and management in response to climate uncertainty and impacts
Finding 7: Many utilities do not have the capacity to become climate ready	**Recommendation 8:** Better integrate climate change information into existing utility technical assistance initiatives **Recommendation 12:** EPA should take early action steps in close cooperation with applicable federal agencies, NGOs, and water sector professional associations
Finding 8: Climate change impacts create challenges for current "regulatory stationarity"	**Recommendation 9:** Develop an adaptive regulatory capacity in response to potential climate change alteration of underlying ecological conditions and systems
Finding 9: Water sector utilities are overwhelmed with climate change information and lack of coordination by federal agencies, state agencies, and other water sector actors	**Recommendation 7:** Improve access to and dissemination of easy-to-understand and locally relevant climate information **Recommendation 11:** Advocate for better coordination of federal agency climate change programs and services
Finding 10: The water sector is underserved by available climate science and by information regarding adaptation and mitigation costs and benefits	**Recommendation 10:** Develop a comprehensive water sector, climate change research strategy
Finding 11: Water sector utility GHG mitigation efforts are an important aspect of the sector's climate-related strategy	**Recommendation 7:** Improve access to and dissemination of easy-to-understand and locally relevant climate information **Recommendation 10:** Develop a comprehensive water sector, climate change research strategy

Section 2: Recommendations

The CRWU Working Group has prepared 12 recommendations in response to its findings, its determination of what it means to be a climate ready utility, and its understanding of the incentives, tools, training, and program integration needed to motivate and enable utilities to become climate ready. Recommendation 1 addresses the development of a climate ready utilities initiative, while Recommendations 2 through 12 address the key components of such an effort.

Recommendation 1: EPA should develop a well-coordinated program to articulate and support the adoption of climate ready activities by utilities. As indicated in Finding 1, current and projected changes in climate are seen to hold the potential to reduce water management system flexibility, reliability, and sustainability, while placing upward pressure on the cost of capital improvements, operations, and maintenance. Within this context, EPA, in coordination with other federal partners and cooperation with water sector professional associations can strengthen its existing climate change efforts and substantially aid the water sector by: a) supporting water sector climate adaptation and mitigation strategy evaluation, planning, and response; b) working with others to build out the concept of "climate ready" articulated in this report; and c) preparing guidance, case studies (representing the variety of utility characteristics including size, operations, and climate conditions), and other reference materials that inform utilities of the adaptation and mitigation options they have and how best to evaluate and implement these choices. In support of these actions, EPA must set a vision and refine its strategic plan to implement programs and projects that will bring about the transformation in how utilities prepare for climate change, including making clear how an expanded concept of water infrastructure fits into climate readiness.

Importantly, climate ready water utility programs must not be viewed by utilities or EPA as a separate, stand-alone initiative, even as initially a specific focus on climate change considerations may be needed to highlight opportunities and challenges. Ultimately, however, climate readiness must be folded into comprehensive utility management and operations strategies, as well as a comprehensive EPA climate change strategy that is integrated with other utility sector management programs. Moreover, in close partnership with other federal agencies, tribes, state agencies, and water sector associations, EPA should create a water sector leadership team to assist utilities in preparing for climate change. The leadership team must represent an interdisciplinary approach that includes water, land, air, and energy sector representation. The team should cut across the functional offices of EPA and align the activities of those and the regional offices. EPA should consider Recommendations 2 through12 as critical building blocks for refining its strategic approach to water sector climate readiness.

Recommendation 2: EPA should build out the concept of "climate ready" utilities based on the Findings and CRWU Adaptive Response Framework in this report. As EPA moves to develop a focused program in support of climate ready utilities, it should adopt an approach that recognizes the diversity of conditions faced by individual utilities and the substantial uncertainty that exists regarding the nature, timing, and magnitude of localized climate impacts. The Adaptive Response Framework

articulated in this report is designed to address these challenges, while encouraging all utilities to become more climate ready. The framework does this by: a) establishing a continuum of engagement from basic to very focused activity; b) encouraging utilities to adopt an adaptive management framework to support climate impact assessment and implementation actions; c) emphasizing the importance of integrating climate considerations into on-going utility functions; and d) making no and low cost, no-regrets managerial, operational, and capital choices that can perform well under a variety of hydrological and meteorological (weather, ecological, and other) conditions. In light of the expectation that climate change impact uncertainty will remain high for the foreseeable future, the Working Group believes the adaptive framework approach to climate readiness is very appropriate and practical for providing utilities with a balanced approach for improving water sector utility climate resiliency.

Recommendation 3: Establish for utility staff a climate change continuing education and training program. At a basic level, utilities will need to engage internal staff on climate change challenges to promote and gain support for the integration of climate considerations into utility planning and development processes. As a form of internal engagement, utilities will need to educate staff and decision makers at all levels of operations on the implications of climate change on water management. EPA could offer climate-related education through existing in-house programs or through the development of new programs in close cooperation with national and state water sector associations, state water resources research institutes, cooperative extension service agencies, and other relevant entities. Water sector continuing education efforts provide a further avenue for training and educating current utility staff on climate-related vulnerabilities and responses. The most effective training will be provided at the local or watershed level.

Recommendation 4: Build on and strengthen advanced decision support models and tools to support utility climate change efforts. To improve adaptation success, utilities will need a more locally refined understanding of the risks posed by climate change and the benefits and costs of alternative adaptation and mitigation strategies. This indicates a need to apply advanced decision support models and tools (including ecological services valuation and other tools and methods that can aid in the assessment of alternatives, including emerging strategies such as green infrastructure) that provide utility managers with the ability to evaluate – at the local level – potential management strategies under different climate change scenarios. Work has been done in this area, and EPA should partner with other federal and state agencies, water sector professional associations, the scientific community, tribes, NGOs, and others to further develop, disseminate, and provide training on the use of decision support models to address the complex challenges associated with an uncertain climate and the need to reach beyond conventional infrastructure approaches.

Recommendation 5: Increase interdependent sector knowledge of water sector climate-related challenges and needs. Utility experience to date indicates that interdependent sectors (i.e., large volume water users such as agriculture, industrial, energy, and maritime/navigation interests) and interdependent public agency actors (i.e., economic development, land use planning, state planning,

and elected officials) hold the ability to strongly influence water quality, quantity, availability, and access, and either mitigate or exacerbate the water resource management challenges local water utilities face. Enhanced cooperation and integration with these organizations is necessary to ensure local utility adaptation and mitigation needs and interests are clearly understood and addressed. EPA should partner with national and regional water sector associations to target efforts designed to enhance water sector utility and interdependent sector and actor knowledge and appreciation of shared water management responsibilities, as well as opportunities for shared risk partnerships. These efforts would stress the impacts these sectors and actors can have on water resources and, in particular, the operations and long-term reliability of water, wastewater, and stormwater utility services. Information could also articulate opportunities available to water sector utilities and advocate for partnership relationships by identifying and reviewing productive partnership examples. These efforts can help create an environment in which local utility managers will encounter informed and welcoming partners as they undertake efforts to engage interdependent sectors and ask for their assistance in building shared responsibility and risk partnerships.

Recommendation 6: Improve and better integrate watershed planning and management in response to climate uncertainty and impacts. Successful climate change adaptation is anticipated to require effective water resources management at the watershed level. The scale of these efforts – large river basin, sub-basin, local watershed, or neighborhood – will vary depending on a number of factors.

Participation among all invested partners in the watershed would focus on a comprehensive strategy to identify the potential effects of climate change on local hydrology/water resources and collective actions by all parties in the watershed necessary to mitigate and adapt to those potential effects. This watershed approach promotes and relies on cross-jurisdictional partnerships, recognizes that all sectors will be affected, and encourages coordinated and complementary group investments in adaptation and mitigation strategies that address the broader systemic issues associated with climate change that are beyond any single sector (such as agriculture, energy, industry, etc.) or set of requirements (such as ESA, CWA, SDWA, National Flood Insurance Program regulations, etc.).

In this context, utilities that promote and engage in intra- and inter- jurisdictional water resource management partnerships and enhancements and have the increased flexibility to invest in watershed-wide adaptive actions (e.g., the introduction of riparian vegetation as a response to water temperature concerns) will be more successful in meeting climate change challenges. Watershed planning and management can ensure that water resource objectives and climate adaptations are well integrated with those for economic vitality, environmental protection, and social and cultural goals (i.e., effectively address and balance triple bottom line considerations). Moreover, improving the water resource management context to include watershed stakeholders will improve the efficacy of current watershed-based planning and permitting approaches, enabling more complete consideration of non-traditional approaches (such as green infrastructure) to achieve watershed objectives in land-use planning, watershed based permits, habitat and natural resource protection, and TMDLs. The improvements will need to increase utility and other watershed actor flexibility to make investments in source water

protection, distributed and green infrastructure, and joint partnerships with other water utilities that take into account adaptation strategies related to water management, flood mitigation, natural systems, and land use planning.

EPA, in partnership with other federal, state, tribal, and local water sector actors, should:

- Seek to encourage the continued adoption of integrated water resources management planning at the utility level, including distributed and green infrastructure;
- Create a more supportive context for implementing adaptation actions by clarifying and ensuring consistent implementation of existing investment flexibilities (such as the use of riparian vegetation for surface water temperature management), expanding on existing flexibilities as needed, and better integrating and reconciling the requirements of key statutes such as ESA, CWA, and SDWA; and
- Target funding to support integrated planning (i.e., integrated water management and land use planning that captures urban, agricultural, industrial, and natural system needs at the neighborhood and river basin scale) and the formation of institutional systems that can enable effective decision and management structures on a watershed/regional scale.

EPA must further recognize that to deal with climate change in a holistic manner, watershed based permitting must be part of EPA's climate adaptation strategy (and can act as a vehicle for reconciling and rationalizing disparate requirements). EPA must empower and support states to work with utilities and other watershed partners in developing programs and permits that provide for effective and efficient environmental benefits.

Utilities, for their part, need to build relationships with local partners in water resource management including:

- Collecting and providing watershed planners appropriate data;
- Participating in the development of strategies to address watershed planning; and
- Partnering with other water utilities in their watershed for collaborative planning.

These actions can improve the water resource management context within which utilities will undertake adaptation planning and management by improving current watershed planning and permitting approaches. These improvements will in turn enable utilities to make more effective climate change adaptation investments in source water protection and distributed and green infrastructure, and join in partnerships with other watershed actors.

Recommendation 7: Improve access to and dissemination of easy-to-understand and locally relevant climate information. Water sector utilities, especially smaller or financially constrained systems, gain value in knowledge acquisition but have limited capacity to seek out, organize, and interpret disparate climate-related information. In addition, Climate science is complex and often expressed in technical,

ambiguous, and scientific form that can be difficult for utilities to understand, communicate to their local community, and translate into action. To increase the likelihood of timely and appropriate adaptation action, there is a resultant need to provide utility managers with consistent, easy-to-understand, and locally relevant information on climate science, planning methods, tools, resources, and approaches for evaluating and responding to actual or projected climate change impacts. EPA, in terms of first steps, can identify who and what those resources are, and identify credible sources (e.g., other federal agencies, state agencies, water sector associations, the scientific community) from which utilities can increase their awareness, and who can translate climate impact scientific findings and projections into more synthesized, water-sector specific, and less technical material that is specifically tailored to regional (and local, where possible) conditions. EPA should work with these organizations to prepare targeted, synthesized information offerings (e.g., fact sheets, brochures, web casts) that speak directly to the climate change information needs of utility managers. For example, EPA could work closely with NOAA to have that agency translate the outcomes of its climate change modeling and research work to have specific relevance to utility managers for a full range of systems and in different regions of the country (e.g., southeastern coastal communities).

EPA, in close cooperation with water associations, will need to continue and enhance current efforts to inform community decision makers and the general public about the potential impacts of climate change to water systems, the benefits of enhancing local vulnerability assessment and planning to address climate change, and the opportunities for proactive, "no regrets" actions to buffer against climate change impacts. Furthermore, EPA should participate in the recently formed Climate Services Roundtable, which is being led by the Office of Science and Technology Policy, to coordinate federal agency climate service activities. EPA's participation could focus on ensuring that water sector needs are represented in this process. Establishing a focused set of channels through which this information will flow (e.g., state and national association initiatives such as WaterISAC and the national climate change assessment process) will enhance the effectiveness of this education/information strategy for water utilities and the communities they serve.

Recommendation 8: Better integrate climate change information into existing utility technical assistance initiatives. As discussed in Finding 7, other immediate, concrete needs (e.g., security, regulatory requirements, aging infrastructure, and aging work force) will by necessity remain priorities that absorb the majority of available technical and financial capacity for many utilities, including small, rural, and financially challenged systems. In response, EPA and its federal partners addressing climate change, along with professional associations and others, will need to identify and design specific, focused efforts (such as technical assistance to build technical and human capacity) to support utilities at all levels to become climate ready. One way to build climate change adaptation capacity (especially for utilities with limited resources) is to leverage and adapt existing partnership programs (such as those offered through National Rural Water Association, the Rural Community Assistance Partnership, EUM, and state capacity building programs) which already specialize in technical assistance delivery. EPA could partner with these and other organizations to integrate climate change adaptation considerations and opportunities into existing assistance modules (e.g., capital planning, financial planning, emergency

response planning) and seek funding to underwrite such efforts. The focus of these capacity building efforts would include: understanding and applying local climate science information; vulnerability assessment techniques; long-range planning approaches; flexible operating strategies; mitigation options; and operational partnerships. Additionally, because water sector climate adaptation thinking is evolving quickly and in many ways is led by a relatively small group of "sentinel" utilities and water sector associations, an opportunity may exist to involve these leaders in the transfer of knowledge to less engaged utilities. In particular, an effort to recruit these utilities and associations to share experiences periodically in structured forums directed at less engaged utilities could help to disseminate the latest information available in a timely fashion and potentially form the basis for on-going mentoring relationships. Regional collaborations should be promoted among large and small entities within a watershed to further expand the knowledge and resources available.

Recommendation 9: Develop an adaptive regulatory capacity in response to potential climate change alteration of underlying ecological conditions and systems. As indicated in Finding 8, the current federal and state water resources protection and management regulatory framework is grounded in baseline conditions and assumptions based on pre-existing hydrological, meteorological, and ecological conditions. Climate change has begun and is projected to place substantial pressure on these conditions. In response, EPA, in partnership with the states, water sector, tribes, and NGOs, must: a) identify current areas and programs where existing or projected changes in underlying water quality and quantity are creating or are anticipated to create significant new challenges to meeting regulatory requirements or to create new public health or environmental problems; b) integrate these challenges into continued expansion and update of EPA's strategies in the *National Water Program Strategy: Response to Climate Change*, (NWPS:RCC), c) in support of NWMP:RCC, develop robust tools and data collection systems to assess projected climate changes nationally and regionally; d) as deemed necessary, integrate the implications of the emerging and projected changes into standard setting, permitting, and modeling efforts for the water sector to ensure that clean and safe water and ecosystem goals are met; e) ensure that cross-media impacts and associated costs are clearly identified; and f) establish focused and practical pilot responses to these challenges and use this experience to recommend more proactive approaches within the existing regulatory framework to enhance utility and ecosystem resilience.

Recommendation 10: Develop a comprehensive water sector, climate change research strategy. Currently, the water sector is underserved by available climate science, expertise, and resources, as well as information regarding the costs and benefits of alternative adaptation and mitigation strategies. In response, it is vital that EPA, other federal agencies, and Congress place the needs of the water sector high on the national agenda to ensure the availability of the proper guidance on the use of model output, and tools and information necessary to make sound adaptation and GHG mitigation decisions. EPA and other federal agencies should involve the full range of their water sector partners in considering what climate research to prioritize and fund so that the research needs of the water sector are reflected in the development of research agendas. In this context, special attention should be placed on the following water sector needs: a need to develop a more locally refined understanding of the risks posed

by climate change with an emphasis on downscaling research and techniques; and a need for additional information from other sources and sectors (domestic and international) regarding adaptation and mitigation options, including no regrets options, and the costs and benefits associated with each.

Recommendation 11: Advocate for better coordination of federal agency climate change programs and services. The ongoing federal Interagency Climate Change Adaptation Task Force and the impending National Assessment are opportunities to coordinate initiatives horizontally across federal agencies as well as align federal, state, and local governmental activities on adaptation. These two related initiatives, as well as others, have the opportunity to establish a national-level framework through which the water sector can engage with the federal government. EPA, through its participation in the Interagency Task Force, should advocate for the ongoing need for federal coordination. For example, EPA should advocate for cross-federal coordination on the development of National Climate Services, particularly between NOAA and DOI, as well as with other relevant departments, as such service centers would be one potential vehicle to further examine and begin developing needed tools, training, and products identified in the Resources section of this report. More generally, EPA should push for the Task Force to articulate guidance for how federal agencies should work together to strengthen coordination across federal government and collaborate with the water sector. Furthermore, there is a pressing need for a coordinated, collaborative, technical assistance and information strategy that is supported by the key agencies and organizations, and that helps make the most effective use of limited financial and technical resources available to address climate change challenges. These efforts can ensure that there is better coordination and consistency of efforts that the water sector's key climate adaptive interests are understood and addressed, and that resources available for climate adaptation are maximized and efficiently delivered.

Recommendation 12: EPA should take the following early action steps in close cooperation with applicable federal agencies, NGOs, and water sector professional associations.

- More fully articulate the elements of the adaptive framework and make clear linkages to existing resources such as guidance to enable adoption, not just within the EPA Office of Water but across functional regional offices.
- Develop and articulate strategies for integrating climate change adaptation and mitigation approaches into existing utility priorities, on-going asset management and infrastructure repair and replacement efforts, and emergency response, capacity, and capital planning. Integration can help reduce many utility's concerns that climate ready engagement will be an added burden to an already full plate. It can also help ensure additional financial requirements are minimized as operations, maintenance, and infrastructure dollars are leveraged to produce multiple benefits, including better climate change resilience.
- Ensure funding and other resources currently available for climate change are well coordinated and aligned to water sector needs, and that current infrastructure funding enables informed climate-related decision making (e.g., provides for climate vulnerability assessments) and a full

range of adaptation strategies (consistent with Finding 5). There is a further need to ensure that future water infrastructure investments, including those in small and disadvantaged communities, align existing priorities and climate change needs to best leverage scarce funds, and that water sector adaptation funding requirements need to be documented and articulated to provide a firm basis for future funding requests.

- Inform other federal agencies about the impact federally funded projects (such as those associated with federal highway funds, USACE infrastructure investments, and FEMA public assistance and mitigation funds) can have on water sector utility climate readiness. In this context, help these agencies to identify project design opportunities that will support water sector climate resilience and stress the importance of ensuring federally funded projects account for climate change considerations.
- Link climate ready adaptive response framework activities with EPA's EUM and CRE programs to ensure climate readiness becomes part of on-going utility planning and management efforts as opposed to a completely new set of activities for utilities to undertake, and post this report on the EUM website.
- Identify, develop, and leverage opportunities to incentivize implementation of climate ready adaptation and mitigation strategies. At the outset EPA should partner with other agencies to develop a climate ready water utility information-sharing community and seek to incorporate climate ready actions as criteria for existing award evaluation. In addition, EPA should leverage existing funding sources including federal and state programs as well as private sector programs for ways to provide financial incentives to utilities implementing adaptive response actions. Finally, as the concept of climate readiness evolves, EPA could look to develop a specific recognition program for climate ready water utilities; however, EPA should only do so after a gap analysis has been completed to ensure such a program would be the most successful way to motivate action and change behavior.

Section 3: Adaptive Response Framework

The Working Group has developed a conceptual "climate ready utilities adaptive response framework" which generally describes the types of activities that a climate ready utility undertakes as its level of engagement evolves over time. The framework is designed to be illustrative of the types of actions utilities can take to be climate ready – it is not, however, designed to be comprehensive nor rigid as climate ready utility options and opportunities are emergent and remain fluid. The Framework further reflects the fact that climate science is evolving and uncertainty regarding the timing, nature, direction, and magnitude of localized climate change impacts is, and is expected to remain, high. At the same time, because utility investments are often capital intensive, long-lived, and can require long lead times to ensure system reliability and maintenance of desired service levels, building climate considerations into utility decision making is a current necessity.

Figure 1 depicts the climate ready utility adaptive response framework. The framework divides utility climate-related engagement into two stages: Assess and Plan; and Implement and Evaluate. The figure stresses the iterative, continual, and adaptive focus of becoming climate ready and maintaining climate readiness.

Figure 1: Climate Ready Adaptive Response Framework

Five activity areas are contained within each of the two stages. These areas of utility activity reflect the expectation that the water sector will see a continuum of engagement tailored to local conditions, needs, and capacity. The continuum moves from **basic engagement** – geared primarily to generate general climate change challenge awareness and implementation of effective utility management choices – to **focused engagement** – geared to produce explicit, climate-related planning, managerial, and operational adaptation and mitigation actions and investments.

Table 3 provides examples of basic and focused engagement strategies associated with each of the activity areas. The table is provided for illustrative purposes, and is not intended to be an exhaustive list of all climate change activities in which a utility can be involved.

Basic Engagement reflects the expectation that certain utilities do not view climate impacts as immediately relevant to system reliability and maintenance of service levels, or will not have the

knowledge or technical and financial resources necessary for in-depth assessments of climate change adaptation and mitigation strategies. At the same time, basic engagement reflects the belief that integration of general climate impact awareness into typical utility management activities such as emergency response, capacity, and capital planning is important to individual utility and water sector resilience. In this sense, the framework positions basic engagement as forward looking, recognizing that many utilities will not face the local conditions and/or have the capacity to engage at even this basic level absent focused federal and state support. At the same time, this engagement level is seen as the minimum necessary to achieve the following:

- Adopt an adaptive management framework to support climate impact assessment that generates sufficient climate science development awareness and implications for local utility operations to support understanding if and when specific, climate-related managerial, operational, and planning adjustments are needed;
- Understand and incorporate into their on-going planning and operations opportunities for no-regrets, multiple-benefits, no and low cost operational changes and investments that can act as a hedge against climate impacts by performing well under a variety of weather and ecological conditions;
- Avoid making large, long-term investments that do not consider and reflect the potential need to adapt to or minimize climate impacts;
- Understand their water resource management interdependencies with large system users, other local infrastructure providers (e.g., transportation), other water utilities, and institutional actors (such as local land use and economic development agencies) and engage in partnerships as needed to better share and address climate-related water management risks; and
- Maintain a basic awareness of their GHG emissions profile and evaluate and pursue opportunities (such as cost effective energy efficiency improvements) to reduce emissions.

Focused Engagement is an extension of basic engagement and emerges in response to "actionable signals" (either actual or projected conditions) that local climate change challenges pose a direct threat to utility system reliability and associated service levels. The objective of focused engagement is the development of robust strategies for climate change adaptation, mitigation, and resiliency (i.e., build the capacity to accommodate, withstand, and/or rapidly respond to or recover from climate change impacts) in the context of greater climate-related uncertainty and potential operational effects. Focused engagement represents an enhanced level of climate engagement, with the utility undertaking a structured, systematic, climate vulnerability assessment and feeding results into its long-range planning activities. Focused engagement further includes making strategic investments to enhance operational flexibility and establish shared risk and responsibility relationships with critical interdependent actors.

The Adaptive Response Framework reflects the flexible response strategy that utility managers and water sector experts have used to address climate change considerations. It reflects the expectation

that a utility will grow into and regularly revisit its climate readiness in response to experience, information, and analysis generated from its assessment and implementation actions. The adaptive process could include establishing triggers for action (e.g., increases in groundwater salinity in a coastal community) related to local hydrological and meteorological conditions and evaluating climate modeling and downscaling efforts for the potential of more actionable outputs. The stronger the signals, the more engaged a utility will need to be reflective of a desire to increase utility climate resilience. The two stages, and their associated activity areas, are described below in more detail.

Table 3a: Climate Ready Adaptive Response Framework Summary Table of Stage 1 Activities

Areas of Utility Engagement	Stage 1: Understand and Assess - Continuum of Utility Engagement	
	Example Elements of Basic Engagement	Example Elements of Focused Engagement
1.1 Understand Climate Impacts and Uncertainties	▪ Maintain basic awareness of climate science developments and implications for local operational conditions. ▪ Encourage utility personnel to examine operating conditions in light of the potential for climate change challenges. ▪ Conduct screening level climate impacts assessment to identify obvious threats and opportunities. ▪ Integrate climate impact considerations into normal planning and decision making, including emergency response, capacity, and capital planning.	▪ Conduct vulnerability assessment of a range of water system component responses to potential climate change impacts. ▪ Develop strategies to address any identified vulnerabilities. ▪ Transition from long-range planning based on the historic past to uncertainty-based planning methods. ▪ Cultivate relationships with the scientific community to stay abreast of new developments in climate science and to generate top down (downscaled climate impacts data) and bottom up impacts assessments for use in local planning. ▪ Provide input to scientific community on information needed for vulnerability analysis and long-range planning purposes.
1.2 Understand Utility Climate Adaptation and Mitigation Opportunities	▪ Understand organizational, operational, and capital investment options undertaken by similar utilities to better understand opportunities for no and low cost, no-regrets, operational actions and capital investments.	▪ Expand efforts to identify, understand, and evaluate utility climate adaptation and mitigation practices (e.g., enhanced long-range planning methods, hedging strategies, and supply and treatment diversification options).
1.3 Understand Federal/State Policies and Programs	▪ Maintain a basic awareness of GHG emission policy directions. ▪ Maintain awareness of policies and programs relating to the selection, design, and implementation of alternative adaptation strategies.	▪ Understand opportunities emerging as a result of policy developments (e.g., GHG offset opportunities). ▪ Anticipate and plan for the possibility of GHG emission reduction requirements. ▪ Track developments of regulatory adaptation efforts designed to address tensions between current regulatory requirements and changes in underlying ecological conditions.
1.4 Understand Climate Related Community Conditions	▪ Establish awareness of local/state/regional climate adaptation efforts to ensure effective utility participation. ▪ Understand local community leadership perspectives on climate change impacts in the local setting.	▪ Actively engage with community leaders to ensure sophisticated awareness of climate change implications. ▪ Actively engage in local/state/regional climate adaptation efforts to ensure a fully synergistic relationship between utility-based adaptation plans and strategies and those plans developed by other entities.
1.5 Understand Interdependent Actor and Sector Conditions	▪ Establish awareness of critical interdependent actor and sector climate-related water resource actions to ensure effective utility representation.	▪ Actively involve interdependent actors and sectors in utility planning and operational climate-related strategies to ensure high compatibility and leveraging of efforts.

Table 3b: Climate Ready Adaptive Response Framework Summary Table of Stage 2 Activities

Areas of Utility Engagement	Stage 2: Implement and Evaluate - Continuum of Utility Engagement	
	Example Elements of Basic Engagement	Example Elements of Focused Engagement
2.1 Create Internal Understanding, Support, and Capacity	▪ Provide general education and training to internal staff on potential climate change impacts. ▪ Involve staff in identifying and implementing no and low cost operational changes designed to provide a hedge against potential climate impacts.	▪ Promote and gain support from staff for the integration of climate considerations into utility planning and development. ▪ Cultivate an internal culture to support establishing and maintaining an adaptive response footing for climate change. ▪ Engage wider expertise in day-to-day operations and decision making (e.g., meteorologists and land use planners).
2.2 Establish Shared Risk and Responsibility Partnerships	▪ Establish on-going dialog with interdependent actors and sectors to enable basic coordination of key actions that affect water resources management.	▪ Engage interdependent sectors (e.g., energy, agricultural, maritime, and navigation sectors) and institutional actors (e.g., local land use and economic development departments) to jointly and proactively maintain awareness of the potential need to collaborate on climate adaptation management. ▪ Establish and strengthen formal collaborative partnerships with critical interdependent actors both within and outside of the basin focused on establishing joint climate adaptation management responsibility and development of shared risk strategies.
2.3 Generate Community Understanding and Support	▪ Seek to understand community interest and perspectives on climate change. ▪ Tailor climate-related activities and messaging consistent with identified community interests.	▪ Acknowledge the importance of, and establish a clear basis for, climate adaptation action and build local decision maker and general community support for planned organizational and operational climate-related changes.
2.4 Establish Organizational and Operational Flexibility	▪ Implement opportunistic, no regrets, multiple benefits, operational and capital investment actions that target no and low cost operational approaches that can perform well under current as well as a range of possible future climate impact conditions. ▪ Avoid making large, long-term investments that do not consider and reflect the potential need to adapt to or minimize climate impacts.	▪ Implement a diversified portfolio of near, mid, and longer-term managerial, operational, and capital investment actions consistent with an organizational emphasis on identifying robust solutions that perform well under a variety of climate impact scenarios.
2.5 Energy and GHG Management	▪ Maintain attentiveness to energy management opportunities, implement cost effective energy efficiency upgrades, and maintain general awareness of GHG improvements that result.	▪ Establish a focused GHG emission reduction strategy starting with an emissions inventory, establishing GHG emissions indictors, and identifying and implementing GHG reduction actions.

STAGE 1: Assess and Plan

The **Assess and Plan** stage covers five areas of utility engagement: Impacts and Uncertainties; Utility Experience; Federal/State Policies and Programs; Climate-Related Community Conditions; and Critical Interdependent Sector Conditions. These five areas cover the core activities for establishing, at a basic level, climate-related situational and opportunity awareness and, at a more focused level, specific planning outputs that will support specific climate-change focused implementation efforts. The overall objective of Stage 1 is to develop an increasingly refined understanding of what impacts (if any) a utility can anticipate locally and/or any shift in the predictability of background hydrological and meteorological conditions. Stage 1 also focuses on enhancing a utility's awareness and understanding of opportunities to address climate challenges in an effort to avoid being blindsided if and when projected impacts are realized. Basic engagement within Stage 1 produces an initial level of understanding of climate change challenges, which can become enhanced over time, and pave a path forward for more focused, assertive utility engagement if and when conditions indicate the necessity, capability, and feasibility to do so.

Activity Area 1.1 - Impacts and Uncertainty

Basic Engagement: Under this activity area, basic utility engagement would involve maintaining general awareness of climate science developments with potential local relevance. Engagement could take the form of, for example, establishing a relationship with local climate science researchers or participating in water sector association led climate impacts forums as a means to be informed of climate science developments. Basic engagement also would include seeking to understand localized climate alterations by expanding and/or focusing hydrological and meteorological monitoring efforts and using this information to evolve and refine modeling capabilities. For example, utilities can encourage personnel to examine operating conditions in light of the potential for climate change challenges (e.g., discerning shifts in storm intensities, monitoring salt water intrusion into surficial aquifers to identify salt water intrusion from sea level rise) with the intent to proactively identify any projected or actual emerging hydrological or meteorological conditions that are outside the range of the utility's current system planning and design assumptions. Finally, basic engagement would include undertaking a screening level impacts assessment to identify obvious threats and opportunities and integrating these findings into normal utility planning activities such as emergency response, capacity, and capital planning.

Focused Engagement: For this activity area, focused engagement emerges in response to information signaling the utility is exposed to specific, discernable climate-related risks that threaten system reliability and associated service levels. Focused engagement would seek to integrate climate change considerations and related uncertainty into enhanced long-range planning, while concurrently trying to reduce uncertainty through on-going engagement with the climate research community. In response, the utility could engage in the following types of activities.

Local Climate Research: Under focused engagement, a utility would cultivate specific, cooperative relationships with the scientific community to stay abreast of new developments in climate science and generate downscaled climate impacts data for use in local planning and analysis. These relationships could also provide an opportunity for the utility to provide specific guidance on the types of information it needs for vulnerability analysis and long-range planning purposes.

Vulnerability Assessment: In response to actionable signals indicating localized climate impacts hold the potential to affect operations, a utility would conduct a systematic climate vulnerability assessment looking at a broad range of potential systems implications and options for adaptation. This focused engagement would include assessing the vulnerability of a range of water system component responses to climate change-related watershed variation, including extreme events. A climate change vulnerability assessment is used to evaluate the vulnerability of water systems to climate impacts. Two alternative, though potentially complementary, approaches to vulnerability analysis have been articulated: top-down (quantitative scenario risk approach); and bottom-up (qualitative threshold risk assessment). The quantitative scenario risk approach seeks to employ downscaled outputs of general circulation climate models (GCMs) as inputs to localized hydrologic and other models to simulate a range of water system component responses to climate change-related watershed variation. Bottom up approaches draw on the general findings of climate research, with utilities identifying system components potentially dependent on the status of key climate variables (e.g., temperature and precipitation) resulting in a preliminary risk assessment based on the professional judgment of experts who know the system and local watershed conditions. In response to vulnerability assessment outputs, the utility would develop strategies to address the identified vulnerabilities, including expanded operating flexibility, expanded capacity, and development of alternative supply and treatment options.

Long-Range Planning: A utility would alter conventional long-range planning to better address the uncertainty and complexity of climate change impacts, transitioning from planning based on the historic past to uncertainty-based planning methods. Water sector utility planning traditionally has used historical climate and hydrology patterns to project future supply and treatment needs. This foundational planning assumption, which treats hydrologic aspects of future water supplies and treatment needs such as temperature, precipitation, stream flow, and evaporation as observed in the past, is referred to as “stationarity.” With this assumption, planning often has been based on a single forecast of future conditions. Under climate change and its associated uncertainties (which can be difficult to characterize probabilistically), utilities are challenged to prepare for a range of possible impacts by using planning techniques that better address greater uncertainty and variability than conventional water planning techniques. A key aspect of these planning techniques is the development and exploration of a range of future conditions or scenarios often treated as equally plausible. Scenarios can be developed based on available climate impact projections and setting possible ranges for impacts (e.g., ten percent decrease in annual groundwater recharge, five percent increase in temperature driven demand). A further key aspect of these planning techniques is the evaluation of alternatives with robustness rather than optimality criteria to make systems resilient to a range of potential future conditions and events. The planning process seeks to identify actions and strategies (typically in the

form of projects and programs) that relate across all or many of the individual scenarios. This overlap signals the actions and strategies will support addressing a wide range of possible futures (as represented by the planning scenarios), performing well in relation to both expected future conditions and the less likely to occur alternative scenarios. Other aspects of these planning approaches include the possible expansion of the planning horizon out to fifty years or more (in light of the long-lived nature of utility assets and the indication from climate projections that more severe impacts emerge in the 50-plus year timeframe), use of such tools as drainage hydrological models to assess system sensitivity and the value of improvements to a range of conditions, and embracing a shift to a more integrated, watershed-based approach and an expanded concept of infrastructure to include a full range of distributed and green technologies and practices.

Activity Area 1.2 - Utility Experience

Basic Engagement: At a basic engagement level, a utility would seek to understand organizational, operational, and capital investment options and actions undertaken by similar utilities to better understand opportunities for no and low cost, no-regrets operational actions and capital investments. Under basic engagement, a utility would depend upon key water sector actors such as federal and state oversight bodies and associations to make such information readily accessible and actionable.

Focused Engagement: Under focused engagement, a utility would expand efforts to identify, understand, and evaluate utility adaptation options that move beyond basic, no-regrets efforts. Adaptation options to be explored and evaluated would include hedging strategies, supply and treatment diversification options, and alteration and relocation of facilities.

Activity Area 1.3 – Federal and State Policies and Programs

Basic Engagement: At a basic engagement level, a utility would maintain a fundamental awareness of GHG emission policy directions, and climate change adaptation and mitigation policy directions and technical and funding assistance programs.

Focused Engagement: At a more engaged level, the utility would seek to understand opportunities emerging as a result of policy and funding developments (e.g., GHG offset opportunities), and it would seek to anticipate and plan for the possibility of GHG emission reduction requirements and cost-share assistance. The utility would also track developments of regulatory adaptation efforts designed to address tensions between current regulatory requirements and changes in underlying ecological conditions. A more engaged utility would participate in, inform, and help shape federal and state policy development efforts.

Activity Area 1.4 - Climate-Related Community Conditions

Basic Engagement: At a basic engagement level, a utility would acknowledge the importance, and establish an awareness of any community (defined broadly and including state-level activity) climate-related planning and actions to ensure its perspectives and needs are recognized and accommodated.

This would include awareness of any local/state/regional climate adaptation planning efforts to ensure consistency with utility operational and planning efforts. Basic engagement would also include understanding local community leadership perspectives on climate change impacts in the local setting.

Focused Engagement: Under focused engagement, a utility would actively engage in community climate change-related planning and implementation activities. The utility would further seek to integrate its planning and actions and establish partnerships with these actors (see activities 2.2 and 2.3 below).

Activity Area 1.5 - Critical Interdependent Actor and Sector Conditions

Basic Engagement: At a basic engagement level, a utility would recognize that the actions of several water intensive sectors (e.g., agriculture, energy, maritime, and navigation) hold the potential to mitigate or exacerbate the water resource management challenges the local utility faces. For example, certain energy sector GHG mitigation strategies are highly water intensive (e.g., development of biofuels). Additionally, there are several local and regional institutional actors (e.g., local land use and economic development departments) that strongly influence water quality and quantity and the distribution of people and economic activity (which holds the potential to change as climate impacts result in displacement and relocation of people and industry). The utility will also seek to maintain awareness of and understand any specific actions undertaken by these interdependent sectors (e.g., urban design plans that account for climate change adaptation) to assure key utility needs and interests are represented.

Focused Engagement: Under focused engagement, a utility would seek to raise awareness among interdependent sectors and actors relative to local climate-related water resource vulnerabilities and the implications land use, economic development, and other decisions will have on them. The utility would actively involve interdependent actors in its planning and operational climate-related strategies to ensure high compatibility across sectors and actors and leveraging of joint efforts. This places a high premium on developing strong communications with these sectors and ensuring they understand the water-related implications of their decisions. Enhanced cooperation and integration with these organizations will reflect a need to ensure climate-related vulnerabilities and risks are effectively understood and managed. This engagement can establish the foundation for collaborative partnerships to implement shared risk strategies as discussed under Activity 2.2.

STAGE 2: Implement and Evaluate

Stage 2 consists of five activity areas: Community Understanding and Support; Shared Risk and Responsibility Partnerships; Internal Understanding, Support, and Capacity; Organizational and Operational Flexibility; and Energy and Greenhouse Gas Management. As with Stage 1 activity areas within Stage 2 will reflect a continuum of engagement from basic to focused, depending on local conditions and the strength of climate challenge signals. Implement and Evaluate activities will be very much informed and likely directed by Stage 1, Assess and Plan, activities. For example, if Assess and Plan

activities indicate a lack of actionable evidence for climate impacts and uncertainty, then a utility likely will focus on no and very low cost, no-regrets actions that represent as much overall smart management as they do specific climate ready actions. Alternatively, Assess and Plan activities that signal specific, climate-related threats to system reliability (e.g., consistent projections and direct experience with increased storm surge levels in coastal areas) will likely produce specific climate response actions such as altering design standards and facility siting criteria for new and renovated facilities.

Activity Area 2.1 - Internal Understanding, Support, and Capacity

Basic Engagement: At the basic engagement level, the utility would educate and train internal staff to generate understanding of potential climate change impacts (building off awareness gained through 1.1) and to establish awareness of potential operating conditions that might signal a need for more focused climate-related engagement. Further basic actions would include educating and training staff about no and low cost, no-regrets, operational changes designed to provide a hedge against potential climate impacts.

Focused Engagement: Under focused engagement, the utility would promote and gain support for the full integration of climate considerations into utility planning and development processes, cultivate an adaptive internal culture to support establishing and maintaining a foundation for adaptive response with regard climate change, and potentially engage wider expertise (e.g., meteorologists and land use planners) in planning, day-to-day operations, and decision making.

Activity Area 2.2 - Shared Risk and Responsibility Partnerships

Basic Engagement: Under basic engagement, the utility would seek to establish on-going, generally informal, dialog with water intensive sectors and local institutional actors that hold the potential to mitigate or exacerbate the water resource management challenges it faces. The purpose of this dialog would be to enable basic coordination of key actions that will influence community water resource management (e.g., urban design plans that affect stormwater management options).

Focused Engagement: At a focused engagement level, the utility will move beyond raising awareness among interdependent sectors (e.g., energy, agricultural, maritime, and navigation sectors) and institutional actors (e.g., local land use and economic development departments) about shared risks and responsibilities (as undertaken in Activity 1.5). The engagement will also move beyond informal dialog that enables basic coordination among interdependent actors and seek to implement and strengthen formal collaborative partnerships based on a commitment to joint climate adaptation management responsibility with critical interdependent actors, sectors (both within and outside of the basin in which a utility operates), and community stakeholders. These partnerships would seek to enable jointly coordinated action that provides mutual (and hopefully enhanced) benefits among the interdependent parties. Partnerships, for example, could be formalized through integrated regional water management agreements that support a shared risk approach through better coordination of the needs and resources of interdependent systems.

Activity Area 2.3 - Community Understanding and Support

Basic Engagement: At the basic engagement level, a utility would seek to understand its community's level of interest in and perspectives on climate change challenges an impacts. The utility would use this knowledge to tailor its climate-related activities (e.g., screening assessment under 1.1 and implementation of no-regrets operational changes under 2.4) and messaging about them consistent with community interests. This will likely reflect a range from limited or no specific mention of climate change considerations as a motivator for operational change to substantial leveraging of any specific community climate change interests and concerns.

Focused Engagement: Under more focused engagement, utility efforts will focus on acknowledging the importance of, and establishing a clear basis for action and seeking local support for, planned organizational and operational climate-related changes and investments. This would include preparing an articulation of potential climate change-related challenges and using it to educate customers and key local decision-makers about potential climate-related considerations, implications, and actions. This activity is designed to establish a foundation of community understanding that can be drawn upon as more substantial climate-related engagement is needed. Focused engagement could further include providing key local decision makers and utility customers a more detailed explanation of how potential or anticipated climate impacts could affect utility operations. Additionally, enhanced long-range planning activity can be anticipated to require focused stakeholder engagement to support the process of developing and evaluating climate impact scenarios and utility responses.

Activity Area 2.4 - Organizational and Operational Flexibility

Basic Engagement: Under basic engagement, a utility would seek to implement a no regrets, multiple benefits, managerial, operational, and capital investment strategy that targets flexible, no and low cost, solutions that can perform well under current, as well as a range of possible future, climate impact conditions. All utilities will also avoid making large, long-term investments that do not consider and reflect the potential need to adapt to or minimize climate impacts. No regrets actions are designed to be beneficial irrespective of future climate conditions and yield near-term economic, environmental, and/or social benefits. Implementation of these actions represents effective utility management as much as they do a response to climate-related concerns, per se, and therefore, do not require an articulation or demonstration of climate impacts to justify implementation. No regrets actions can include increasing efficiency of water, energy, and material use; implementing conservation and demand management programs; protecting development preserves and critical habitat areas; developing emergency preparedness plans for floods, droughts, and other severe conditions to reduce consequences; and implementing green infrastructure source control projects that can dampen the effects of increased storm intensity or air temperature and promote carbon sequestration.

Focused Engagement: Focused engagement would emerge in direct response to vulnerability assessment and enhanced long-range planning results (that emerge from activity under 1.1). Consistent with the planning emphasis on identifying robust solutions that perform well under a variety of climate

impact scenarios, the utility would seek to deploy a diversified portfolio of near-, mid-, and longer-term actions. Diversification is a key strategy to increase robustness and resilience. Effective portfolios include near-term actions common across multiple possible future conditions/ scenarios. They also include hedging strategies based on a set of initial, near-term actions, establishing "trigger points" or "signposts" (essentially key monitored indicators of how actual conditions are unfolding) that indicate what additional or alternative actions are needed, and a set of contingent or deferred actions undertaken consistent with emerging conditions. Hedging examples include utilizing a mix of water supply sources that do not share the same climate impact risks and seeking to break capacity-related projects into increments that allow for adjusting to changing conditions.

Activity Area 2.5 - Energy and GHG Management

Basic Engagement: At the basic level, a utility would prepare an energy management program, including monitoring energy use, establishing energy efficiency measures, using renewable energy where feasible, evaluating the energy intensity of new or replaced system components, and implementing cost effective energy efficiency upgrades (e.g., Southern Nevada Water Authority use of energy optimization Supervisory Control and Data Acquisition (SCADA) upgrades) to address energy costs and opportunistically reduce GHG emissions.

Focused Engagement: Under focused engagement, a utility would consider and pursue a portfolio of options to support and demonstrate leadership in GHG mitigation efforts. Practices include, but are not limited to: conducting a GHG emissions baseline inventory; establishing GHG emissions indicators; measuring and reporting on GHG reduction progress; undertaking reforestation projects; forming conservation-related partnerships; engaging in programs such as rebates for energy efficient hot water heaters or providing incentives to replace lawns with xeriscaping; producing on-site renewable energy through such sources as solar, wind, hydro, and biogas; establishing employee transportation programs for carpooling and public transit; and replacing fleet vehicles with hybrids and alternative fuel vehicles.

Integration with Other EPA Programs

The Working Group agrees that the findings, recommendations, and climate ready adaptive response framework activity areas outlined in this report should be linked with existing EPA programs, as appropriate, so that climate readiness becomes part of on-going efforts as opposed to a completely new set of utility activities. The Working Group believes the best place to pursue opportunities to integrate climate change concepts into overall water utility management is through the EUM program developed by EPA and six water sector associations. The Working Group strongly encourages EPA to build the Working Group's final report into future actions under the EUM program and to post the Working Group report on the EUM website. A secondary area for integration is with EPA's CRE program. This program provides fewer opportunities for linking to the Working Group's findings and is more limited in its reach in that there are only 28 National Estuary Programs (NEP) – all in coastal areas. Where climate ready

water utility concepts can be integrated, however, EPA should do so. More specific opportunities for integration with both programs are described below.

Effective Utility Management

The EUM Initiative, launched by EPA and six water sector associations in 2007, is based on a series of ten Attributes of Effectively Managed Water Sector Utilities (Attributes) and five Keys to Management Success. These Attributes describe a concise set of outcomes for utilities to use as the basis for assessing and improving their performance in all areas of utility operations. The Attributes are also a key element of EPA's overall strategy for promoting and recognizing excellence in sustainable utility management. Many of the activity areas in the climate ready adaptive response framework described in this report are encompassed within these Attributes. Table 4 summarizes the linkages between the adaptive response framework and the Attributes.

Table 4: Linkages between Effective Utility Management and Climate Ready Water Utilities

Attribute of Effective Utility Management	Climate Ready Adaptive Response Framework Activity
Operational Optimization – Conducts ongoing performance improvements; awareness and timely adoption of operational and technology improvements	2.4 Establish Organizational & Operational Flexibility
Operational Resiliency – Proactively establishes tolerance levels and effectively manages risks (including legal, regulatory, financial, environmental, safety, security, and natural disaster-related)	1.1 Understand Climate Impacts & Uncertainties 1.2 Understand Utility Climate Adaptation and Mitigation Opportunities 1.3 Understand Federal/State Policies and Programs
Water Resource Adequacy – Ensures water availability through long-term resource supply and demand analysis, conservation, and public education	1.1 Understand Climate Impacts & Uncertainties 1.2 Understand Utility Climate Adaptation and Mitigation Opportunities 1.3 Understand Federal/State Policies and Programs 2.4 Establish Organizational & Operational Flexibility
Community Sustainability – Efficiently uses water and energy resources to maintain and enhance ecological and community sustainability and promote economic vitality	2.4 Establish Organizational & Operational Flexibility 2.5 Energy and Greenhouse Gas Management
Stakeholder Understanding and Support – Creates understanding and support from oversight bodies, community watershed interests, and regulatory bodies; actively involves stakeholders in the decisions that will affect them	1.4 Understand Climate Related Community Conditions 1.5 Understand Interdependent Actor & Sector Conditions 2.2 Establish Shared Risk & Responsibility Partnerships 2.3 Generate Community Understanding & Support
Employee Leadership and Development – Undertakes collaborative organization dedicated to continual learning and improvement and retention of institutional knowledge	2.1 Create Internal Understanding, Support & Capacity
Financial Viability – Includes financial implications in analysis of adaptation options and long-range planning decisions; improves cost structure through better energy management	1.1 Understand Climate Impacts & Uncertainties 2.4 Establish Organizational & Operational Flexibility 2.5 Energy and GHG Management
Customer Satisfaction – Encourages responsiveness to community values and involves those affected by rates and service reliability in understanding and providing input on operational decisions	1.4 Understand Climate Related Community Conditions 2.3 Generate Community Understanding & Support
Infrastructure Stability – Ensures informed infrastructure choices and effectively manages long-term viability of systems	1.1 Understand Climate Impacts & Uncertainties 2.4 Establish Organizational & Operational Flexibility
Product Quality – Enhances background ecological conditions and identifies options that affect product quality	1.1 Understand Climate Impacts & Uncertainties 1.2 Understand Utility Climate Adaptation and Mitigation Opportunities 2.4 Establish Organizational & Operational Flexibility

To complement the Attributes, EPA and the Associations created the EUM Primer in 2008. The Primer provides a step-by-step methodology for utilities to assess their strengths and weaknesses based on the Attributes, and also includes a set of performance improvement measures for each Attribute. Other useful information about the EUM Initiative, including a set of case studies, can be found at

http://www.watereum.org. When a utility assesses its current conditions using the EUM Primer, it can use the linkages with climate readiness to evaluate its operations, identify and prioritize strengths and areas for improvement, adopt strategies for selected areas for improvement, and develop metrics to track performance over time.

Climate Ready Estuaries

EPA's CRE program was established to build capacity for climate change adaptation within the NEP. The NEP is a voluntary, ecosystem-based management program established to restore and maintain the water quality and ecological integrity of estuaries of national significance. CRE provides tools and assistance to help NEPs in their efforts to: a) assess climate change vulnerabilities; b) engage and educate stakeholders; c) develop and implement adaptation strategies; and d) share lessons learned with other coastal managers. This list of actions represents substantial overlap and, therefore, opportunity for collaboration, with the climate ready utility adaptive framework. In response, EPA should coordinate on its CRWU and CRE efforts to leverage any opportunities to share tools (e.g., for joint vulnerability assessments) and resources to engage stakeholders and establish shared risk partnerships. Table 5 summarizes key areas of overlap between CRE and the climate ready adaptive response framework.

Table 5: Linkages between Climate Ready Estuaries and Climate Ready Water Utilities

Climate Ready Estuary Activity	Climate Ready Adaptive Response Framework Activity
Assess climate change vulnerabilities	1.1 Understand Climate Impacts & Uncertainties 1.2 Understand Utility Climate Adaptation and Mitigation Opportunities
Engage and educate stakeholders	1.4 Understand Climate Related Community Conditions 1.5 Understand Interdependent Actor and Sector Conditions 2.2 Establish Shared Risk & Responsibility Partnerships 2.3 Generate Community Understanding & Support
Develop and implement adaptation strategies	2.2 Establish Shared Risk & Responsibility Partnerships 2.3 Generate Community Understanding & Support 2.4 Establish Organizational & Operational Flexibility
Share lessons learned	1.4 Understand Climate Related Community Conditions 1.5 Understand Interdependent Actor and Sector Conditions 2.2 Establish Shared Risk & Responsibility Partnerships 2.3 Generate Community Understanding & Support

Coordination with the CRE program will have limited scope relative to the overall water sector and, therefore, level of effort should be commensurate. One potential action is for EPA to identify key utilities that reside within the NEP boundaries and identify opportunities for collaboration between those utilities and the CRE effort.

Section 4: Needed Resources

This section identifies five categories of tools, trainings, and products (resources) Working Group members agreed are needed to implement a climate ready water utility adaptive response framework successfully. For each category, examples of currently existing resources that could be used to help address that need area are provided. The list is meant to be illustrative of existing resources, but is by no means a comprehensive inventory of all available resources to address the need areas or to implement the adaptive response framework. The Working Group recognizes that substantial information already exists (including that prepared by National Association of Clean Water Agencies (NACWA), Association of Metropolitan Water Agencies (AMWA), Water Environment Federation (WEF), American Water Works Association (AWWA), Water Research Foundation, Water Environment Research Foundation (WERF), and Water Utility Climate Alliance (WUCA)) which provide comprehensive inventories of existing climate-related tools, training, and products, as well as identified gaps in those resources that are needed to support utilities' climate adaptation and mitigation actions. The Working Group did not wish to duplicate or restate work already completed, and recommends that EPA consult these sources for further ideas on existing and needed resources beyond what the Working Group identified.

Within each category there is a list of specific tools (or tool functionalities), trainings, or products that are not known to currently exist and that Working Group members agreed are needed to support implementation efforts. The Working Group also identified whether those items are needed in the short (within the next three years) or long (three-plus years) term as a means of prioritizing the list. The Working Group recognizes that although general short and long-term timeframes are identified, based primarily on the extent of existing resources available for interim support, how soon a certain tool, training, or product is needed depends on how quickly a utility pursues and progresses along the climate ready adaptive response framework and which actions within that framework the utility is undertaking. In addition, for any tool to be useful there must be on-going support for its use. Lastly, in Table 6 specific resource needs are tied directly to the report recommendation(s) they help to support.

The Working Group acknowledges that the needs list is rather extensive and that although EPA should play a leadership role in addressing the gaps, its resources may be limited. As part of climate ready program implementation, EPA should work to identify partners who could take on the responsibility of developing some of the needed tools, trainings, and products so that all needs may be met to the greatest extent possible. Furthermore, although the needs list focuses on tools for use by water utilities, it does not preclude the need for EPA to reach out to interrelated sectors, planning organizations, and others to identify opportunities to enhance existing tools in those arenas to provide better integrated data and information to support climate ready actions within the water sector. This includes working with agencies such as NOAA and NASA that have begun to address historical hydrological and meteorological records that have become a less reliable predictor of future conditions.

Internal Understanding and Education

To successfully assess, implement, and advocate for climate ready actions, consistent sector-level and comprehensive utility level foundational awareness of environmental and water utility operating conditions, trends, and options to address change is needed. This situational awareness must occur at all levels of utility operations, from upper management through front line operators. In addition, similar to today's universities recognizing the need for a broader education and consequently changing their approach to teaching, utility managers will need to recognize and support the broader skill sets (e.g., technical, financial, managerial, communications) required to maintain future operations. The Working Group has identified a number of needed tools, trainings, or products to support and enhance the basic utility understanding and education needed to support long-term CRWU program implementation.

Needed Tools, Trainings, or Products

- A central, organized, and readily and openly accessible resource bank of all the water sector focused climate-related information currently available, and identification of credible sources (e.g., associations, universities, federal and state agencies) from which utilities can seek out further information. To be most useful this must also include sustained staffing resources to field public inquiries. (Short term)
- Targeted, synthesized fact sheets, brochures, and/or web casts that translate potential climate change scenarios into tangible threats and impacts and that speak directly to the needs of utility managers. (Short term)
- An on-line training center for utility managers and staff interested in learning about the potential effects of climate change on utility operations, and strategies for climate adaptation and GHG mitigation. A good model for this, which also includes a resource bank (per the first bullet in this list) and an individual certification component, is EPA's Watershed Academy. (Short term)
- A continuing climate change education and training program for water utility staff. (Long term)
- Online learning modules or another type of training to develop skills for people who are well positioned to act as a bridge for translating, coordinating, and disseminating information between the research community and the water sector. (Long term)
- Structured forums and regional collaborations to share information, especially between less engaged and more engaged utilities. (Long term)

Existing Tools, Trainings or Products

The Water Research Foundation Climate Change Clearinghouse is a new website offering the water community (drinking water, wastewater, and water reuse) easily accessible information on climate change science relevant to water utilities, impacts climate change can have on water resources, guidance on planning and adaptation strategies, and Water Research Foundation research relevant to climate change. Information is organized by energy management, utility infrastructure, management

and communications, water quality, and water resources. The regularly updated site also includes an interactive Web 2.0 component with a Twitter account and RSS feeds.

The Effective Utility Management Primer for Water and Wastewater Utilities is a free, downloadable document designed to help water and wastewater utility managers at all size utilities make practical, systematic changes to achieve excellence in utility performance. The primer was developed by the participants of the 2007 joint agreement between EPA and six national water and wastewater associations to promote effective utility management based on the *Ten Attributes of Effectively Managed Water Sector Utilities* and five *Keys to Management Success*. The primer provides a framework, built from on-the-ground experience, intended to help utility managers identify and address their most pressing needs through a customized, incremental approach that is relevant to the day-to-day challenges utilities face.

Climate Change and Water Resources: A Primer for Municipal Water Providers is a document prepared by the Water Research Foundation and the University Corporation for Atmospheric Research which summarizes scientific information on climate change, looks at hydrological implications of climate impacts on water utilities, and provides case studies and guidance on integrating climate change information into utility planning and adaptive management. The primer focuses on known implications of climate change for the water cycle and availability and quality of water resources. The primer includes examples of on-the-ground activities by utilities that have begun to plan and prepare for potential climate change impacts and is meant to introduce water utility managers who may be less familiar with climate change science and implications to the topic.

Partnership Building

The Working Group identified shared risk, and therefore, responsibility in facing climate change by all interrelated sectors in some way connected to the water sector (e.g., energy, agriculture, planning, the public). In addition, shared responsibility calls for a change in how water is managed, including creating inter-local agreements and deploying an integrated resource management process. Therefore, to successfully implement a climate ready program, water utilities need to identify all the interrelated entities and get the right people from those entities to the table to develop solutions. There are a couple of resources utilities could use to help build these necessary partnerships.

Needed Tools, Trainings, or Products

- A comprehensive review of productive partnership examples and identification of opportunities available to water sector utilities to build cross-sector relationships. (Long term)
- A process model for engaging interdependent sectors that helps to identify who the partners are and how to approach them. (Long term)

Existing Tools Existing Tools, Trainings, or Products

The American Assembly Process is a model for facilitating communication and action among multiple stakeholders including academics, business people, government officials, the media, policy makers, and community leaders. The process focuses on examining the aspects of public policy questions and moving

toward consensus in making recommendations for action. The process includes development of white papers defining key issues, formulation of key policy questions, and a facilitated workshop (or series of workshops) to allow participants of varying views, experiences, and interests to come together for in-depth discussions. The process concludes with the adoption of an Assembly Statement formalizing the views of the participants.

EPA's Community-Based Water Resiliency Tool is a self-launching CD containing multiple tools and resources to support local communities in developing and implementing community-based water resiliency efforts. These tools are designed to help communities remain resilient during water emergencies by increasing understanding of unique interdependencies and critical users, highlighting multiple benefits of preparedness and security practices, and improving integration of the water sector into community emergency preparedness and response efforts. The tool focuses on bringing together utilities, city and county managers, public works officials, emergency responders, and members of the public ahead of an emergency with the goal of making communities more resilient in the event of a water service interruption.

Climate Impact Assessment

Implementation of a climate ready adaptive response framework relies on a utility's ability to address the local uncertainty associated with the nature and magnitude of potential climate impacts, and to consider a range of impact scenarios based on weather, ecological, and other conditions. Climate impact assessment tools need to be flexible and scalable to provide utility managers with the most useful scientific data that then feeds into long-range decision making. In this context, there is an opportunity to leverage resources of national, regional, and state associations and agencies, as well as the research community, to collaborate and foster information sharing to enhance local and regional level climate impact awareness.

Needed Tools, Trainings, or Products

- Translation of climate impact scientific findings and projections into more synthesized, water-sector specific, and less technical material that is specifically tailored to regional, and when possible local, conditions and designed for use by water sector utility managers. (Short term)
- A tool to help utilities assess potential impacts of climate change scenarios on the quality of their water supply. (Short term)
- Regionally/locally relevant climate impact, adaptation, and mitigation case studies. (Short term)
- Localized hydrology models that can use downscaled climate model data to project changes in local hydrology. Such hydrology models could facilitate interactions between scientists and local water utilities and should be flexible enough to accommodate new climate modeling data as it becomes available. (Long term)
- A user's guide for downscaling that explains the different models available, their intended applications, limitations, uncertainties, appropriate uses, and other details necessary to educate the

water sector about the tools and how they can be used to better understand climate impacts. (Long term)

Existing Tools, Trainings, or Products

The Hydrologic Modeling System (HEC-HMS) is designed to simulate the precipitation-runoff processes of dendritic watershed systems. It is designed to be applicable in a wide range of geographic areas, including large river basin water supply and flood hydrology, and small urban or natural watershed runoff. Hydrographs produced by the program are used directly or in conjunction with other software for studies of water availability, urban drainage, flow forecasting, future urbanization impact, reservoir spillway design, flood damage reduction, floodplain regulation, and systems operation. This complex tool is meant for use by those familiar with hydrologic modeling systems.

Better Assessment Science Integrating point and Non-point Sources (BASINS) is a multi-purpose environmental analysis system that integrates a geographical information system, national watershed data, and state-of-the-art environmental assessment and modeling tools into one package. This tool is designed to be easy to use and accessible for those with a basic understanding of its components.

Water Evaluation and Planning System (WEAP) is a surface and groundwater resource simulation tool based on water balance accounting principles. It can be used by water utility planners and analysts to conduct what-if analyses of various policy scenarios and long-range planning studies.

NOAA's Coastal Inundation Models use high resolution hydrodynamic models to simulate coastal flooding due to extreme events. The models use unstructured grids with highly refined topography and elevation data to simulate flood propagation. Inputs are drawn from the latest available hydrographic surveys to provide bathymetric depths, combined with topographic data including high resolution Light Detection and Ranging data, the USGS National Elevation Dataset, and other sources. These models are housed within NOAA and run by NOAA scientists.

Options for Improving Climate Modeling to Assist Water Utility Planning for Climate Change is a White Paper prepared by WUCA. The paper was developed to spur dialogue with the climate research and funding communities on what improvements can be made in climate data collection and monitoring, climate models and downscaling techniques so that they can be applied in a manner that is more useful for the water sector. It identifies seven enhancements to existing global climate modeling that would help make climate models more useful to the water sector by identifying the affects of climate change on water resources and related adaptation strategies.

Climate Adaptation Decision Support

In an adaptive response framework, climate assessment data at the local, regional, and watershed levels are fed into scenario planning and coupled with individual utility operating conditions to evaluate benefits and costs (economic and non-economic) of alternative future options and to help inform investment decisions. Long-range water utility planning and short-term decision-making will need to

evolve to better address amplified operating condition uncertainty when utilities are exposed to, for example, increased unpredictability around extreme weather events. For this to occur, a suite of scenario planning and decision support tools that utilities of all sizes can use is needed. These tools must allow for robust outcomes across a variety of scenarios, including extreme events that may be considered as outliers, and must consider vulnerabilities from other interdependent sectors. Similar to climate assessment tools, the tools must also be flexible to incorporate new data outputs, be locally relevant, and account for variability.

Needed Tools, Trainings, or Products

- Guidance, case studies, and other reference materials that inform utilities of the adaptation and mitigation options they have and how best to evaluate and implement these choices. (Short term)
- A primer on the basic low and no cost actions that can be implemented now as preemptive measures. (Short term)
- Economic tools to evaluate vulnerabilities, resiliency, and potential benefits and costs of impacts. These tools should identify weakest links and secondary impacts (e.g. population shifts), be updatable, and lead to development of alternative plans for addressing vulnerabilities. (Short term)
- Scalable vulnerability assessment tools that account for variability and include sensitivity analyses. (Short term)
- A tool to help water utilities develop a GHG inventory of their operations. This could be based on existing accepted and established protocols for developing GHG inventories, such as those by The Climate Registry. (Short term)
- Cost and triple bottom line benefit analysis of green or distributed infrastructure. (Short term)
- Economic tools to evaluate benefits and costs, including utility financial capacity planning and ecological services valuation, of alternative adaptation and mitigation strategies. (Long term)
- Training on the use of advanced decision support models and on non-conventional adaptation and mitigation alternatives. (Long term)

Existing Tools, Trainings, or Products

Vulnerability Self Assessment Tool (VSAT) provides a comprehensive system for water and wastewater utilities seeking to analyze their vulnerability to both intentional threats and natural disasters. This proprietary software tool (developed by NACWA, PA Consulting Group, and SCIENTECH) includes reference libraries of both potential threats and countermeasures, and provides a method for managing the information generated by security vulnerability assessments.

EPA's Climate Resilience Evaluation and Awareness Tool (CREAT) is a new software tool currently being tested to assist drinking water and wastewater utilities of any size in identifying climate change impacts from quantitative, downscaled projections of temperature and precipitation and through qualitative descriptions of regional-level impacts. The tool also provides users with a library of adaptation measures

along with a cost-risk reduction analysis to enable users to assess the most cost effective adaptation projects.

Decision Support Planning Methods: Incorporating Climate Change Uncertainties into Water Planning is a White Paper prepared by WUCA. The paper was developed to present multiple outcome planning techniques to water utilities interested in integrating climate change information into their planning efforts. The paper provides guidance to water utilities currently engaged in, or considering, vulnerability assessments and wanting to move forward with adaptation on how to incorporate the large range of new information into their planning.

Greenhouse Gas Emission Inventory and Management Strategy Guidelines for Water Utilities is a guidance document developed by the Water Research Foundation to assist water utilities in understanding the need and purpose in quantifying the GHG impacts of their operations and to provide the information necessary to prepare GHG inventories in accordance with accepted standards. The document provides a comprehensive summary of existing protocols and quantification tools, the fundamental accounting principles used to create a GHG emission baseline inventory, a method of data management specific to water utilities, examples of emission calculations, a discussion of emission sources that are unique to water utilities, and strategies for managing GHG emissions through internal reduction and external project opportunities.

The Center for Neighborhood Technology's Green Values Calculator (GVC) compares green infrastructure performance, costs, and benefits to conventional stormwater practices at the site and neighborhood scales. The tool provides a quantified analysis of green infrastructure environmental benefits including reduced runoff volume and maintenance savings, in addition to carbon sequestration, reduced energy use, and groundwater recharge. The GVC uses precipitation data from the nearest NOAA weather station anywhere in the US and provides a range of runoff reduction goals that represent current innovation in stormwater regulation around the country. Users can choose from a list of regulations aimed at achieving varied levels of runoff volume reduction chosen from exemplary communities around the country. The specified runoff reduction goal sets a standard against which a selected suite of management practices performs in relation to that standard. Users may also define the predevelopment conditions of their site.

UK Climate Impacts Programme (UKCIP) Adaptation Wizard is a five-step process that helps to assess vulnerability to current climate and future climate change, identify options to address key climate risks, and aid in developing a climate change adaptation strategy. The Wizard scratches the surface of climate change risk assessment which may not be sufficient to ensure that major investment decisions on long time scales are resilient to climate change. The Wizard can be used to raise awareness of climate change and adaptation, access the information, tools and resources UKCIP provides, assess vulnerability to climate change, make the case for adaptation in an organization, and make a decision, to develop a project, program, policy or strategy, that is resilient to climate change, or develop and implement a

climate change adaptation strategy. Completing the Wizard involves working with colleagues and partners to gather information and answer the questions.

Stakeholder Communication

To develop comprehensive plans, utilities will need to develop a broader understanding of stakeholder groups and their needs within a watershed, and include these perspectives and needs in the early stages of a two-way planning process. In addition, for long -term successful implementation of climate ready actions, utilities will need support from their stakeholders including customers, elected officials, and community members. This support, in large part, will rely on a utility's ability to explain and make understandable climate change scenarios and adaptation and mitigation options. Although communication with stakeholders will not be new to many utilities, the level of engagement and complexity of the topic will be, and therefore, new and enhanced resources will be needed to support these communications and outreach efforts.

Needed Tools, Trainings or Products

- Guidance and training on how to communicate with stakeholders and customers on climate uncertainty and potential impacts. (Short term)
- Visualization tools to communicate climate change risks and adaptation and mitigation efforts. These tools could include static graphs and photos, slideshows, interactive graphics showing potential graduated impacts over time, video documentaries, etc. (Long term)

Existing Tools, Trainings, or Products

The Next Communities Initiative, through the New England Environmental Finance Center, is a comprehensive three-day curriculum package for helping local officials, conservation trust leaders, developers and others, including water utility personnel, concerned about the difficulty of agreeing on community change to create effective approaches to those challenging decisions. Smart growth principles, leadership, political and regulatory processes, and consensus-building skills make up the three modules.

Effective Risk and Crisis Communication during Water Security Emergencies is a summary EPA report of three EPA sponsored water security risk message mapping workshops held in 2005 and 2006. The report provides information about effective message development and delivery, including questions likely to be asked following a water security incident and how to prepare clear and concise answers to the questions along with supporting information and key messages prior to a crisis occurring. This report is intended for utility personnel tasked with developing risk communication plans and conducting public outreach.

EPA's Table Top Exercise (TTX) Tool for Water Systems: Emergency Preparedness, Response, and Climate Resiliency is a self-launching CD with fully-customizable materials to assist drinking water and wastewater utilities and their partners and stakeholders in planning and conducting tabletop exercises. The TTX Tool provides resources that aid in the development of scenario-driven, discussion-based

tabletop exercises that allow water systems to practice, test, and improve emergency response plans and procedures.

NOAA's Sea Level Rise and Coastal Flood Frequency Viewer is a very simple, easy to use visualization tool to map how rates of sea level rise could impact a community. Flooding frequency information is also provided. This is helpful for those involved in coastal planning and it is useful for efforts to educate citizens about local sea level rise issues.

Table 6: Summary of Needed Tools, Trainings, and Products

Category	Existing Resource Examples	Needed Tool, Training, or Product	Short or Long Term?	See Recommendation
Internal Understanding and Education	▪ Water Research Foundation Climate Change Clearinghouse ▪ EUM Primer ▪ Climate Change and Water Resources Primer	▪ Central resource bank of available climate-related information	Short	7
		▪ Targeted materials translating potential climate change scenarios	Short	7
		▪ Online training center	Short	3
		▪ Continuing climate change education program	Long	3
		▪ Training to bridge the research community and water sector	Long	7
		▪ Forums and collaborations to share information	Long	8
Partnership Building	▪ American Assembly Process Model ▪ EPA Community-Based Water Resiliency Tool	▪ Review of partnership examples and identification of opportunities	Long	5 & 6
		▪ Process model for engaging interdependent sectors	Long	5 & 6
Climate Impact Assessment	▪ USACOE HEC-HMS ▪ EPA BASINS ▪ WEAP model ▪ NOAA Coastal Inundation Model ▪ WUCA Climate Modeling White Paper	▪ Synthesized, tailored climate data	Short	7
		▪ Water quality assessment tool	Short	4
		▪ Regional/ local climate impact, adaptation, and mitigation case studies	Short	7
		▪ Localized hydrology models	Long	4
		▪ User's guide for downscaling	Long	4
Climate Adaptation Decision Support	▪ EPA VSAT ▪ EPA CREAT ▪ WUCA Decision Support White Paper ▪ Water Research Foundation GHG Emissions Inventory	▪ Reference materials on adaptation and mitigation options	Short	1
		▪ Primer basic low and no cost actions	Short	1
		▪ Economic tools to evaluate vulnerabilities and potential costs of impacts	Short	4

Category	Existing Resource Examples	Needed Tool, Training, or Product	Short or Long Term?	See Recommendation
	Guidelines ▪ The Center for Neighborhood Technology's GVC ▪ UKCIP Adaptation Wizard	▪ Scalable vulnerability assessment tools that account for variability	Short	4
		▪ GHG inventory development tool	Short	4
		▪ Cost and benefit analysis of green or distributed infrastructure	Short	4
		▪ Economic tools to evaluate benefits and costs of adaptation and mitigation strategies	Long	4
		▪ Training on advanced decision support models and non-conventional alternatives	Long	4
Stakeholder Communication	▪ New England Environmental Finance Center Next Communities Initiative ▪ EPA Table Top Exercise ▪ EPA Effective Risk and Crisis Communication Document ▪ NOAA Sea Level Rise Viewer	▪ Guidance and training on how to communicate on climate impacts	Short	5
		▪ Visualization tools to communicate climate change risks, adaptation and mitigation efforts	Long	5

Section 5: Incentives

This section provides a description of potential incentives to facilitate expanded adoption of the water utility climate change adaptation and mitigation strategies outlined in the adaptive response framework section of this report. Per the Working Group's charge, discussions were generally limited to awards and recognition programs, with broad consideration within that scope. Working Group members believe that, for any award or recognition program to be successful in advancing water utility climate readiness, it should have two attributes: 1) it should occur on a continual basis (e.g., not be one-time only) and, 2) within one program or across a number of programs, there should be a continuum of recognition for utilities engaged in climate ready actions at all levels.

As the concept of climate readiness is emerging and anticipated to evolve over time, the Working Group has identified two initial incentives to recognize water utilities that take early climate ready actions and to encourage continued advancement of adaptive response actions by water utilities. In addition to these two incentive areas, the Working Group encourages EPA to consider at the outset of any climate ready water utilities program additional financial incentive opportunities as a means for advancing implementation of climate ready actions. Due to the currently evolving nature of what it means to be climate ready, the Working Group believes it is premature to invest in recognition and leadership programs that move beyond communications forums and annual awards at this time. Before a more structured recognition effort is developed, there is a need to examine similar efforts to understand their success in changing behavior and motivating action. Once climate readiness matures, and if the evaluation of other programs indicates the potential usefulness of a climate ready incentives program, EPA could consider development of a more structured and in-depth recognition program for water utilities undertaking climate ready actions.

In addition to those incentives discussed below, the Working Group believes opportunities should be sought to encourage groups that are more broadly focused on climate change and sustainability issues at regional and local levels (e.g., National Association of Counties, National League of Cities, ICLEI-Cities for Climate Protection, the American Planning Association, the United States Conference of Mayors) to explicitly incorporate the utility perspective and foster engagement and partnership with water utilities. Recognition for creating and sustaining such partnerships should occur on both sides. In other words, existing planning or other sector recognition programs should include partnering with water utilities as an element of program evaluation, and vice versa with existing and future water utility recognition programs.

Early Leadership and Awards Incentives

As the concept of climate readiness for water utilities evolves, the Working Group believes there is an opportunity to highlight utilities that are engaging in climate adaptation and mitigation actions at the forefront of the sector. Spotlighting climate ready water utility actions and fostering communication about those actions sends a message to the water sector that utilities are thinking about and

successfully implementing climate ready actions. This can create an incentive for others to do the same. The Working Group identified two ways to highlight early actions and encourage broader adoption at the forefront of a climate ready utilities initiative.

First, EPA could create an opportunity for participation in a community of utilities that is linked by their interests in what it means to be climate ready. Examples of this type of community are the Drinking Water Source Protection Forum (http://www.sourcewaterinfo.on.ca/) and the Small Business Community Forum (http://www.smallbusinessforums.org/), which are online forums where participants sign up to share information and ideas, strategize about new approaches, and access relevant information that is updated on a regular basis. Membership forums can act to demystify topics, create familiarity with current thinking and practice, and promote collaborations and synergies that can advance thinking and practice. In creating such a community, EPA should seek to partner with other organizations and/or leverage other relevant existing and emerging forums, such as those planned for development through the Interagency Task Force on Climate Adaptation and the National Climate Assessment.

Second, EPA should consider working with existing, well-established sector awards programs to incorporate basic climate ready practices into their evaluation process. The annual awards listed below are designed to highlight utility performance accomplishments at a specific point in time. These programs should be examined for opportunities to incorporate recognition of water utility climate change actions undertaken by organizations and individuals, either as specific criteria for award evaluation or as a separate award within the program, realizing that the ultimate decision to incorporate such revisions is up to the program administrators. Incorporating climate ready practices into the criteria and considerations for qualifying and receiving these awards will send a sector-wide signal of the importance of climate ready behaviors, as well as spotlight success stories that can act as models for other utilities. Most of the existing programs referenced below primarily target larger utilities; therefore, EPA and others must also identify additional opportunities for spotlighting climate ready actions by smaller utilities.

- **EPA's Sustainable Water Leadership Program** – EPA's Sustainable Water Leadership Program is a new program under development that recognizes water and wastewater utility commitment to sustainable management approaches that promote resource efficiency and protection. This redesigned CWA Recognition Awards program includes managed decentralized and municipal stormwater systems and drinking water facilities. Program criteria focus on effective utility management and encourage applicants to highlight other initiatives such as energy conservation, watershed approaches, pretreatment, and biosolids.
- **NACWA National Environmental Achievement Awards and Excellence in Management Recognition Program** – Both of these awards are given on an annual basis to NACWA members. NACWA's Environmental Achievement Awards recognize individuals and member agencies for outstanding contributions to environmental protection and clean water. The Excellence in

Management Recognition Program acknowledges significant achievements of member agencies in the utility management arena.

- **The Association of Metropolitan Water Agencies Utility Performance and Service Awards** – AMWA's Utility Performance and Excellence Awards recognize large public drinking water systems exhibiting high performance in the ten areas of effective utility management. Awards are given for two levels – Gold and Platinum. AMWA's Service Awards include the President's Award for individuals making outstanding contributions to the improvement of water supply management and the Donald R. Boyd Award for extraordinary personal service in the drinking water quality field.
- **Partnership for Safe Water** – The Partnership is a voluntary cooperative effort between the EPA, AWWA, and other drinking water organizations, with more than 200 utilities throughout the United States. The Partnership includes two programs, the Water Treatment Program and the Distribution System Optimization Program (scheduled to begin in September 2010). Each program includes a commitment, annual data collection, self-assessment, and optimized performance review and follows a four phase approach. Recognition awards are given for completion of certain phases, demonstrated improved performance, and maintenance of optimized performance.

New Leadership and Recognition Program Development

Once the concept of water utility climate readiness becomes more stable, a more in-depth recognition program, which includes a maintenance component to ensure backsliding does not occur, could be considered. Before any new programs are developed, however, the Working Group recommends completion of a gap analysis to determine whether a new program is needed or if additional existing programs could be modified to accommodate water utility adaptive response activities. One factor to examine as part of the analysis is the number and types of utilities that apply to relevant programs. The Working Group considered a number of existing programs in their discussions, but acknowledges it did not have the time or resources to complete a comprehensive review of all potentially relevant existing programs and opportunities for incorporating recognition of climate ready actions. Too many awards or recognition programs in one sector can minimize their effectiveness in fostering action by discouraging utilities from applying, due to the overwhelming number of programs and criteria to consider and/or by reducing the meaningfulness of the awards.

As part of the recommended gap analysis, well established programs should be analyzed to determine their success in achieving their respective goals and objectives. Only if such programs have shown measureable success should a new, similar program be considered specifically to promote climate ready utilities. In addition, the focus of any new program should be to raise the level of climate awareness and encourage engagement at all levels of water utility activity. A new program should also encourage connecting high capability systems with low capability systems as a means of information sharing and to

support partnership building with interdependent sectors. If such a program were developed it should also include a leadership role for utilities to help set the program standards and criteria.

Following is a description of two existing programs that could serve as models for a potential new climate ready utility recognition program.

- **Leadership in Energy and Environmental Design (LEED)**. The Working Group encourages consideration of a LEED-type program involving progressive certification of water utilities' engagement in climate readiness activities through demonstration of fulfilling specific performance benchmarks. A program such as this would have a discrete set of program components based off of the Working Group's recommendations and be grounded on verifiable levels of achievement that are well defined, objectively determined, and tailored to regional and local conditions. One weakness of the LEED program is that it is missing a maintenance aspect, which should be included in any similar program developed. Developing and implementing a LEED-type program would take substantial resources, therefore identifying the organization or entity that is most applicable and able to do so would be a key. As a starting point, the Working Group recommends EPA partner with AWWA, which is actively working on a project to scope out a LEED-style certification for sustainable utilities. This type of program would be most successful in advancing climate ready efforts for high achieving, high capacity utilities.
- **Interagency Partnership for Sustainable Communities.** Similar to the tri-agency partnership (HUD-DOT- EPA), the Working Group encourages development of an inter-agency program to create cooperation within the federal government around climate ready water utility actions. This cooperation and leadership on the federal side would incentivize water utilities to take action by providing a consistent framework and compiling resources in support of this effort.

The Working Group also considered the Energy Star and Water Sense programs as models, recognizing their success. The Working Group, however, concluded that these types of programs are primarily product and consumer focused, and therefore not highly applicable in terms of encouraging overall utility/ system management. A link could be made however, by including voluntary participation in these programs as one factor of evaluation under a broader utility recognition or leadership program.

Incentives Beyond Awards and Recognition

Although the scope of the Working Group's charge was limited to awards and recognition programs, the Working Group agreed other types of incentives, most prominently financial, are essential to both entice and facilitate utilities' engagement in implementing a climate ready adaptive response framework. The level and types of other incentives that would be most applicable will differ geographically, dependent on the level and types of climate ready strategies needed in certain areas. Two additional incentive areas are discussed below. The first seeks to highlight and promote existing sources of funding to support implementation activities, while continuing to maintain support to, for example, small and disadvantaged utility capacity development efforts. The second area focuses on encouraging

breakthrough technological innovations that utilities could apply as part of their overall climate ready framework. The Working Group encourages full consideration of these additional incentive actions as drivers for advancing implementation of a climate ready water utility adaptive response framework.

The Working Group encourages EPA to ensure available funding sources – such as SRFs – and programs that it has historically supported –such as treatment plant upgrades, implementation activities, training programs, operator certification, and pollution abatement programs – continue to be supported at current or greater levels. At same time EPA should look to leverage these existing funding sources to enable the availability of funds for climate ready actions. EPA's dedicated funding for the Green Project Reserve under the SRF program, for instance, includes eligibility for climate adaptation planning in addition to source water protection, green infrastructure, and water and energy efficiency. Ensuring similar availability of other funding sources to support climate ready implementation activities is a key to program success. Opportunities for leveraging identified by the Working Group include, but are not limited to:

- Integrating climate ready considerations over time into key implementation actions emanating from the SRF Sustainability Policy;
- Ensuring climate ready utility action would be eligible in the context of Supplemental Environmental Projects;
- Promoting eligibility for climate ready actions within current related state and federal funding sources (e.g., funding tied to resource planning);
- Changing eligibility requirements for water sector grants to create opportunities for funding climate ready actions; and
- In instances where permit fees go to state general funds – rather than being part of a fee for service framework – forgive a portion of those fees if those dollars are used to implement climate ready actions.

Another way to encourage utilities' engagement in climate readiness activities is through capital financing. EPA could play a role in this arena by compiling information over time that establishes a relationship between climate readiness and lower operational risk to water utilities. This information could in turn influence private equity markets to create better financing terms for loans to water utilities for capital improvement and other projects incorporating climate ready adaptation or mitigation components.

The Working Group also believes a pool of resources is needed to promote applied research and breakthrough innovation. These resources could come from three areas: research associations, foundations, and/or private companies that provide technology support to the water sector. First, EPA should look to communicate with the key water sector research institutions to articulate climate ready research needs and ensure funding is applied to these needs. Second, EPA should reach out to, and

establish partnerships with, foundations that fund environmental and climate change related projects and encourage foundation funding of pilot and demonstration projects in the water sector. Third, EPA should look for ways to encourage private industry investment (such as that through the X PRIZE Foundation) in research and development of green technologies and new climate change adaptation and mitigation strategies for implementation by water utilities. Ideally these innovative solutions would have multiple cross-sector benefits and be applicable to the water sector as well as other interdependent sectors such as energy, planning, and agriculture.

Appendix A: Working Group and Federal Partners Rosters

Working Group Roster

Matthew Appelbaum
Councilmember
City of Boulder, Colorado

Katherine Baer
Senior Director
National Clean Water Program
American Rivers

George Crombie
Senior Faculty Member
Public Works Administration
Norwich University
School of Graduate Studies

Jeff Cooley
Utilities Operations Manager
City of Vacaville-Utilities Department

Patrick Davis
Sustainability Manager
Orange Water and Sewer Authority

Paul Fleming
Manager, Climate and Sustainability
Seattle Public Utilities

Cindy Forbes
Chief, Southern California Field Operations Branch
California Department of Public Health

Gregory McKnight II
Security and Emergency Response Coordinator
Office of Drinking Water
Washington State Department of Health

Olga Morales
Rural Development Specialist
Rural Community Assistance Partnership

Patricia Mulroy/ Richard Holmes
General Manager/
Director of Environmental Resources
Southern Nevada Water Authority

Antonio Quintanilla
Assistant Director of Maintenance and Operations
Metropolitan Water Reclamation District of Greater Chicago

Sri Rangarajan
Adjunct Professor
Columbia University

Stephen Schmitt
Vice President, Operations Services
American Water

Lisa Sparrow
President
Utilities Inc.

Marcia St. Martin
Executive Director
Sewage and Water Board of New Orleans

Michael Wallis
Director of Operations and Maintenance
East Bay Municipal Utility District

Rebecca Weidman
Director of Water Resource Protection
New England Interstate Water Pollution Control Commission

Rebecca West
Deputy General Manager of Technical and Engineering Services
Spartanburg Water

Paul Whittemore
Board Member - New Hampshire
National Rural Water Association

Douglas Yoder
Deputy Director
Miami-Dade Water and Sewer Department

Lauren Wisniewski
Designated Federal Official
Water Security Division
U.S. Environmental Protection Agency

Federal Partners Roster

Veronica Blette
Chief, WaterSense Branch
U.S. Environmental Protection Agency

Geoffrey Bonnin
Chief, Hydrologic Science and Modeling Branch
National Oceanic and Atmospheric Administration

Joan Brunkard
Epidemiologist, Waterborne Disease Prevention Branch, Centers for Disease Control and Prevention

Hiba Ernst
Acting Director, Water Infrastructure Protection Division, U.S. Environmental Protection Agency

Kim Fox
Division Director, Water Infrastructure Protection
U.S. Environmental Protection Agency

Becky Fulkerson
External and Intergovernmental Affairs Office
Bureau of Reclamation

James Goodrich
Acting Director, Water Supply and Water Resources Division
U.S. Environmental Protection Agency

Juliette Hayes
Community Planner
FEMA, Region IX, Mitigation Division

Roger Pulwarty
Director, National Integrated Drought Information System Program Office
National Oceanic and Atmospheric Administration

Marty Savoie
Technical Director for Installations,
Engineer Research and Development Center
U.S. Army Corps of Engineers

Frederick Sharrocks
Chief, Assessment and Planning Branch FEMA Mitigation Directorate

Richard Scholze
Engineer Research and Development Center,
U.S. Army Corps of Engineers

Mark Sudol
Institute for Water Resources
U.S. Army Corps of Engineers

David Travers
Director, Water Security Division
U.S. Environmental Protection Agency

Paul Wagner
Ecologist, Institute for Water Resources
U.S. Army Corps of Engineers

Appendix B: List of Expert Presenters

Meeting #1

- **Pat Davis**, Sustainability Manager, Orange Water and Sewer Authority
  - Topic: Practice based examples of adaptation and mitigation actions to address water sector climate change impacts
- **Paul Fleming**, Climate and Sustainability Manager , Seattle Public Utilities
  - Topic: Practice based examples of adaptation and mitigation actions to address water sector climate change impacts
- **Rachel Schmeltz**, Environmental Protection Specialist, EPA Office of Atmospheric Programs
  - Topic: Overview of Congressional Development on Climate Change

Meeting #2

- **Joan Brunkard**, Epidemiologist , CDC Waterborne Disease Prevention Brach
  - Topic: Public health impacts of climate change impacts within the water sector
- **Dr. James Goodrich**, Senior Environmental Scientist, EPA Office of Research and Development National Risk Management Research Laboratory
  - Topic: Climate change impacts on drinking water
- **Kevin Young**, Managing Director Hunter Water Corporation
  - Topic: Australia's water utility sector response to climate change impacts

Meeting #3

- **Randall Blankenhorn**, Executive Director, Chicago Metropolitan Agency for Planning
  - Topic: Chicago Metropolitan Agency for Planning formation and activities
- **Steve Moddemeyer**, Associate Principal, CollinsWoerman & Seattle
  - Topic: Long-term solutions for potential climate change impacts

Meeting #4

- **Levi Brekke**, Hydraulic Engineer, US Bureau of Reclamation Technical Services Center
  - Topic: Bureau of Reclamation & Climate Change and Water Working Group Activities related to CRWU Report Activity 1.1 (Understand Climate Impacts & Uncertainties)
- **Stephen Fries**, Civil Engineer Senior Professional, Computer Science Corporation and **Dean Moss**, General Manager, Beaufort-Jasper Water and Sewer Authority
  - Topic: EPA's Climate Resilience Evaluation and Awareness Tool
- **Brad Udall**, Director, University of Colorado Western Water Assessment NOAA Earth System Research Laboratory
  - Topic: Connection between Water Use and Climate Change
- **Paul Wagner**, Ecologist, USACE Institute for Water Resources
  - Topic: USACE Watershed Investment Tool

Meeting #5

- **Karen Metchis**, Climate Change Advisor, EPA Office of Water
  - Topic: Office of Water Climate Strategy
- **Sheila O'Brien**, National Climate Assessment Coordinator, US Global Change Research Program
  - Topic: The National Climate Assessment
- **John Whitler**, Environmental Protection Specialist, EPA Office of Water
  - Topic: Climate Ready Water Utilities Toolbox and related activities

Appendix C: References

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