

National Water Program 2012 Strategy: Response to Climate Change

Public Comment Draft



U.S. Environmental Protection Agency

March 2012

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Definitions of Key Terms From: *America's Climate Choices* (NRC, 2010a-d)

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

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

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

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

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

Stationarity: The idea that natural systems fluctuate within an unchanging envelope of variability.

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



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I. Executive Summary

National Goal: Government agencies and citizens work collaboratively to manage freshwater resources in response to a changing climate in order to assure adequate water supplies, to protect human life, health and property, and to protect water quality and aquatic ecosystems.

❖ *Interagency Climate Change Adaptation Task Force— Freshwater Workgroup*

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

❖ *EPA National Water Program 2012 Strategy*

Climate change poses significant challenges to water resources and the Environmental Protection Agency's (EPA) National Water Program (NWP). The *NWP 2012 Strategy: Response to Climate Change* addresses climate change in the context of our water programs. It emphasizes assessing and managing risk and incorporating adaptation into core programs. Many of the programs and activities already underway throughout the NWP are even more important to do in light of climate change – such as protecting healthy watersheds and wetlands, managing stormwater with green infrastructure, improving the efficiency and sustainability of water infrastructure including promoting energy and water efficiency, and reducing pollutants. However, climate change poses such significant challenges to the nation's water resources that more transformative approaches will be necessary.

This *2012 Strategy* articulates such a transformative approach. The reader is advised not to interpret the framing of individual strategic actions that use terms such as "encourage" or "consider" to mean that the NWP doesn't recognize the urgency of action. Rather, we recognize that adaptation is itself transformative, and requires a collaborative, problem solving approach especially in a resource-constrained environment. Further, "adaptive management" doesn't imply a go-slow or a wait-and-see approach; rather, it is an active approach to understand vulnerability, reduce risk, and prepare for consequences.

Table ES-1, below, summarizes the Visions, Goals and Strategic Actions described in this 2012 Strategy. In total, we describe 5 Visions, 19 Goals, and 51 Strategic Actions.

A. The Evolving Context

The first *National Water Program Strategy: Response to Climate Change* was published in 2008; it identified 44 key actions that could be taken in the near term to begin to understand and address the potential impacts of climate change on water resources and EPA's mission. This *2012 Strategy* builds upon the momentum gained since then; it describes a set of long term goals for the management of sustainable water resources for future generations in light of climate change and charts the key 'building blocks,' i.e., strategic actions that would need to be taken to achieve those goals. It also reflects the wider context of climate change-related activity that is underway throughout the nation. The *2012 Strategy* is intended to be a roadmap to guide

future programmatic planning, and inform decision makers during the Agency's annual planning process. It describes an array of important actions that should be taken to be a 'climate ready' national water program.

The NWP *2012 Strategy* is designed to reflect the findings of the Interagency Climate Change Adaptation Task Force (ICCATF), and includes EPA's commitments under three climate change strategic plans under development within the federal government:

- for freshwater resources by the ICCATF Freshwater Work Group,
- for the ocean, coasts, and Great Lakes by the National Ocean Council (NOC), and
- for fish, wildlife, and plants by the National Fish, Wildlife and Plants Climate Adaptation Workgroup.

This *2012 Strategy* is also intended to be consistent with EPA's broader adaptation planning. Recognizing that climate change is one stressor among many others that water resource managers are grappling with, this strategy is also designed to build upon other initiatives such as the recent *Coming Together for Clean Water* strategy and the EPA's *Clean Water and Safe Drinking Water Infrastructure Sustainability Policy*.

Impacts of Climate Change on Water Resources

- ❖ **Increases in Water Pollution Problems** due to warmer air and water temperatures and changes in precipitation patterns, causing an increase in the number of waters categorized as "impaired," with associated impacts on human health and aquatic ecosystems;
- ❖ **Impacts on water infrastructure and aquatic systems** due to more extreme weather events, including heavier precipitation and tropical and inland storms;
- ❖ **Changes to the Availability of Drinking Water Supplies** due to increased frequency, severity and duration of drought, changing patterns of precipitation and snowmelt, increased evaporation, and aquifer saltwater intrusion, affecting public water supply, agriculture, industry, and energy production uses;
- ❖ **Waterbody Boundary Movement and Displacement** as rising sea levels alter ocean and estuarine shorelines and as changes in water flow, precipitation, and evaporation affect the size of wetlands and lakes;
- ❖ **Changing Aquatic Biology** due to warmer water and changing flows, resulting in deterioration of aquatic ecosystem health in some areas;
- ❖ **Collective Impacts on Coastal Areas** resulting from a combination of sea level rise, increased damage from floods and storms, coastal erosion, salt water intrusion to drinking water supplies, and increasing temperature and acidification of the oceans; and
- ❖ **Indirect Impacts** due to unintended consequences of human response to climate change, such as those resulting from carbon sequestration and other greenhouse gas reduction strategies.

B. Programmatic Visions, Goals and Strategic Actions

The core programmatic elements of this strategy include:

- Infrastructure;
- Watersheds and Wetlands;
- Coastal and Ocean Waters;
- Water Quality; and
- Working with Tribes.

Each section addressing these core elements is organized using a three-tier framework: *Vision, Goals, and Strategic Actions*. Each section includes a long-term **Vision**, or outcome, for which EPA may be only one of many actors.

Ten Guiding Principles

- ❖ Integrated Water Resources Management (IWRM)
- ❖ Adaptive Management
- ❖ Collaborative Learning and Capacity Development
- ❖ Long Term Planning (i.e., multi-decadal time horizon)
- ❖ Water-Energy Nexus
- ❖ Systems & Portfolio Approach
- ❖ Cost of Inaction
- ❖ Environmental Justice
- ❖ Performance Evaluation
- ❖ Mainstreaming Climate Change into Core Programs

For each Vision, we identify a set of **Goals** that reflects the same long-term time frame as the Vision. The Goals, however, articulate EPA’s mission and role in achieving the Vision, and describe *what* we are trying to achieve.

Finally, each Goal contains several **Strategic Actions**. The Strategic Actions are the programmatic building blocks that are needed to achieve the Goals. These describe *how* the NWP plans to work over the next three to eight years in pursuit of our longer term Goals and Vision.

C. Geographic Climate Regions

The chapter on Geographic Climate Regions describes the collective strategic focus of EPA Regions working together, organized by the climate impact regions delineated by the U.S. Global Change Research Program (USGCRP) with the addition of a ‘Montane’ region (Figure ES-1). Several EPA Regions span multiple USGCRP regions and therefore each EPA Region will need to address a variety of climate impacts in its program implementation.

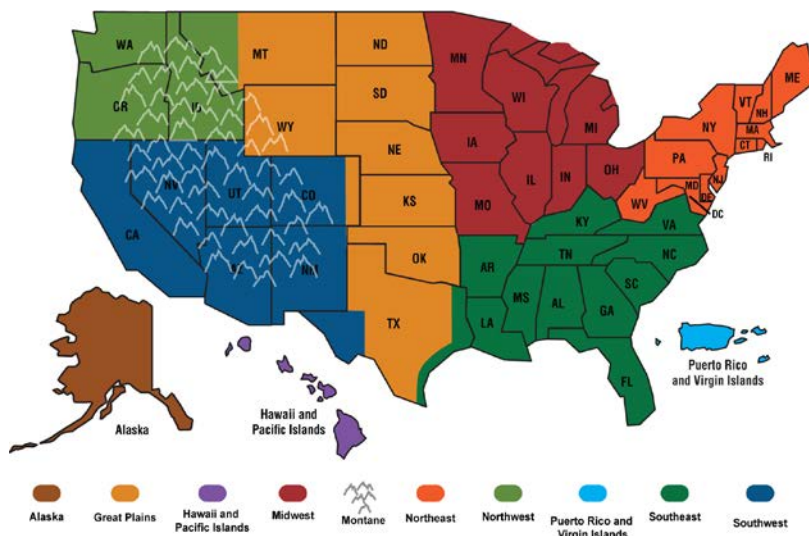


Figure ES-1

Successfully achieving the long term goals will require strong partnerships with federal agencies, states, tribes, local governments, and other stakeholders. Specific partnerships in each climate region will vary according to the needs and issues of that region. Of particular importance are the federal efforts underway by the ICCATF to develop ‘regional consortia’ of federal agencies to coordinate delivery of climate services to regional and local stakeholders and that include, among others: U.S. Department of the Interior’s (DOI) Landscape Conservation Cooperatives (LCCs) and Climate Science Centers (CSCs); and National Oceanic and Atmospheric Administration (NOAA’s) Regional Integrated Sciences and Assessments (RISAs) and National Climatic Data Centers.

USGCRP Climate Regions and EPA Regions

Climate Regions	EPA Regions
Northeast	1, 2, 3
Southeast	3, 4, 6
Midwest	2, 5,7
Great Plains	6, 7, 8
Southwest	6, 8, 9
Pacific Northwest	8, 10
Montane	8, 9, 10
Alaska	10
Caribbean Islands	2
U.S. Pacific Islands and Territories	9

D. Cross-Cutting Program Support

Three Sections in this chapter describe essential processes to support and effectively implement the Visions, Goals and Strategic Actions.

Communication, Collaboration, and Training: The NWP will strengthen and expand collaboration, outreach and training with key partners throughout EPA and within other federal agencies, work with State and Tribal water program managers, and use formal and informal stakeholder involvement opportunities.

Tracking Progress and Measuring Outcomes: Measuring progress toward adaptation is complicated. The current state of practice leans largely to tracking institutional *progress* in incorporating climate change considerations into programs. Similarly, the NWP is developing an approach that evaluates the collectivity of outputs and actions to demonstrate progress in each of several phases towards achieving resilience to climate change. The NWP will work with the State-Tribal Climate Change Council and other partners to refine this approach. As EPA and the ICCATF develop methods for measuring *outcomes*, the NWP will incorporate those measures into its evaluation process. In addition, this *2012 Strategy* includes the NWP’s commitment to meet the Agency-wide strategic measures adopted in the current EPA 2011-2015 Strategic Plan:

- By 2015, additional programs from across EPA will promote practices to help Americans save energy and conserve resources, leading to expected greenhouse gas emissions reductions of 740.1 MMTCO² Eq. from a baseline without adoption of efficient practices.

- ❖ *The WaterSense Program will contribute to achieving greenhouse gas reduction goals through 2015.*
- By 2015, EPA will integrate climate change trend and scenario information into five major scientific models and/or decision-support tools used in implementing Agency environmental management programs to further EPA's mission, consistent with existing authorities.
 - ❖ *Under the Climate Ready Water Utilities (CRWU) initiative, the NWP will deploy an upgraded version of the Climate Ready Evaluation and Awareness Tool (CREAT), as well as a comprehensive toolbox of water-related climate resources by the end of 2012, to better assist water and wastewater utilities in becoming more resilient to climate change.*
- By 2015, EPA will account for climate change by integrating climate change trend and scenario information into five rule-making processes to further EPA's mission, consistent with existing authorities.
 - ❖ *The NWP will incorporate climate change considerations in the development and implementation of a rulemaking by 2015.*
- By 2015, EPA will build resilience to climate change by integrating considerations of climate change impacts and adaptive measures into five major grant, loan, contract, or technical assistance programs to further EPA's mission, consistent with existing authorities.
 - ❖ *The NWP will help National Estuary Program (NEP) grantees consider as a potential priority climate adaptation and resilience in their Comprehensive Conservation and Management Plans and develop climate adaptation plans and implementation strategies where considered a priority.*

Climate Change and Water Research Needs: The *2012 Strategy* identifies the types of research needed to support the goals and strategic actions. The NWP will continue to work with the Office of Research and Development (ORD), other water science agencies, and the water research community to further define needs and develop collaborative and coordinated research opportunities.

E. Conclusion

Climate change alters the hydrological background in which EPA's programs function. In response, EPA must revise data collection, analytical methods, and even regulatory practices that have been developed over the past 40 years since passage of the Clean Water Act (CWA) and the Safe Drinking Water Act (SDWA). This is no easy task. Ensuring EPA's programs continue to protect public health and the environment and sustain the economy requires immediate and sustained collaboration at the federal, state, tribal, and local levels.

Table ES-1: Summary of Visions, Goals and Strategic Actions

<p>❖ Infrastructure: <i>In the face of a changing climate, resilient and adaptable drinking water, wastewater and stormwater utilities (i.e. the water utility sector) ensure clean and safe water to protect the nation’s public health and environment by making smart investment decisions to improve the sustainability of their infrastructure and operations and the communities they serve, while reducing greenhouse gas emissions through greater energy efficiency.</i></p>	
<p>Goal 1: Build the body of information and tools needed to incorporate climate change into planning and decision making.</p>	<ul style="list-style-type: none"> • SA1: Improve access to vetted climate and hydrological science, modeling, and assessment tools through the Climate Ready Water Utilities program.
	<ul style="list-style-type: none"> • SA2: Assist wastewater and water utilities to reduce greenhouse gas emissions and increase long-term sustainability with a combination of energy efficiency, co-generation, and increased use of renewable energy resources.
	<ul style="list-style-type: none"> • SA3: Explore climate change challenges to drinking water safety and assist public water systems in meeting health-based drinking water standards..
	<ul style="list-style-type: none"> • SA4: Promote sustainable design approaches to ensure the long-term sustainability of infrastructure and operations.
<p>Goal 2: Support Integrated Water Resources Management to sustainably manage water resources.</p>	<ul style="list-style-type: none"> • SA5: Understand and promote through technical assistance the use of water supply management strategies.
	<ul style="list-style-type: none"> • SA6: Evaluate and provide technical assistance on the use of water demand management strategies.
	<ul style="list-style-type: none"> • SA7: Increase cross-sector knowledge of water supply climate challenges and develop watershed specific information to inform decision making.
<p>❖ Watersheds & Wetlands: <i>Watersheds are protected, maintained and restored to ensure climate resilience and to preserve the ecological, social and economic benefits they provide; and the nation’s wetlands are maintained and improved using integrated approaches that recognize their inherent value as well as their role in reducing the impacts of climate change.</i></p>	
<p>Goal 3: Identify, protect, and maintain a network of healthy watersheds and supportive habitat corridor networks.</p>	<ul style="list-style-type: none"> • SA8: Develop a national framework and support efforts to protect remaining healthy watersheds and aquatic ecosystems.
	<ul style="list-style-type: none"> • SA9: Collaborate with partners on terrestrial ecosystems and hydrology so that effects on water quality and aquatic ecosystems are considered.
	<ul style="list-style-type: none"> • SA10: Integrate protection of healthy watersheds throughout the NWP core programs.
	<ul style="list-style-type: none"> • SA11: Increase public awareness of the role and importance of healthy watersheds in reducing the impacts of climate change.
<p>Goal 4: Incorporate climate resilience into watershed restoration and floodplain management.</p>	<ul style="list-style-type: none"> • SA12: Consider a means of accounting for climate change in EPA funded and other watershed restoration projects.
	<ul style="list-style-type: none"> • SA13: Work with federal, state, tribal, and local partners to protect and enhance buffers to rivers, streams, lakes, wetlands, and coastal resources as a means of building resiliency.

Table ES-1: Summary of Visions, Goals and Strategic Actions

<p>Goal 5: Watershed protection practices incorporate Source Water Protection to protect drinking water supplies.</p>	<ul style="list-style-type: none"> • SA14: Encourage states to update their source water delineations, assessments or protection plans to address anticipated climate change impacts. • SA15: Continue to support collaborative efforts to increase state and local awareness of source water protection needs and opportunities, and encourage inclusion of source water protection areas in local climate change adaptation initiatives.
<p>Goal 6: Incorporate climate change considerations into the CWA 404 regulatory program as they relate to permit reviews and compensatory mitigation.</p>	<ul style="list-style-type: none"> • SA16: Consider the effects of climate change, as appropriate, when making significant degradation determinations in the CWA Section 404 wetlands permitting and enforcement program. • SA17: Evaluate, in conjunction with the U.S. Army Corps of Engineers, how wetland and stream compensation projects could be selected, designed, and sited to aid in reducing the effects of climate change.
<p>Goal 7: Improve baseline information on wetland extent, condition and performance to inform effective adaptation to climate change</p>	<ul style="list-style-type: none"> • SA18: Expand wetland mapping by supporting wetland mapping coalitions and training on use of the new federal Wetland Mapping Standard. • SA19: Produce a statistically valid ecological condition assessment of the nation’s wetlands.
<p>❖ Coastal and Ocean Waters: Adverse effects of climate change along with collective stressors and unintended adverse consequences of responses to climate change have been successfully prevented or reduced in the ocean and coastal environment. Federal, tribal, state, and local agencies, organizations, and institutions are working cooperatively; and information necessary to integrate climate change considerations into ocean and coastal management is produced, readily available, and used.</p>	
<p>Goal 8: Collaborate to ensure information and methodologies for ocean and coastal areas are collected, produced, analyzed, and easily available.</p>	<ul style="list-style-type: none"> • SA20: Collaborate to ensure that synergy occurs, lessons learned are transferred, federal efforts effectively help local communities, and efforts are not duplicative or at cross-purposes.. • SA21: Work to be sure that knowledge and information needed to protect ocean and coastal areas is collected, produced, analyzed, and formatted for users, and is easily available..
<p>Goal 9: Support and build networks of local, tribal, state, regional and federal collaborators to take effective adaptation measures for coastal and ocean environments through EPA’s geographically targeted programs.</p>	<ul style="list-style-type: none"> • SA22: Work with the NWP’s larger geographic programs to incorporate climate change considerations, focusing on both the natural and built environments. • SA23: Address climate change adaptation and build stakeholder capacity when implementing NEP Comprehensive Conservation and Management Plans and through the Climate Ready Estuaries Program. • SA24: Conduct outreach and education, and provide technical assistance to state and local watershed organizations and communities to build adaptive capacity in coastal areas outside the NEP and Large Aquatic Ecosystem programs.
<p>Goal 10: Address climate driven environmental changes in</p>	<ul style="list-style-type: none"> • SA25: Support coastal wastewater, stormwater, and drinking water infrastructure owners and operators in reducing climate risks and encourage adaptation in coastal areas.

Table ES-1: Summary of Visions, Goals and Strategic Actions

<p>coastal areas and ensure that mitigation and adaptation are conducted in an environmentally responsible manner.</p>	<ul style="list-style-type: none"> • SA26: Support climate readiness of coastal communities, including hazard mitigation, pre-disaster planning, preparedness, and recovery efforts. • SA27: Support preparation and response planning for impacts to coastal aquatic environments.
<p>Goal 11: Protect ocean environments by incorporating shifting environmental conditions and other emerging threats into EPA programs.</p>	<ul style="list-style-type: none"> • SA28: Consider climate change impacts on marine water quality in NWP ocean management authorities, policies, and programs. • SA29: Utilize available authorities and work with the Regional Ocean Organizations and other federal and state agencies through regional ocean groups and other networks to ensure offshore renewable energy production does not adversely affect the marine environment. • SA30: Support the evaluation of sub-seabed and ocean sequestration of CO₂. • SA31: Participate in interagency development and implementation of federal strategies through the NOC and the NOC Strategic Action Plans.
<p>❖ Water Quality: <i>Our Nation's surface water, drinking water, and ground water quality are protected, and the risks of climate change to human health and the environment are diminished, through a variety of adaptation and mitigation strategies.</i></p>	
<p>Goal 12: Protect waters of the United States and promote management of sustainable surface water resources.</p>	<ul style="list-style-type: none"> • SA32: Encourage states and communities to incorporate climate change considerations into their water quality planning. • SA33: Encourage green infrastructure and low-impact development to protect water quality and make watersheds more resilient. • SA34: Promote consideration of climate change impacts by National Pollutant Discharge Elimination System permitting authorities. • SA35: For future Total Maximum Daily Loads, recommend that water quality authorities consider climate change impacts when developing waste load and load allocations. • SA36: Identify and protect designated uses that are at risk from climate change impacts. • SA37: Clarify how to re-evaluate aquatic life water quality criteria on more regular intervals; and develop information to assist States and Tribes who are developing criteria that incorporate climate change considerations for hydrologic condition.
<p>Goal 13: As the nation makes decisions to reduce greenhouse gases and develop alternative sources of energy and fuel, work to protect water resources from unintended adverse consequences.</p>	<ul style="list-style-type: none"> • SA38: Seek opportunities to provide additional assistance to states and permittees to assure that geologic sequestration of CO₂ is responsibly managed. • SA39: Work with ORD to better understand the risks of storing ethanol-supplemented transportation fuels and with the Office of Underground Storage Tanks to explore options to mitigate such risk through updated policies. • SA40: Provide outreach materials for stakeholders to encourage the adoption of alternative sources of energy and fuels that are water efficient and maintain water quality.

Table ES-1: Summary of Visions, Goals and Strategic Actions

	<ul style="list-style-type: none"> • SA41: As climate change affects the operation or placement of reservoirs, work with other federal agencies and EPA programs to understand the combined effects of climate change and hydropower on flows, water temperature, and water quality.
<p>Goal 14: Collaborate to make hydrological and climate data and projections available.</p>	<ul style="list-style-type: none"> • SA42: Monitor climate change impacts to surface waters and ground water.
	<ul style="list-style-type: none"> • SA43: Collaborate with other federal agencies to develop new methods for use of updated precipitation, storm frequency, and observational streamflow data, as well as methods for evaluating projected changes in low flow conditions.
	<ul style="list-style-type: none"> • SA44: Enhance flow estimation using National Hydrography Dataset Plus (NHDPlus).
<p>❖ Working With Tribes: <i>Tribes are able to preserve, adapt, and maintain the viability of their culture, traditions, natural resources, and economies in the face of a changing climate.</i></p>	
<p>Goal 15: Incorporate climate change considerations in the implementation of core programs, and collaborate with other EPA Offices and federal agencies to work with tribes on climate change issues on a multi-media basis.</p>	<ul style="list-style-type: none"> • SA45: Ensure that the revised NWP Tribal Strategy and subsequent implementation of CWA, SDWA, and other core programs incorporate climate change as a key consideration.
	<ul style="list-style-type: none"> • SA46: Incorporate adaptation into tribal funding mechanisms, and collaborate with other EPA and federal funding programs to support sustainability and adaptation in tribal communities.
<p>Goal 16: Ensure tribes have access to information on climate change for decision making.</p>	<ul style="list-style-type: none"> • SA47: Collaborate to explore and develop climate change science, information and tools for tribes, and incorporate local knowledge.
	<ul style="list-style-type: none"> • SA48: Collaborate to develop communication materials relevant for tribal uses and tribal audiences.
<p>Cross-Cutting Program Support</p>	
<p>Goal 17: Communicate, Collaborate, and Train.</p>	<ul style="list-style-type: none"> • SA49: Continue building the communication, collaboration, and training mechanisms needed to effectively increase adaptive capacity at the federal, tribal, state, and local levels.
<p>Goal 18: Track Progress and Measure Outcomes</p>	<ul style="list-style-type: none"> • SA50: Adopt a phased approach to track programmatic progress towards Strategic Actions; achieve commitments reflected in the Agency Strategic Plan; work with the EPA Work Group to develop outcome measures.
<p>Goal 19: Identify Climate Change and Water Research Needs</p>	<ul style="list-style-type: none"> • SA51: Work with ORD, other water science agencies, and the water research community to further define needs and develop research opportunities to deliver the information needed to support implementation of this <i>2012 Strategy</i>, including providing the decision support tools needed by water resource managers.

II. Introduction: The Evolving Context

A. 2008 Strategy vs. 2012 Strategy

The *National Water Program Strategy: Response to Climate Change*, published in 2008 (*2008 Strategy*), describes the likely effects that climate change will have on water resources and their implications for the EPA's NWP.¹ The *2008 Strategy* laid out 44 "key actions" that the NWP intended to take during 2008-2009, and an update extended the period of action to 2010-2011 (EPA, 2008a).

The *2012 Strategy* describes a longer-term vision for the management of sustainable water resources in light of climate change and identifies the key 'building blocks' or strategic actions that need to be taken to achieve the long term goals. It also reflects the wider context of climate change-related activity that is underway throughout the nation. This *2012 Strategy* is a roadmap that reflects directional intention. While it describes an array of important actions that should be taken to be a 'climate ready' national water program, it does not outline commitments to act within a specific time frame. All proposed activities are contingent upon availability of resources and subject to change as new information develops to inform adaptive responses.

B. Relationship of the 2012 Strategy to Other Planning Activities

The **Interagency Climate Change Adaptation Task Force** (the Task Force) was established under Executive Order 13514 (CEQ, 2009) to develop recommendations for climate change adaptation. On October 5, 2010, the Task Force delivered its initial report to the President with a first set of recommendations (CEQ, 2010a).

Two recommendations in the October 2010 Task Force Report inform the development of the *2012 Strategy*. First, the Task Force's **Freshwater Workgroup**² was asked to develop a National Action Plan (NAP) in coordination with similar action plans under development; one by ICCATF's **Fish, Wildlife and Plants Climate Adaptation Workgroup** (FWP Workgroup) and the other by the **National Ocean Council** (NOC) addressing ocean, coastal, and Great Lakes resources. An ICCATF coordinating team has work together to ensure that the three national adaptation strategies produced by these three workgroups are complementary.

Subsequently, the Freshwater Workgroup published the NAP titled *Priorities for Managing Freshwater Resources in a Changing Climate*³ (CEQ, 2011a) which describes a National Goal, supported by six recommendations:

¹ The term 'National Water Program' refers to the Office of Water (OW) plus the water programs in the ten EPA Regions, and recognizes that many of our programs are implemented by state and tribal water authorities.

² Since 2009, Michael Shapiro, EPA Deputy Assistant Administrator for Water, has served as co-chair of the Task Force's Water Workgroup along with Matthew Larsen, USGS Associate Director for Climate and Land Use Change, and Jeffrey Peterson, CEQ Deputy Associate Director for Water Policy.

³ Printed copies of the National Action Plan are available by sending an email stating addressee, mailing address, and the number of copies desired (limit of 3) to the following address: adaptation@ceq.eop.gov.

National Goal: Government agencies and citizens work collaboratively to manage freshwater resources in response to a changing climate in order to assure adequate water supplies, to protect human life, health and property, and to protect water quality and aquatic ecosystems.

- **Recommendation #1:** Establish a Planning Process and Organizational Framework
- **Recommendation # 2:** Improve Water Resources and Climate Change Information
- **Recommendation # 3:** Strengthen Assessment of Vulnerability
- **Recommendation # 4:** Expand Water Use Efficiency
- **Recommendation # 5:** Support Integrated Water Resources Management
- **Recommendation # 6:** Support Training and Outreach to Build Response Capability

❖ *ICCATF Freshwater National Action Plan (CEQ, 2011a)*

The Freshwater NAP lays out 24 key actions that support the six recommendations. For some of the supporting actions, EPA will provide leadership, and for those led by other federal Agencies, EPA will participate as a team member, as appropriate. EPA water program staff and managers also participate on the National Ocean Council (NOC, 2011) and the FWP Workgroup (FWP, 2011), and EPA National Water Program's commitments in those adaptation plans are also reflected in this *2012 Strategy*.

The second recommendation of the Interagency Task Force report called on every federal agency to develop and implement a climate adaptation plan addressing the challenges posed to our missions and operations. The Council on Environmental Quality (CEQ) issued implementation instructions on climate adaptation planning to all federal agencies (CEQ, 2011a and b); initial plans are to be submitted by June 2012, and more complete plans by June 2013. In response, EPA established a Policy on Climate Change Adaptation, issued June 2, 2011 (EPA, 2011a), and formed a **cross-EPA Work Group on Climate Change Adaptation Planning** (EPA Work Group). The Office of Water (OW) and the ten EPA Regions participate on the EPA Work Group and will ensure that the two Strategies (NWP's and EPA's) are consistent and mutually reinforcing.

Despite many successes over recent years, the rate at which waters are being listed for impairment exceeds the rate at which they are being restored. The causes of degradation are in many cases far more complex, and not as visible to the naked eye as they were years ago; the solutions are often available technically, but because the pollution comes from multiple sources, and involves a greater array of pollutants and stressors, it requires new and innovative partnerships and approaches. In some cases EPA and state authorities are limited in scope, and as a result it is challenging to directly address root causes—i.e., population growth, urbanization, agriculture and other nonpoint source pollution. Building strong and effective partnerships with the widest range of stakeholders, state, local, and tribal partners, and other federal agencies has never been so urgent if we are to protect our water and its multiple uses for generations to come.

❖ *Coming Together for Clean Water, (EPA, 2011b)*

Additionally, EPA has adopted Agency-wide goals that call for each program office to incorporate climate change science trend and scenario information into five major scientific models and/or decision-support tools, five rule-making processes, and five major grant, loan, contract, or technical assistance programs, and sets a target for reducing greenhouse gas

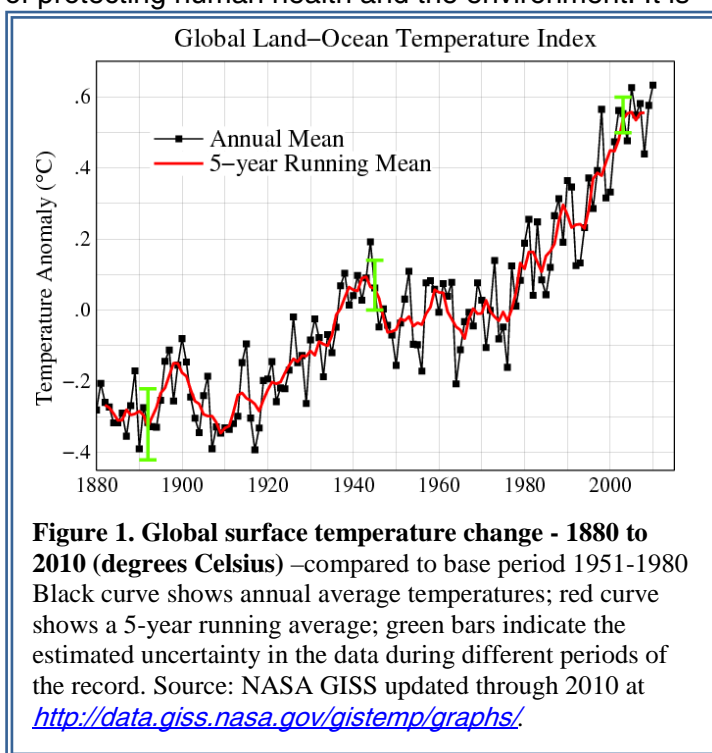
emissions through energy and resource conservation [EPA, 2010a]. This *2012 Strategy* reflects the NWP’s commitment to achieving each of these measures by 2015. (See the section in Chapter V on *Tracking Progress and Measuring Outcomes* for more discussion.)

Finally, in 2010 EPA convened a forum to discuss how to accelerate progress protecting the nation’s waters. The resulting white paper, titled *Coming Together for Clean Water (CT4CW)* recognizes that climate change is just one of the several stressors to water resources (EPA, 2011b). The *Coming Together* strategy presents a framework for how EPA’s national water program will work to address today’s clean water challenges, such as stormwater, nutrients, and protecting and restoring watersheds. The *Infrastructure Sustainability Policy* reflects EPA’s goal to ensure that federal investments, policies, and actions support water infrastructure in efficient and sustainable locations to best aid existing communities, enhance economic competitiveness, and promote affordable neighborhoods. The NWP *2012 Strategy* should be viewed as an in-depth treatment of climate change, addressing one of the new and challenging issues facing our program, and as an integral and complementary part of overall NWP strategic planning and initiatives.

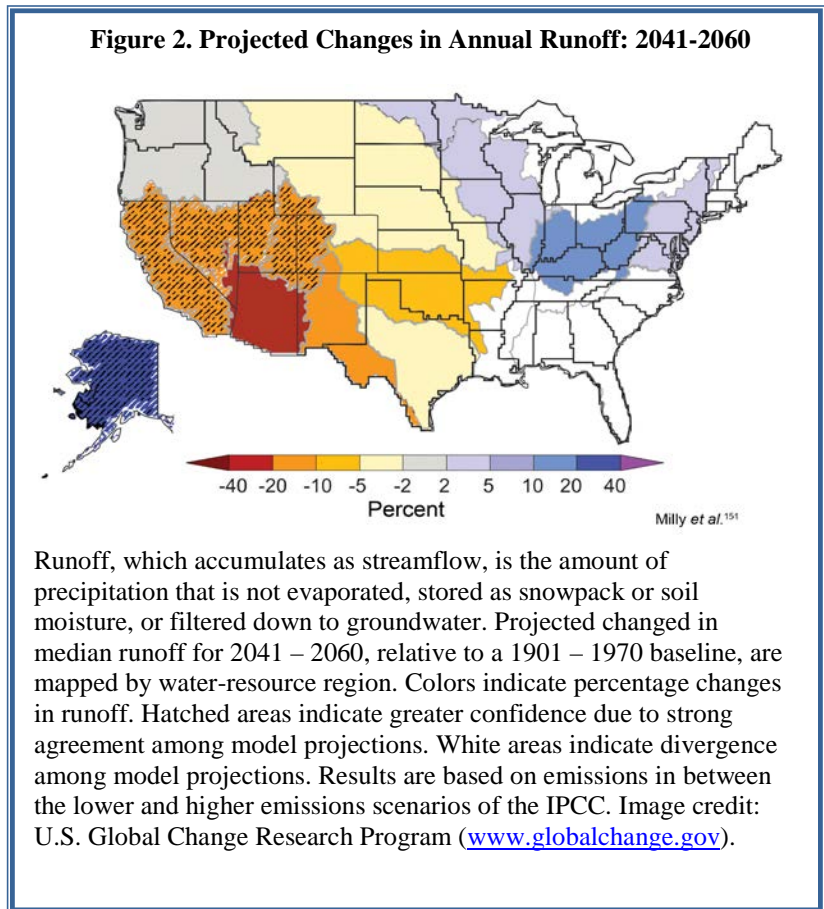
C. Impacts of Climate Change on Water Resources: Recent Literature

Assessments and other reports recently published reinforce the findings in the *2008 Strategy* that climate change has significant implications for water resources and water programs. They support EPA’s determination that these implications need to be addressed in each part of the NWP in order to achieve EPA’s mission of protecting human health and the environment. It is important to note that not all impacts of climate change will necessarily be disruptive to particular programmatic endpoints, and that some could at least in the near term provide beneficial opportunities. However, on balance the range of challenges posed by the interface between built and natural systems and the changing hydrometeorological background conditions is likely to require response actions in order to minimize detrimental effects to current built and natural systems.

The impacts listed here refer to the general risks to water resources posed by climate change, but whether and to what degree these risks are likely to be realized in specific locations will require local assessment. The reader is referred to the original *2008 Strategy*, as well as more recent literature cited below, for a more detailed discussion of the implications of climate change for water resources and EPA’s water programs, which include:



- **Increases in Water Pollution Problems:** Warmer air temperatures will result in warmer water. Warmer waters will hold less dissolved oxygen making instances of low oxygen levels and “hypoxia” more likely (i.e., when dissolved oxygen declines to the point where aquatic species can no longer survive); foster harmful algal blooms; and change the toxicity of some pollutants.
- The number of waters categorized as “impaired” is likely to increase, even if pollution levels are stable, with associated impacts on human health from waterborne disease and degradation of aquatic ecosystems.
- **Impacts on water infrastructure and aquatic systems due to more extreme weather events:** Heavier precipitation in tropical and inland storms will increase the risks of flooding, expand floodplains, increase the variability of streamflows (i.e., higher high flows and lower low flows), increase the velocity of water during high flow periods and increase erosion. These changes will have adverse effects on water quality and aquatic ecosystem health. For example, increases in intense rainfall result in more nutrients, pathogens, and toxins being washed into waterbodies.
- **Changes to Water Availability:** In some parts of the country, droughts, changing patterns of precipitation and snowmelt, and increased water loss due to evaporation as a result of warmer temperatures will result in changes to the availability of water for drinking and for use for agriculture, industry, and energy production. In other areas, sea level rise and salt water intrusion will have the same effect. Warmer air temperatures may also result in increased demands on community water supplies and the water needs for agriculture, industry, and energy production are likely to increase.



- **Waterbody Boundary Movement and Displacement:** Rising sea levels will move ocean and estuarine shorelines by inundating lowlands, displacing wetlands, and altering the tidal range in rivers and bays. Changing water flow to lakes and streams, increased evaporation, and changed precipitation in some areas, will affect the size of wetlands and lakes. Water levels in the Great Lakes are expected to fall.

- **Changing Aquatic Biology:** As waters become warmer, the aquatic life they now support will be replaced by other species better adapted to the warmer water (i.e., cold water fish will be replaced by warm water fish). This process, however, will occur at an uneven pace disrupting aquatic system health and allowing non-indigenous and/or invasive species to become established. In the long-term (i.e., 50 years), warmer water and changing flows may result in significant deterioration of aquatic ecosystem health in some areas.
- **Collective Impacts on Coastal Areas:** Most areas of the United States will see several water-related impacts, but coastal areas are likely to see multiple impacts associated with climate change (e.g., sea level rise, increased damage from floods and storms, coastal erosion, changes in drinking water supplies, and increasing temperature and acidification of the oceans); acidification (e.g., decreases in pH, decreases in carbonate ion availability for calcifying organisms, changes in fish behavior); and nitrogen and phosphorus pollution, that could result in more profound consequences to water resources and ecosystem services. These overlapping impacts make protecting water resources in coastal areas especially challenging.

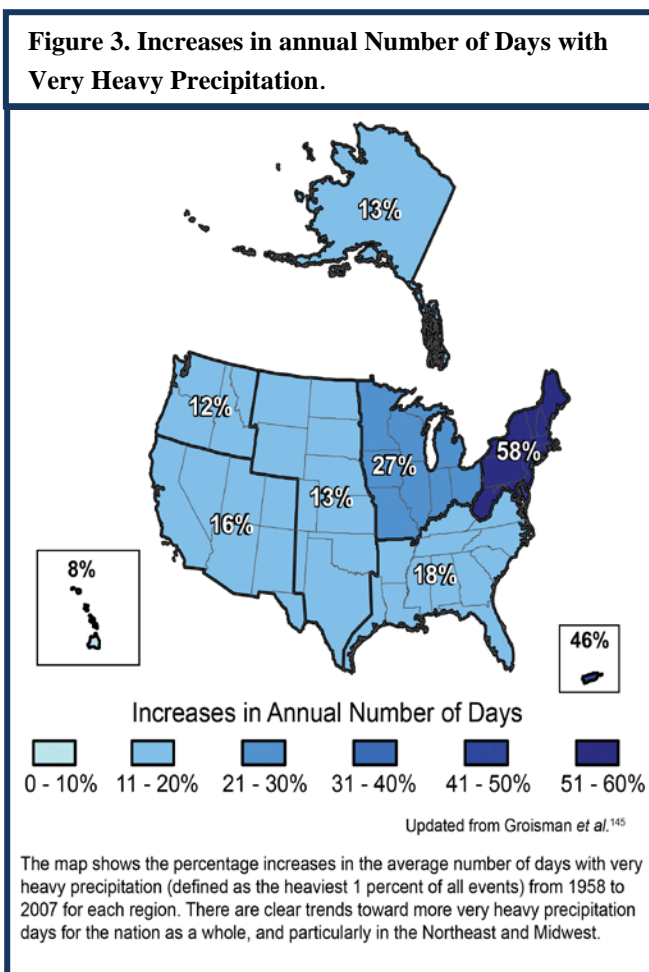


Image credit: U.S. Global Change Research Program (www.globalchange.gov).

- **Indirect Impacts:** Likely response to climate change include development of alternative methods of energy and fuel production that reduce emissions of greenhouse gases as well as finding ways to sequester carbon generated by energy production. Alternative methods of both energy production and sequestration can have impacts on water resources, including: increased water use and withdrawals, potential nonpoint pollution impacts of expanded agricultural production, increased water temperatures due to discharge of process cooling waters, pollution concentration due to low flows, and effects of carbon sequestration on groundwater or ocean environments.

As noted, not all near term impacts of climate change will necessarily be disruptive, and could, in some cases provide benefits. For example, increased precipitation could improve flows supporting aquatic ecosystem health in some areas, and changing sea levels could aid submerged aquatic vegetation.

Recent publications on the impacts of climate change include the June 2009 report titled *Global Climate Change Impacts in the United States*, produced by the USGCRP

(formerly the U.S. Climate Change Science Program). The report reviews the scientific findings of twenty-one Synthesis and Assessment Products (SAPs), and builds on previous USGCRP

and Intergovernmental Panel on Climate Change (IPCC) assessments. It describes both observed and expected impacts of climate change for the United States and presents regional and sectoral assessments (USGCRP, 2009a). In December 2009, EPA issued the *Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act*. EPA relied on the major scientific assessment reports to find that greenhouse gases pose a risk to public health and welfare. Observed and projected impacts of climate change on water resources in the U.S. were components of the Findings (EPA, 2009a).

The National Research Council (NRC) produced a set of reports in 2010 at the request of Congress (Public Law 110-161) to study the issues associated with global climate change and provide advice on the most effective steps and strategies that can be taken to respond. The study, entitled *America's Climate Choices*, resulted in five reports: *Advancing the Science of Climate Change*, *Limiting the Magnitude of Future Climate Change*, *Adapting to the Impacts of Climate Change*, *Informing Effective Decisions and Actions Related to Climate Change*, and *Synthesis for Policy Makers*, synthesizing the previous four (NRC, 2010a-d).

In late 2010, the NRC produced the report, *Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia*, including an associated brochure (NRC, 2010e; NRC, 2011a). The report describes likely ranges of temperature increases during the 21st century and beyond for a given concentration of greenhouse gases in the atmosphere, and associates those temperatures with likely effects on natural and human systems:

Scientific progress has increased confidence in the understanding of how global warming levels of 1°, 2°, 3°, 4°, 5°C, and so on, affects many aspects of the physical climate system, including regional and seasonal changes in temperature and precipitation, as well as effects on hurricanes, sea ice, snow, permafrost, sea level, and ocean acidification. Climate Stabilization Targets attempts to quantify the outcomes of different stabilization targets on the climate system, as much as is possible based on currently available scientific evidence and information (NRC, 2011a).

The *Climate Stabilization Targets* report then presents an indicative (not comprehensive) evaluation of likely impacts of each °C (1 °C = 1.8 °F) of warming, including, for example:

- 5-10% changes in precipitation across many regions;
- 3-10% increases in the amount of rain falling during the heaviest precipitation events;
- 5-10% changes in streamflow across many river basins;
- 15% decreases in the annually averaged extent of sea ice across the Arctic Ocean, with 25% decreases in the yearly minimum extent in September; and
- 5-15% reductions in the yields of crops as currently grown.

Other effects of varying levels of warming include:

- Increases in the number of exceptionally warm summers (i.e., 9 out of 10 boreal summers that are “exceptionally warm” in nearly all land areas for about 3°C of global warming, and every summer “exceptionally warm” in nearly all land areas for about 4°C, where an

“exceptionally warm” summer is defined as one that is warmer than all but about 1 of the 20 summers in the last decades of the 20th century);

- 200-400% increases in the area burned by wildfire in parts of the western United States for 1-2°C;
- Increased coral bleaching and net erosion of coral reefs due to warming and changes in ocean acidity (pH) for carbon dioxide (CO₂) levels corresponding to about 1.5-3° C; and
- Sea level rise in the range of 0.5 to 1.0 meters in 2100, in a scenario corresponding to about 3° C (plus or minus 1° C), with an associated increase in the number of people at risk from coastal flooding, as well as wetland and dryland losses.

Furthermore, the report underscores the point that “adaptation” is not a one-time event. Rather, we have entered an era of long-term continual change that must be considered by decision makers to inform ongoing adaptation strategies. The NWP will continue to monitor developments in climate change and water science, including new science efforts to support and inform adaptation strategies.

D. The Economics of Climate Change Actions

Many of the actions we could take to adapt to climate change are actions that provide value independent of changing climate. Siting new water infrastructure in a coastal area at an elevation that is resilient to storm surge in the face of sea level rise would be beneficial even at current sea levels. Coastal wetlands are important resources for a variety of services, of which protection from sea level rise and storm surge is only one important component. Sources for drinking water are already at risk; best management practices employed by water utilities and solutions encouraging water conservation and efficiency to deal with climate change impacts may also provide cost-effective relief from pressures caused by growing populations. In this sense, adaptation practices can be no or low-regret methods to manage risk in the face of uncertainty regarding the pace and magnitude of climate change effects, provided they cost-effectively address stressors in addition to the risks posed by climate change.

Quantifying the projected cost of climate change impacts with any degree of certainty is difficult due to the complexity, variability and uncertainty in the pace, magnitude and locally specific impacts of climate change. Likewise, it is hard to monetize the costs and benefits associated with the wide range of mitigation and adaptation opportunities available to water managers in the United States. Nevertheless, assigning a dollar value to actions and inactions related to climate change not only helps society determine its preferred level of mitigation and adaptation, but also provides a common unit of measure to compare among options, helping decision-makers determine where and how to best implement mitigation and adaptation practices. The *EPA Guidelines for Preparing Economic Analyses* (EPA, 2010b) recognizes the complexity of environmental impacts more generally, while also explaining how valuation of such impacts can benefit decision-making.

The NWP will monitor developments and work with partners within and outside of EPA to explore ways to characterize costs and benefits to support climate change-related decision making. A sample of these studies follows⁴:

- Kirshen et al. (2006) quantifies the climate change impacts on water quality, water supply, and water demand, among other areas of impact, in the Boston region. For example, they estimate capital costs to account for managing lower levels of dissolved oxygen due to warmer waters to range between \$30 and \$39 million.
- Frederick and Schwarz (2000) look at the impact of increased flood damages and drought on the United States due to climate change, and estimate that annual average flood damages may increase from \$5 billion in 1995 to \$8 billion in 2030 to \$18 billion in 2095.
- Dore and Burton (2001) evaluate climate adaptation costs for a variety of actions in Canada. They estimate that expanding wastewater treatment capacity in Toronto to account for more intense precipitation and other impacts could range from \$533 million to \$9 billion, depending on the level of risk the city is willing to accept.
- USGCRP's Global Climate Change Impacts in the United States (2009) highlights a water resources adaptation decision. Boston's Deer Island sewage treatment plant was built 1.9 feet higher to account for projected sea level rise during the facility's planned life (through 2050) to avoid future costs to build a protective wall around the plant with pumps to transport effluent over the wall.
- Neuman et al. (2010), in an EPA-supported study, evaluated the costs of sea level rise impacts to the contiguous U.S. coastline. The study found that the cost is much larger than prior estimates suggest—more than \$63 billion cumulative discounted cost (at 3%) for a 27 inch rise by 2100, which corresponds to \$230 billion in undiscounted cost.
- Studies related to wetlands also focus on protection from sea level rise and storm surges. The Millennium Ecosystem Assessment (2005) notes that the State of Louisiana put in place a \$14 billion wetland restoration plan (Coast 2050) to protect marsh, swamp, and barrier islands to reduce storm surges.
- Workshop report: *Valuation Techniques and Metrics for Climate Change Impacts, Adaptation, and Mitigation Options* (NCA 2011). The goal of this workshop, convened by the interagency National Climate Assessment Task Force, was to provide a snapshot of the capabilities, readiness, and applicability of methodologies for quantitatively valuing climate impacts and adaptation.

⁴ This list is intended to be illustrative of recent published research. EPA is not endorsing any specific estimate.

III. Framework For A Climate Ready National Water Program

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

Under the CWA, EPA is responsible for ensuring “water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water” through the control of point and nonpoint sources of pollution. Under the SDWA, EPA promulgates national primary drinking water regulations applicable to public water systems to protect human health from drinking water contaminants. EPA’s source water protection and preservation efforts aim to ensure abundant and clean drinking water supplies. However, as climate change shifts hydrological patterns and increases variability outside of historic norms, including frequency, severity and duration of drought or extreme rain events, achieving these goals will become more challenging.

A. Guiding Principles

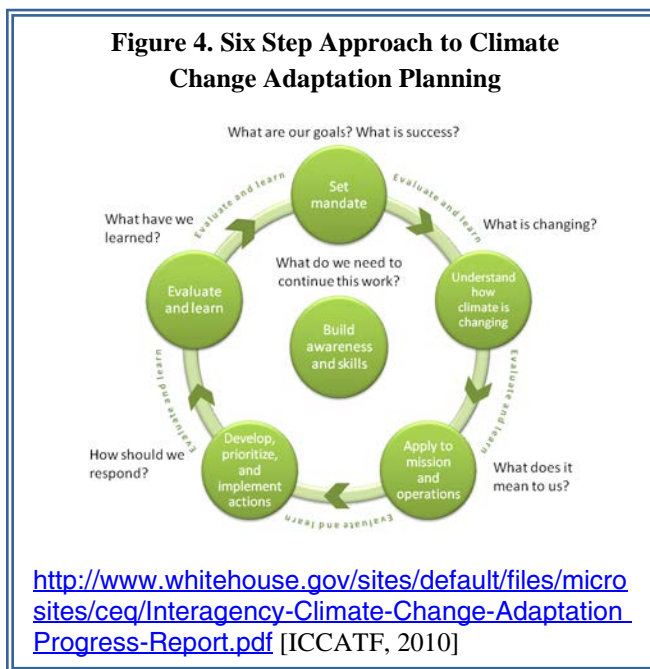
To position the National Water Program as “Climate Ready,” we will work with stakeholders and partners to achieve our Vision. The NWP adopted the following ten principles that inform the development of the 2012 Strategy. These principles are consistent with, and reinforce, the principles promulgated by the ICCATF and reflect additional principles specific to managing water resources.

1. Integrated Water Resources Management (IWRM): Support collaboration among state, interstate, local tribal, and federal governments and among sectors to manage the quality and quantity of sustainable water resources within watersheds and underlying aquifers (IWRM is further discussed below).

2. Adaptive Management: Acknowledge uncertainty as a context of decision making and build flexibility into policy and decision-making to manage risk and to allow for new knowledge input. Uncertainty is not necessarily a reason to defer decisions.

The *Flexible Framework* adopted by the ICCATF (Figure 4) reflects both the evolution of climate science and the likelihood that the uncertainty regarding the timing, nature,

direction, and magnitude of localized climate change impacts will continue. Because



Dealing with Uncertainty

Although we can glean clues about the likely impacts of future climate change from recent observations and research into Earth's past, the picture is still incomplete and our predictions are uncertain. Future climate change will likely be fundamentally different from changes Earth experienced in the past because of the high temperatures that are projected, the rate of climate change, and the fact that climate change is occurring in a setting where human actions have already altered natural ecosystems in many other ways. Despite uncertainties about what the future holds, decisions can be made now. Strategies for managing ecosystems in the future will need to pay special attention to the issue of uncertainty. It will be important to make decisions based on the best currently available information, and implement them in a way that preserves the ability to make adjustments in the future as more information becomes available.

❖ *Ecological Impacts of Climate Change, [NRC, 2009]*

investments such as for construction of water infrastructure are capital intensive, long-lived and require long lead times, building climate change considerations into the design of these investments is necessary even with some degree of uncertainty in climate projections.

3. Collaborative Learning and Capacity Development: Collaborate with other federal water agencies and state, interstate, tribal and local water agencies to contribute to the development of long-range plans that account for climate change impacts. Establish partnerships to assemble and develop planning and decision support tools and the underlying data sets for climate change adaptation and mitigation.

4. Long Term Planning (i.e., multi-decadal time horizon): Look ahead and consider ways to reduce risk over time when making adaptation decisions. Incorporate concepts of sustainability and non-stationarity – i.e., continual change in the hydroclimatic system outside of assumed norms - into the implementation of water programs.

5. Water-Energy Nexus: Saving water saves energy and vice versa. Adaptation and mitigation go hand-in-hand and opportunities for both should be considered whenever possible. Managing the “water/energy nexus” will protect the aquatic environment while preserving freshwater resources for human uses and the economy.

6. Systems & Portfolio Approach: Design integrated and resilient solutions that address the inter-relationships among environmental, public health, social and economic aspects of a climate change impact and that avoids unintended consequences. Incorporate diversification that includes contingency plans

Principles for an Energy-Water Future (See Appendix B for full description)

- ❖ Efficiency should form the foundation of how we develop, distribute, recover, and use energy and water.
- ❖ Generation and use of energy should have the smallest possible impact on water resources.
- ❖ Treatment, distribution, and use of water should have the smallest possible impact on energy resources.
- ❖ Waste water treatment facilities should be viewed as renewable resource recovery facilities.
- ❖ The water and energy sectors should move toward integrated resource management.
- ❖ Maximize comprehensive, societal benefits.

(emergency preparedness and response) to be implemented should adaptation actions under-perform.

7. **Cost of Inaction:** Understand the risk of inaction and its cost (i.e., the value at risk) compared to the cost of proactively adapting to projected climate change impacts. Support decision making and express tradeoffs in terms of costs and benefits (quantified and non-quantified short- and long-term risks), as well as between action and inaction.
8. **Environmental Justice:** Account for the most vulnerable by assuring that our plans and programs consider the needs of those with a higher degree of vulnerability (e.g., children, economically disadvantaged communities, tribes, and islands).
9. **Performance Evaluation:** Set clear goals against which to assess performance and guide adaptation and refinement of program planning, policy design and implementation. Include numeric targets where appropriate.
10. **Mainstreaming Climate Change into Core Programs:** As experience is gained and tools are developed, integrate climate change mitigation and adaptation into core programs. Ultimately, we would no longer need a “climate change” strategy; rather, climate change would be factored in as the new background condition for managing water programs.

B. Integrated Water Resources Management (IWRM)

Because surface water and ground water flows across political jurisdictions, state and local government actions that are coordinated throughout watersheds and across the underlying aquifers can more successfully protect and preserve these resources than disparate actions taken piecemeal. Watershed and aquifer boundaries are the optimal organizing principle for state, interstate, tribal and local management of fresh water to ensure these resources remain abundant and clean across the nation.

IWRM is a framework to holistically address current water resource issues and emerging climate change complications. There are several definitions of this term, but for the purpose of this strategy, the NWP uses IWRM to describe opportunities for state, interstate, tribal and local officials to voluntarily collaborate at watershed or aquifer scales to protect and

Case Study: IWRM in California

In 2002, the Californian legislature passed the Integrated Regional Water Management (IRWM) Act and established IRWM as the framework for collaborative planning for all aspects of water resources in a region. Between 2002 and 2006, California voters passed three Water Bonds authorizing \$1.8 billion to fund competitive grants for IRWM planning and implementation. The California Department of Water Resources established guidelines for Regions to consider as they each developed their own coordination, planning and decision-making processes. Thus far, California has 46 active IRWM regions, covering 82% of the State. In 2011, EPA Region 9 worked with California to develop a technical guide for incorporating climate change into IRWM planning (CA, 2011a). For more information on California's program, see: www.water.ca.gov/irwm/docs/Brochures/Brochure_IRWM_020410.pdf

preserve fresh water resources through mutually beneficial solutions. IWRM calls for inter-sector planning (e.g., between the energy sector and the water sector) to sustainably manage water resources. A short hand way to think of IWRM is “one water.” To be most effective, IWRM should take into account water quantity and quality, surface water and ground water, salinity of coastal estuaries, land use, point and nonpoint sources of pollution, green and grey infrastructure, and climate change adaptation and mitigation [EPA-R9 2011].

Strategic actions described throughout this document point to NWP efforts to work with other federal, state, interstate and tribal agencies in assembling information on the hydrologic relationships between surface water and ground water, and between water quality and quantity; developing planning support tools for water resource managers to address climate change adaptation; and building public understanding of the interaction between water use and the quality and sustainability of ground water and surface water.

The NWP will seek opportunities to integrate IWRM into national and regional activities and coordinate with other federal, state, interstate and tribal agencies to support IWRM at hydrologic scales.

IV. Programmatic Visions, Goals and Strategic Actions

This chapter is divided into five sections. Each section is organized using a three-tier framework: Vision, Goals, and Strategic Actions. Each section articulates a Vision for which EPA may be only one of many actors. This requires EPA to work collaboratively with other federal, state, tribal and local entities to achieve each Vision.

For each Vision, we identify Goals that reflect the same long-term time frame as the Vision. The Goals, however, articulate EPA's mission and role in achieving the Vision, and describe *what* we are trying to achieve.

IWRM is a voluntary collaboration of state, interstate, local and tribal governments and among sectors to sustainably manage the quality and quantity of water resources within watersheds and underlying aquifers.

Each Goal entails several Strategic Actions which are the program building blocks to achieve the goal. The Strategic Actions describe *how* the NWP plans to work over the next three to eight years in pursuit of our longer term Goals and Vision.

Annual objectives will be incorporated into the annual budget and planning process of the Agency, and will reflect the availability of resources and priorities. Progress toward achieving Goals and Strategic Actions will be described in annual reports (see the section in Chapter V on *Tracking Progress and Measuring Outcomes*).

The five sections of this chapter are:

- A. **Infrastructure** – including centralized or decentralized technologies and practices for wastewater, drinking water and stormwater management infrastructure; Climate Ready Water Utilities; energy use and co-generation; water supply and demand management.
- B. **Watersheds and Wetlands** – including landscape strategies to protect and restore watersheds, source water areas including ground water, and wetlands; natural infrastructure and low impact development.
- C. **Coastal and Ocean Waters** – including programs for coastal wetlands and estuaries; Climate Ready Estuaries (CRE); issues associated with coastal infrastructure and coastal drinking water (sea level rise, saline intrusion, etc.); ocean water quality, ocean habitats and marine life.
- D. **Water Quality** – including policies, programs, and regulatory controls to protect human health and ecological integrity, e.g., Water Quality Standards (WQS), TMDLs, NPDES permits, Green Infrastructure for stormwater management, underground injection control (UIC), wellhead protection, etc.
- E. **Working With Tribes** – including how the NWP will utilize “traditional knowledge” to help guide this strategy and long-term implementation of adaptation measures.

A. Infrastructure

VISION: *In the face of a changing climate, resilient and adaptable drinking water, wastewater and stormwater utilities (i.e., the water utility sector) ensure clean and safe water to protect the nation's public health and environment by making smart investment decisions to improve the sustainability of their infrastructure and operations, and the communities they serve, while reducing greenhouse gas emissions through greater energy efficiency.*

The viability of drinking water and wastewater treatment and related infrastructure directly affects the protection of public and ecosystem health. Population growth, land use change, aging infrastructure, economic and regulatory constraints, and various water quality stressors are already driving the water sector to take action. Climate change adds another dimension that will complicate these long standing challenges for water sector operators and public officials. This chapter highlights how the NWP plans to continue assisting the water sector in achieving public health and ecosystem objectives in light of climate change.

"Because the perception that climate fluctuates around a stationary mean is in conflict with recently observed climate dynamics, decision makers need an approach that is responsive to changes in the likelihood of extreme outcomes as well as changes in the "average" climate ... Rather than managing the resource to maintain its past condition and state, management may need to take steps to protect the resource ... or allow the resource to change as needed to adapt to climate change ... In other words the managers of these resources must work to incorporate the impact of climate change in their plans and operations."

❖ NRC, 2010d

GOAL1: *The NWP works with the water utility sector to build the body of information and tools needed to incorporate climate change into planning and decision making to build the sector's adaptive capacity, reduce greenhouse gases, and deliver drinking water and clean water services.*

This Goal highlights the objectives of the Climate Ready Water Utilities (CRWU) initiative to work with drinking water, wastewater, and stormwater utilities to advance their understanding of climate science and adaptation options. Through the CRWU program, the NWP will seek to expand the water sector's understanding of climate change risks and respond to the recommendations of the *Climate Ready Water Utilities: Final Report of the National Drinking Water Advisory Council* [NDWAC, 2010]. EPA's *Clean Water and Safe Drinking Water Infrastructure Sustainability Policy* [EPA, 2010c] also encourages water sector utilities to incorporate climate change considerations into their planning and operations, and supports the work of the CRWU initiative.

As recommended by the National Drinking Water Advisory Council (NDWAC) CRWU working group, climate change activities need to be closely coordinated with other federal and state agencies, water sector associations, non-governmental organizations and tribes. CRWU activities also need to be linked to other EPA programs such as the Climate Ready Estuaries (CRE) program, and Effective Utility Management (EUM). The EUM initiative is a collaborative partnership between EPA and major water sector associations, and is based on a series of attributes of effectively managed utilities including consideration of climate impacts. By

coordinating with these and other programs, utilities can ensure that their climate change adaptation and mitigation approaches more readily address utility and community sustainability priorities through utility-wide planning, ongoing asset management and infrastructure repair and replacement, emergency response, and capacity development.

Strategic Action 1: The CRWU program will work to improve access to vetted climate data and hydrological science, modeling and assessment tools. This action reflects the NWP's commitment to incorporate climate change science and trend information into a major tool by 2015.

Water utility officials are struggling with the number and volume of climate change studies produced by federal and state agencies, water associations, universities and others. Concurrent with utilities moving forward to address climate change challenges, there is a strong need for continued investment in advancing the understanding of climate impacts and strategies (NDWAC, 2010). The NWP will continue to work with federal and state partners to improve access to hydrologic science and tools, such as trend and risk assessment tools, downscaled climate modeling, and advanced planning support models and decision support tools.

CRWU will refine its Climate Resilience Education and Awareness Tool (CREAT) to assist water utilities with understanding potential climate change impacts and assess their risks. CREAT allows a utility to analyze how various adaptation strategies may help reduce climate risks, enabling them to prioritize the implementation of adaptation measures. CRWU will also improve a searchable toolbox of resources that support all stages of the decision process, from basic climate science through integration of mitigation and adaptation into long-term planning (EPA, 2011c).

Strategic Action 2: The NWP will assist wastewater and drinking water treatment plants to reduce their greenhouse gas emissions and increase their long-term sustainability. The NWP will leverage programs such as effective utility management, sustainable asset management, and energy management, to encourage a combination of energy efficiency, co-generation and renewable energy resources.

About 80% of municipal water processing and distribution costs are for electricity, which comprises an estimated 3 - 4 % of national energy consumption; this percentage ranges up to 13% when residential water use is included (EPRI, 2002; EPA, 2011d). In addition, the Water Environment Research Foundation (WERF, 2010) reports that sewage typically contains ten times the energy required to treat it, presenting an opportunity for using it as an energy source (co-generation). Improved energy management is important to reduce greenhouse gases and help insulate utilities from energy costs or supply disruptions (Figure 5).

The NWP will continue encouraging water sector utilities to use its Energy Management Guidebook (EPA, 2008a) which uses a management systems approach to reduce energy use. As part of this effort, utilities are documenting benefits from adopting energy management programs, such as lowering greenhouse gas (GHG) emissions and operating costs. EPA has also developed a downloadable, Excel-based Energy Audit Tool (EAT) that will allow small and medium drinking water and wastewater utilities to determine baseline energy consumption and

cost and highlight inefficiencies they may find useful in identifying energy improvement projects (EPA, 2012).

The NWP will continue to provide information on energy efficient and co-generation technologies in consultation with other federal agencies, principally the Department of Energy (DOE), and will continue to collaborate with the Office of Air and Radiation and other partners to improve existing tools (e.g., ENERGY STAR's Portfolio Manager) and develop new energy bench marking and auditing tools.

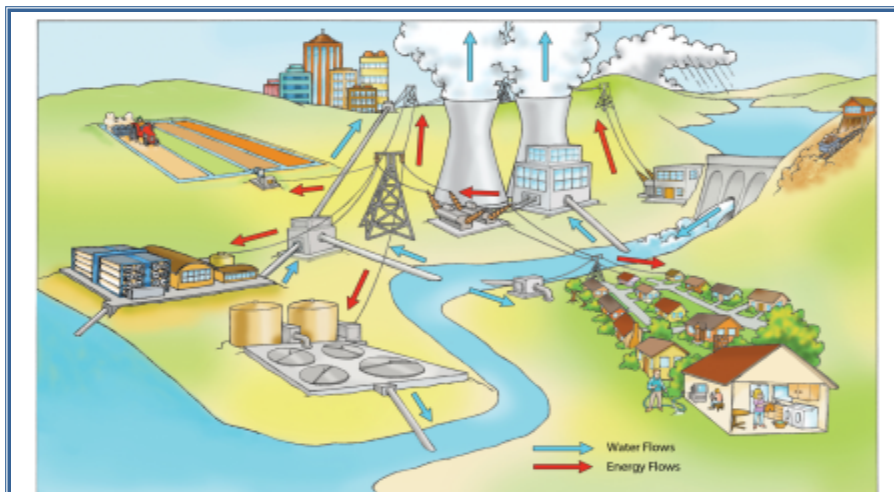


Figure 5. Water and Energy Nexus

Water and energy are intimately connected. Water is used by the power generation sector for cooling, and energy is used by the water sector for pumping, treatment and heating. Without energy, there would be limited water distribution, and without water, there would be limited energy production. Image credit: U.S. Global Change Research Program (www.globalchange.gov).

Strategic Action 3: *The NWP will explore climate change challenges to drinking water safety and assist public water systems, particularly small systems, in meeting health-based drinking water standards.*

The NWP will continue working to enhance partnerships to improve water sector understanding of climate change adaptation options and identify technical assistance activities to help water systems comply with National Primary Drinking Water Regulations (NPDWRs) under changing climate conditions.

CRWU will focus in particular on developing tools for smaller systems. While larger utilities tend to have the resources to engage technical experts for assistance with operations, management and decision support for climate change, smaller utilities have fewer resources. Building capacity requires providing tools and assistance tailored to smaller utilities, including tools that will prepare them to adapt to the changing climate. CRWU climate change adaptation tools will augment the capacity development efforts of the EPA drinking water program to address small system challenges affecting sustainability, compliance, and day-to-day operations. The NWP will also encourage partnerships between water systems to ensure water systems are able to avoid disruptions and consistently provide safe drinking water to their customers.

Strategic Action 4: *The NWP will collaborate with partners to promote sustainable design approaches to ensure the long-term sustainability of infrastructure and operations.* The OW is developing a handbook of information to help utilities incorporate sustainability considerations into their planning. The handbook will focus on key elements of planning such as aligning utility sustainability goals with other community priorities in areas like housing and transportation,

analyzing a range of infrastructure alternatives based on full life cycle costs including green and natural systems, and ensuring that a financial strategy, including appropriate rate structures, is in place to fund, operate, maintain, and replace the alternatives chosen. Energy efficiency and impacts associated with climate change can be considered throughout the elements described in the handbook.

OW is also working with EPA's Office of Community Sustainability and 3 states (New York, Maryland, and California) to identify actions that can be taken to integrate the principles of the HUD-DOT-EPA Sustainable Communities Partnership into their Clean Water SRF programs. Options these states are considering include changes to intended use plans, project priority systems, and other funding guidance documents. Some of these changes could potentially provide incentives for projects that are energy efficient (that also help reduce GHG emissions) and/or that potentially reduce vulnerability to climate impacts. Information on the results of these pilots will be shared with other state Clean Water and Drinking Water Programs.

GOAL 2: EPA programs support IWRM in the water utility sector to sustainably manage water resources in the face of climate change.

Federal and state water resource management and protection agencies can encourage water sector utilities to establish partnerships with each other and the private sector (e.g., energy, agriculture) in the context of an IWRM framework (referred to as integrated water management in NDWAC, 2010). IWRM among water utilities and other partners can increase community resilience to climate change and expand opportunities for watershed-wide adaptive actions. The NWP in consultation with other federal water agencies, states, interstates and Tribes will consider how best to coordinate assistance to support IWRM.

Water supply management and water demand management are IWRM practices to consider, particularly where confidence in the future reliability of water supply quality or quantity is diminishing (e.g., in drought prone, high growth, or coastal communities). The tools described below offer water sector utilities a range of methods to extend their water supplies.

Strategic Action 5: The NWP will seek opportunities to better understand and promote through technical assistance the use of water supply management strategies to increase hydrologic, ecologic, public health and economic benefit.

Aquifer Storage & Recovery (ASR) — The NWP will work to foster research on ASR practices that do not endanger underground sources of drinking water (USDWs). ASR is a process of storing water underground for future use. ASR is increasingly used where fresh water demand is beginning or projected to exceed supply and ASR is likely to increase in drought prone areas, particularly those affected by climate change. When applied to stormwater, this practice can also reduce nonpoint source pollution of our lakes, streams and rivers. However, the infiltration or injection of polluted stormwater risks contamination of fresh water aquifers.

Reclamation and Reuse — The NWP will continue to encourage safe water reclamation and reuse. A wastewater or stormwater utility could, for example, distribute reclaimed water from a centralized treatment system for park irrigation or other uses, recognizing that additional treatment would be required for some applications. Onsite residential reuse of gray water for landscape vegetation reduces the volume of potable water delivered to the site and the volume of wastewater discharged from the centralized wastewater treatment facility. Since outdoor and non-potable water uses typically can account for more than half of all water use, this technique offers significant potential to preserve fresh water resources as well as to reduce treatment costs and energy use (EPA, 2004), and can help address increased frequency, severity and duration of drought.

Water Loss Control — The NWP will provide technical assistance to reduce water loss from drinking water systems, building upon EPA's publication, Control and Mitigation of Drinking Water Losses in Distribution Systems (EPA, 2010d). Much of the estimated 880,000 miles of drinking water infrastructure in the United States has

been in service for decades and can be a significant source of water loss. The American Water Works Association (AWWA) estimated in Distribution System Inventory, Integrity and Water Quality that there are close to 237,600 water line breaks per year in the United States leading to about \$2.8 billion lost in yearly revenue (EPA, 2007).

Treated water that cannot be accounted for equates to lost revenue and requires more water to be treated, which requires more energy and chemical use, which drives up operating costs. A water loss control program improves infrastructure sustainability by reducing costs and maintaining or increasing revenue. A report by the California Public Utilities Commission (CA, 2011b) found after 5 years of research that repairing leaks in water distribution pipes offers the highest energy savings from nine water-related strategies assessed. Water loss control also protects public health by reducing potential distribution system entry points for pathogens (EPA, 2010c).

Desalination for Potable or Nonpotable Uses — Desalination to treat marine or brackish water is becoming increasingly important in certain locations and circumstances. Several coastal communities are piloting or using desalination plants to address increasing demand driven by population growth or drought. These practices are increasing for inland sources for similar reasons or where water sources have been depleted. However, desalination is energy intensive and there may be risks and costs associated with disposing of waste brines from the

**Water Reuse and Recycling:
Examples of inter-utility IWRM in the
Metropolitan Water District of Southern
California**

- **Orange County, California** recycles 70 million gallons per day (MGD) of sewage thru a \$481 million treatment plant (NY Times, 2007) as part of a Ground water Replenishment System (OCWD, 2008).
- **The City of Hemet, CA** in the Eastern Municipal Water District provides recycled water to supply public parks and golf courses throughout the southland (MWDSC, 2008).
- **The Hill Canyon Water Treatment Plant (WTP)** releases recycled water for agricultural irrigation under an exchange agreement between Calleguas MWD and United Water Conservation District (MWDSC, 2008).
- **The Thousand Oaks, Tapia** WTP supplies recycled water to two municipal water districts (MWDs) for municipal and agricultural irrigation (MWDSC, 2008).

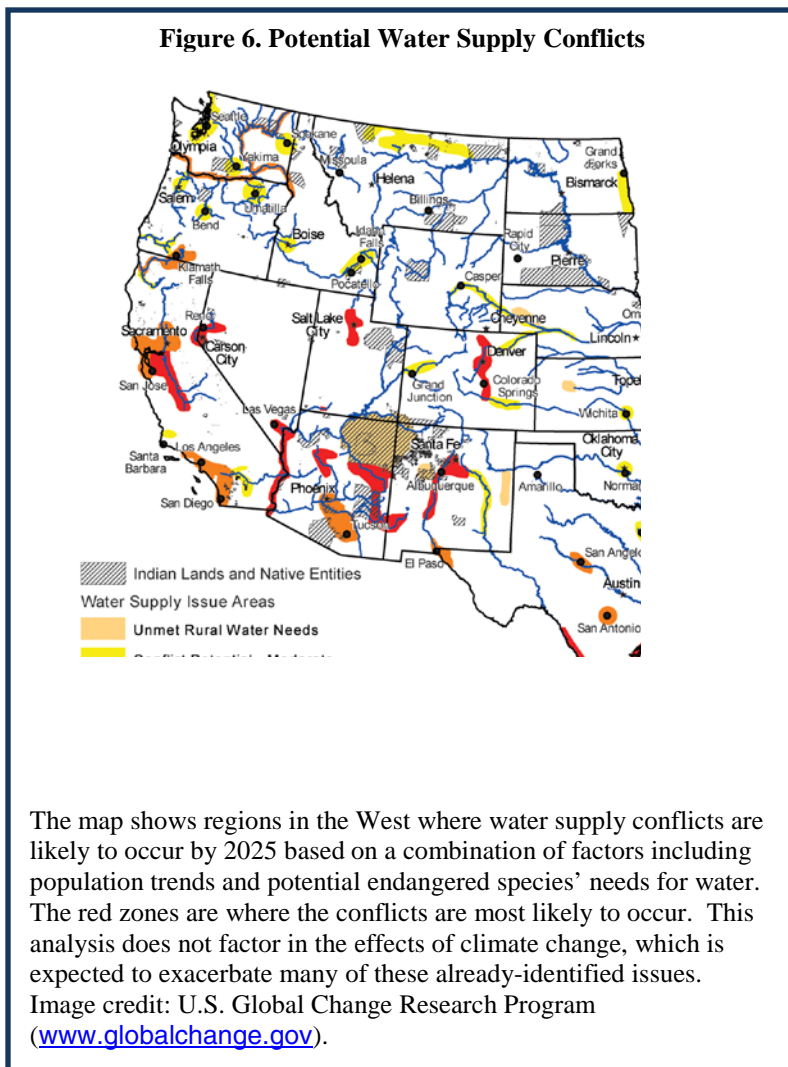
treatment. The NWP will monitor research developments to understand where efforts may be needed to ensure that the disposal of waste brines do not endanger underground sources of drinking water.

Strategic Action 6: *The NWP will seek opportunities to evaluate, and provide technical assistance on, the use of water demand management strategies to increase hydrologic, ecologic, public health and economic benefits.*

Water demand management reduces consumption by providing information, technology and incentives for consumers and industry to use less water. Water demand management calls for consumer education about the full cost of water services. To be sustainable, water utilities must be able to price water to reflect the full cost of treatment and delivery, as well as the cost of protecting water supplies.

Metering and Metrics — The NWP will support the Water Workgroup of the ICCATF by working with other federal water agencies to develop sector specific water use efficiency metrics, and the NWP will continue seeking opportunities to assist water utilities in developing and deploying water metering technologies. Measuring water use enables development of conservation pricing as well as metrics for water use efficiency. Service-connection metering informs customers about how much water they are using, and suppliers use metering to track water use and billing.

Water Use Efficiency & WaterSense — *WaterSense* is an EPA-sponsored voluntary partnership to protect the future of our nation's water supply by bringing together local water utilities and governments, product manufacturers, retailers, consumers and other stakeholders to decrease indoor and outdoor non-agricultural water use through more efficient products and practices. *WaterSense* helps consumers make water-efficient choices and encourages innovation in manufacturing by standardizing rigorous certification criteria that ensure product efficiency, performance and quality (EPA, 2011f). These savings at the consumer level translate



to significant direct savings in operations and maintenance costs, and indirect savings in infrastructure replacement costs, for drinking water and wastewater utilities. EPA will continue to develop specifications for water efficient products, encourage water efficiency in building operations and codes, and educate the public on the value of water use efficiency through its *WaterSense* program.

WaterSense has helped consumers save 125 billion gallons of water and \$2 billion in water and energy bills since 2006. By the end of 2010, WaterSense had partnered with more than 2,100 organizations and professionals, and more than 3,200 plumbing products had earned the WaterSense label. (EPA, 2011e).



Water Pricing— The funding for daily operation and maintenance and long-term capital investments for drinking water and wastewater systems are typically generated through user fees. When measured as a percentage of household income, the U.S. pays less for water and wastewater bills than other developed countries. Because of this, there is a perception that water is readily available and water services are generally inexpensive. To meet our current and future infrastructure needs, public education on water sector system operations and costs as well as private water conservation is needed.

Pricing of water services should accurately reflect the true costs of providing high-quality water and wastewater services to consumers in order to both operate and maintain infrastructure and plan for upcoming repairs, rehabilitation, and replacement of that infrastructure. Drinking water and wastewater utilities must be able to price water services to reflect these costs.

There is an extensive body of knowledge on pricing water services and helping consumers learn about how pricing affects their community. EPA will continue to seek opportunities to work with our utility and state partners in identifying revenue templates that provide sufficient resources for infrastructure operations, maintenance, rehabilitation, and replacement; and send the right market signals about water use.

Strategic Action 7: *The NWP will work to increase cross-sector knowledge of water supply climate challenges and develop watershed specific information to inform state, interstate, tribal and local decision making.*

State and local governments and their constituents need to understand the nature and extent of the water challenges they face to make decisions to address them. The NWP will work with federal and state science agencies and academia to develop location specific information about climate change impacts for different sectors in each watershed and aquifer. For example, EPA is participating with other federal and state water agencies and stakeholders in planning DOI's National Water Census as well as its *WaterSMART* program to promote the efficient use of water (USBR, 2011). The NWP will also expand its effort to collaborate with the U.S. Army Corps of Engineers as it fosters "collaborative relationships for a sustainable water resources future" (USACE, 2010a) including development of a Federal Support Toolbox to provide a common data portal to support IWRM (USACE, 2010b).

B. Watersheds and Wetlands

VISION: *Watersheds are protected, maintained and restored to ensure climate resilience and to preserve the ecological, social and economic benefits they provide; and the nation's wetlands are maintained and improved using integrated approaches that recognize their inherent value as well as their role in reducing the impacts of climate change.*

Healthy watersheds and wetlands will be critical to climate adaptation and mitigation. This section addresses how EPA will ensure protection of healthy watersheds, restore impaired watersheds to enhance climate resiliency and preserve the important functions and ecosystem services provided by the nation's wetlands especially in the face of climate change.

Healthy watersheds and wetlands provide a host of ecological services, including water purification, ground water and surface flow regulation, wildlife habitat, flood and surge impact reduction, water temperature moderation, erosion control, and stream bank stabilization. They also store carbon and sequester other greenhouse gases. These ecosystems already are threatened with a number of stressors, and climate change will exacerbate existing water quality and ecosystem management issues.

“The once seemingly separable types of aquatic ecosystems are, we now know, interrelated and interdependent. We cannot expect to preserve the remaining qualities of our water resources without providing appropriate protection for the entire resource.”

Tennessee Senator Howard Baker on the importance of the Clean Water Act on the Senate floor, 1977

“I ask that your marvelous natural resources be handed on unimpaired to your posterity..”

Theodore Roosevelt, Sacramento, CA 1903

GOAL 3: *Identify, protect, and maintain a network of healthy watersheds and supportive habitat corridor networks across the country that provide resilience to climate change.*

EPA, in partnership with others, is embarking on the Healthy Watersheds Initiative to expand our efforts to protect healthy aquatic ecosystems using a strategic systems-based approach, prevent them from becoming impaired, and accelerate restoration (EPA, 2011g). This Initiative will greatly enhance our ability to meet the full intent and extent of the CWA 101(a) objective, “...to restore and maintain the chemical, physical, and biological integrity of the Nation's waters,” and in doing so, will increase the climate resiliency of aquatic ecosystems and their watersheds. This goal would be difficult to achieve without working with our partners and their programs, such as the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service's (NMFS) National Fish Habitat Action Plan, the U.S. Forest Service's (USFS) watershed protection and restoration programs, the full suite of conservation programs administered by USDA, the U.S. Geological Survey's (USGS) Water Smart Initiative, the Nature Conservancy's Instream Flow and North America Freshwater Conservation Programs, the U.S. Army Corps of Engineers, and others.

The Healthy Watersheds approach is an important component of integrated water resource management (IWRM). IWRM offers a more holistic approach to water quality protection by addressing surface water and ground water quality and quantity as one hydrologic system. As implementation of the Healthy Watersheds approach increases our understanding of some of these relationships (e.g., hydrologic requirements of aquatic ecosystems), that knowledge will provide building blocks for the foundation of IWRM.

Integrated Water Resources Management

"Successful adaptation and mitigation of climate change impacts will require a coordinated effort among all levels of government, tribes, communities, nongovernmental groups, scientific entities and the private sector - that is, Integrated Water Resources Management. These voluntary partnerships will be essential to protecting and restoring watersheds, wetlands and coastal areas."

❖ Nancy Stoner,
Acting Assistant Administrator,
EPA Office of Water, 2011

Strategic Action 8: The NWP will develop a national framework and will support state and tribal efforts to protect a national network of remaining healthy watersheds and aquatic ecosystems, including natural infrastructure for habitat corridors.

A national framework will include indicators to assess, identify, and track healthy watersheds and the success of protection measures. The NWP will support state and tribal efforts to conduct state-wide and tribal lands integrated healthy watersheds assessments that include landscape condition (i.e., habitat corridor and floodplain connectivity and headwaters habitat intactness), hydrology, fluvial geomorphologic processes, and aquatic biology, habitat, and chemical condition. The NWP will also support state and tribal efforts to implement programs aimed at protecting and maintaining healthy, resilient watersheds and habitat.

The NWP will work with partners to develop and pilot watershed projects and management practices that improve the resilience of healthy watersheds to climate change, including the demonstration of methods that preserve and protect natural hydrology, intact active river areas (TNC, 2008), aquatic habitat corridors, natural transport of sediment, and stream geomorphology. The NWP will work to provide technical decision support to local and regional planning commissions and governments for implementing programs to protect identified watersheds in the face of climate change, consistent with the IWRM objective of the ICCATF.

Strategic Action 9: The NWP will collaborate with partners having authorities to give attention to terrestrial ecosystems and hydrology so that their effects on water quality and aquatic ecosystems are considered when dealing with climate change impacts.

Among the multitude of services derived from intact forests are protection of water resources and sequestration of carbon. The NWP will continue collaborating with partner agencies (including the ICCATF Fish, Wildlife and Plants Climate Adaptation Workgroup) to support their management objectives that maximize the adaptive capacity of ecosystems (e.g., through the protection of biodiversity, functional forest groups, keystone species, and protection against invasive species) resulting in reduced vulnerability to disturbance and associated impacts to aquatic ecosystem integrity. In particular, the NWP will actively support and promote appropriate forest protection efforts, afforestation (new plantings) and reforestation (replanting of deforested areas) of non-forest lands, and will promote and explore partnerships with working lands, land

retirement, and forestry programs within other Federal Agencies such as those administered by the US Forest Service and USDA's Natural Resources Conservation Service and Farm Service Agency.

For example, to date, EPA has been working directly with US Forest Service staff in the State and Private Forestry program to promote the use of afforestation and reforestation as a component of green infrastructure, especially as it pertains to water quality protection and stormwater management. EPA has already co-developed a draft manual describing engineered approaches to afforestation and reforestation for stormwater management and has been working through the National Arbor Day Foundation to disseminate this information to arborists, local and state forestry officials, and tree planting volunteers. EPA intends to continue working with USFS and partners such as the National Arbor Day Foundation to support these types of outreach efforts and broaden them to address the backlog of one million acres of national forests that the Forest Service has identified as needing replanting.

EPA has also contributed funds to USFS staff working in the Chesapeake Bay Program office in order to start up a Web-based forestry stewardship program targeting small landowners. A geo-referenced stewardship planning tool has been developed in partnership with the Pinchot Institute, and is operational for three Mid-Atlantic States. The tool allows private landowners to enter information characterizing landownership in order to obtain information about available federal and state programs that encourage afforestation and reforestation while providing economic benefits. Efforts are underway to expand the coverage of this tool nationwide.

Strategic Action 10: The NWP will work to integrate protection of healthy watersheds throughout the NWP core programs.

Strategies that build resilience to climate change include incorporating healthy watershed protection priorities into states' continuing planning process, promoting green infrastructure for managing stormwater, implementing the section 404 wetlands compensatory mitigation rule, incorporating protection of healthy watersheds into funding and technical assistance programs, working with tribes, and strengthening strategic partnerships throughout EPA and the federal government, including smart growth strategies. EPA will encourage permitting authorities to use stormwater permits, as appropriate, to increase watershed resilience; for example, where increased use of green infrastructure or reductions in impervious cover can both address water quality issues and increase resilience to climate change. EPA will work with states to use the continuing planning process to develop and implement healthy watershed protection and restoration priorities.

Strategic Action 11: Increase public awareness of the role and importance of healthy watersheds in reducing the adverse impacts of climate change.

The critical ecological services watersheds and wetlands provide often go unrecognized by the public. Raising public awareness of the importance of protecting healthy watersheds will ensure that there is public support for actions needed to sustain these resources in the face of climate change.

The NWP will develop and implement public outreach programs emphasizing the importance of healthy watersheds, including the economic benefits of protecting and restoring watersheds, wetlands, floodplains, and riparian areas. The climate-induced risks to aquatic ecosystems, and the associated need to enable ecosystem migration, will be further articulated to build support for action. (See for example EPA, 2011h.)

GOAL 4: Incorporate climate resilience into watershed restoration and floodplain management.

Watershed restoration and a watershed approach to floodplain management focus on re-establishing the composition, structure, pattern, and ecological processes of degraded or altered aquatic ecosystems necessary to make them sustainable, resilient, and healthy under current and future conditions. Incorporating climate change factors into planning efforts will be needed to ensure that watershed strategies are successful over the long term.

Strategic Action 12: The NWP will consider a means of accounting for climate change in EPA funded watershed restoration projects and encourage others funding restoration projects to take climate change and resiliency into consideration.

In partnership with other federal, state, interstate and local water sector actors, the NWP will clarify and encourage implementation of existing investment flexibilities to support investments in climate resiliency in watershed restoration approaches, source water protection, green infrastructure, and joint partnerships, consistent with authorizing legislation.

Strategic Action 13: The NWP will work with federal, state, tribal, and local partners to protect and enhance buffers to rivers, streams, lakes, wetlands and coastal resources as a means of building resiliency and protecting water quality.

Buffer areas provide for flood attenuation, allow potential shoreline and lateral stream movement, modulate water level fluctuations, and minimize impacts on infrastructure. The NWP will work with partners to enhance the use of buffers to build resilience. The NWP will also promote and support the use of non-structural, green infrastructure approaches to floodplain management, and discourage the use of structural measures (e.g., stream channelization and levees), where appropriate.

GOAL 5: Watershed protection practices incorporate source water protection, and vice versa, to protect and preserve drinking water supplies from the effects of climate change.

Protecting public health from contaminants in drinking water will require adapting to the impacts of climate change which poses multiple concerns for public water systems. Warmer waters foster pathogen growth, testing the reliability of drinking water disinfection. Increased precipitation may result in additional pollutant loadings of nutrients, pesticides, and other chemicals, further challenging drinking water treatment. Sea level rise in coastal areas puts fresh water supplies for all uses, particularly drinking water, at increasing risk. Salt water intrusion into coastal aquifers is a problem in some areas where withdrawals are outstripping recharge; increased pressure head from a higher sea-level worsens this problem. As sea level

rises, community drinking water intakes may end up in brackish waters as the salt front migrates up coastal rivers and streams.

Strategic Action 14: The NWP will encourage states to consider updating their source water delineations, assessments or protection plans to address anticipated climate change impacts.

NWP program staff will continue working to assure that states include protecting and preserving drinking water supplies (ground water and surface water) in watershed planning and protection programs. States should consider the feasibility and value of periodically updating their source water protection areas and protection plans in concert with state watershed plan updates to address anticipated climate change impacts. EPA and its federal partners will, explore opportunities for providing technical assistance to states as they update their source water delineations, assessments and protection plans to address anticipated climate change impacts.

Strategic Action 15: The NWP will continue to collaborate with stakeholders to increase state and local awareness of source water protection needs and opportunities and encourage inclusion of source water protection areas in local climate change adaptation initiatives.

There are many players who influence the effectiveness of source water protection at the national, state, interstate, tribal and local levels such as water science and regulatory agencies, water sector utility operators, local decision makers and stakeholders. Acting individually they may affect aspects of source water protection and preservation but collaborating on the same watersheds and aquifers increases the potential to protect and preserve those resources. The NWP will work to foster increased collaboration to develop decision support tools to inform deliberations at the local and watershed or aquifer scale.

GOAL 6: EPA incorporates climate change considerations into the CWA 404 regulatory program as they relate to permit reviews and compensatory mitigation.

Since 1989, the Federal government as a whole has embraced a policy goal of no net loss of wetlands under the CWA Section 404 regulatory program. In addition, the program operates under a goal of a net increase in the quality and quantity of the nation's wetlands. EPA's Wetlands Program fosters effective wetlands management through strategic partnerships with States, Tribes, local governments, and other partners. Key to accomplishing these goals and actions is a watershed approach to aquatic resource protection.

Section 404 of the CWA establishes a program to regulate the discharge of dredged or fill material into waters of the U.S., including wetlands. Activities in waters of the U.S. typically regulated under this program include fill for development, water resource projects (e.g., dams and levees), infrastructure development (e.g., highways and airports) and mining projects. Section 404 requires either a permit from the U.S. Army Corps of Engineers (USACE) or an EPA-approved state program before dredged or fill material may be discharged into waters of the U.S.

One basic requirement of the CWA Section 404 permitting program, as implemented by 404(b)(1) Guidelines, is that no discharge of dredged or fill material into wetlands may be permitted if a practicable alternative exists that is less damaging to the aquatic environment or if the nation's waters would be significantly degraded. Significant degradation is broadly defined in the 404(b)(1) Guidelines to include individual or cumulative impacts to human health and welfare; fish and wildlife; ecosystem diversity, productivity and stability; and recreational, aesthetic or economic values.

Strategic Action 16: The NWP will consider the effects of climate change as appropriate when making significant degradation determinations in the CWA Section 404 Wetlands Permitting and Enforcement Programs.

In light of the growing concerns regarding the adverse effects of climate change and the recognition that protecting the Nation's wetlands and other aquatic resources can help to mitigate these effects, EPA will coordinate with USACE to better understand how climate change may impact Section 404 sites and if/how the systematic consideration of climate change impacts could be incorporated into decision processes (including minimization and compensatory mitigation practices) in a scientifically defensible way. EPA's Section 404 permit review process also includes determining if there would be a "substantial and unacceptable" impact to Aquatic Resources of National Importance (ARNI), as provided in Part IV of the 1992 CWA Section 404(q) Memorandum of Agreement (MOA) between EPA and the Department of the Army, often called the elevation procedures. Criteria used for identifying an ARNI could potentially consider the chemical, physical, and biological importance, in light of climate change, of an aquatic resource proposed to be impacted. In partnership with USACE, the NWP will also consider how to incorporate the anticipated effects of climate change as appropriate when determining whether impacts are "unacceptable" (e.g., where discharges would result in harm to wetlands critical to storm surge reduction).

Strategic Action 17: The NWP will evaluate, in conjunction with relevant Federal Agencies when applicable, including USDA, USFWS, and the USACE, how wetland and stream compensation projects could be selected, designed, and sited to aid in reducing the effects of climate change.

Consistent with established regulatory policy, impacts must be compensated for "to the extent appropriate and practicable" after they are avoided and minimized to the greatest extent practicable. As an example, in order to offset permitted impacts, the Corps typically requires between 40,000–50,000 acres of compensatory mitigation annually. This compensation takes the form of restored, created, enhanced and/or preserved complexes of wetlands and streams. EPA, in conjunction with the Corps, will consider how these wetland and stream compensation projects could be selected, designed and sited to aid in reducing the impacts of climate change with a focus on analyzing climate change and associated relative sea level change for coastal mitigation projects. For example, certain types of wetlands mitigation projects might be encouraged in the future because of their scientifically assessed relative carbon sequestration benefits or because siting mitigation projects in coastal zones would facilitate wetland migration as sea level rises while also enhancing the natural lines of defense ("resilience") of the coastline

and community, and creating public green space which enhances the livability and sense of place of the community.

GOAL 7: EPA improves baseline information on wetland extent, condition and performance to inform effective adaptation to climate change.

Baseline information on the location, extent and quality of wetlands and aquatic resources will help to measure changes caused by climate change and other stressors. Ongoing monitoring will inform the development of predictive models and management strategies including for climate change adaptation.

Strategic Action 18: The NWP will expand wetland mapping by supporting wetland mapping coalitions and training on use of the new Federal Wetland Mapping Standard.

While agency conclusions should be informed by detailed, accurate data sources, the existing National Wetland Inventory (NWI) mapping, managed by the USFWS, is a good initial guide about potential wetlands in an area/watershed and is used extensively, including to address the effects of climate change (e.g., modeling relative sea level rise).

“Wetlands are inextricably tied to water levels, and changes in climatic conditions affecting water availability will greatly influence the nature and function of specific wetlands, including the type of plant and animal species within them.”

❖ Secretary of the Interior Ken Salazar, announcing availability of the new wetland mapping standard.
August 18, 2009

The NWI maps were innovative when first produced, but additional work is now needed to update these maps to make them current and to better satisfy the demands for sophisticated analysis that supports effective environmental planning. Hardcopy maps are available for approximately 4/5 of the Nation, and approximately half of the NWI is available online for use in geographic information system (GIS) applications. However, a significant portion of the arid West has not yet been mapped.

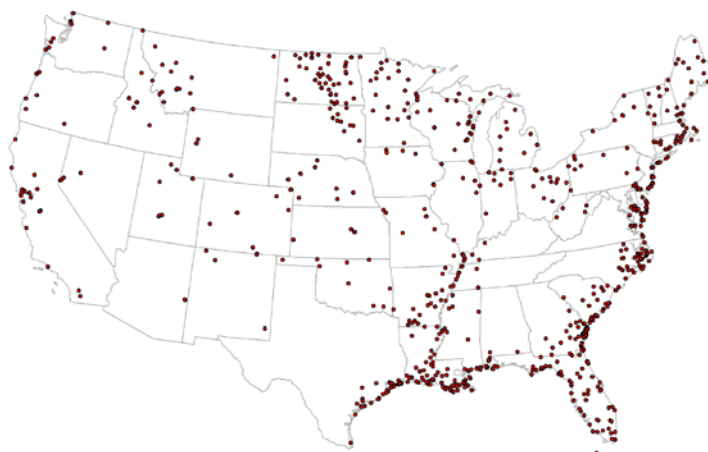
The modernized Wetlands Mapping Standard was developed by the interagency Federal Geographic Data Committee (FGDC), in collaboration with representatives of federal agencies, states, tribes, environmental organizations, management associations, as well as local government associations from both the wetlands and geospatial communities. The Wetland Mapping Standard was developed to improve and standardize mapping data quality in order to accelerate the rate at which the national wetlands mapping is completed and to enable real-time updates of the national wetlands data layer in the future. Using the new Standard, other groups, such as states, tribes, local governments, and non-governmental organizations, are able to collect and upload digitally mapped data to the NWI. EPA and other federal agencies will train and support a range of organizations to complete the national map.

Strategic Action 19: The NWP will produce a statistically valid, ecological condition assessment of the nation's wetlands.

The National Wetland Condition Assessment (NWCA) will be an integrated gauge of wetland condition nationwide, summarizing the cumulative effects of federal, state, tribal, and local government and private-party actions that either degrade wetlands or protect and restore their ecological condition. The NWCA will be repeated at the national scale every five years, and will incorporate those indicators that EPA identifies as most meaningful to detecting and predicting the impacts of climate change on the condition of the nation's wetlands.

EPA worked closely with the USFWS Wetlands Status and Trends program to utilize their network of analysis plots as the sampling frame for the NWCA. When these efforts are paired, we will for the first time be able to measure progress toward the national goal to increase the quantity and quality of the nation's wetlands (Figure 7).

Figure 7. National Wetland Condition Assessment Site Locations



Approx. 1,000 randomly selected wetland sites sampled in 2011.
National Wetland Condition Assessment, EPA, 2011n.

Wetland quality or condition speaks to how wetlands differ from their “natural” state, providing an assessment of the overall ecological integrity of the resource and the relative status of wetland processes, such as the ability of a wetland to absorb nutrients. In addition, the NWCA will identify the stressors most associated with degraded wetland condition because they provide insights into the causes of declining wetland quality.

C. Coastal and Ocean Waters

VISION: *Adverse effects of climate change along with collective stressors and unintended adverse consequences of responses to climate change have been successfully prevented or reduced in the ocean and coastal environment. Federal, tribal, state, and local agencies, organizations, and institutions are working cooperatively; and information necessary to integrate climate change considerations into ocean and coastal management is produced, readily available, and used.*

Coastal and ocean environments are inextricably linked, both spatially and ecologically. This section borrows the concept of the “baseline” (a legal demarcation of ordinary low tide levels that also crosses river mouths, the opening of bays, and along the outer points of complex coastlines) to facilitate the discussion of strategies that may be more applicable to coastal environments (which we loosely define as being on the landward side of the baseline) or ocean environments (seaward of the baseline). The baseline may affect climate change strategies

because of its jurisdictional implications. However, although the terms “coastal” and “ocean” are used primarily to organize this discussion, we recognize that those domains grade into each other and that some strategies may be appropriate on both sides of the baseline.

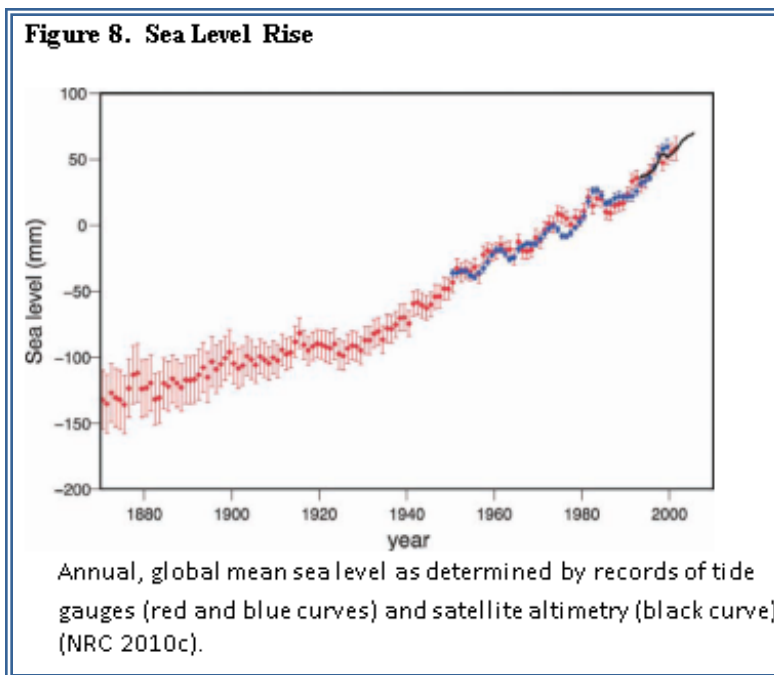
As in other regions, coastal areas will face challenges to wetlands, watersheds, infrastructure, water quality, and drinking water. Some coastal problems, such as nonpoint source pollution and changing precipitation patterns, have the same causes and effects that are found in inland places.

However, the ocean and coasts will experience unique impacts that the rest of the United States will not. Sea level rise is already a multi-faceted problem that is worsening (Figure 8). Coastal wetlands and other estuarine habitats are being inundated or eroded, and many will not be able to sustain themselves as sea levels continue to rise. The potential for ocean acidification to damage the marine food chain, shellfish, and coral is another issue unique to the coastal and ocean environment.

Coastal regions will also experience saltwater intrusion into ground water aquifers, the threats of rising seas to drinking water and wastewater infrastructure, and the effects of varying stream flow on estuarine salinity and ecology.

Scientific research over the last 10 years indicates that the implications of ocean acidification (OA) for ocean and coastal marine ecosystems are potentially very serious since the ocean has a large capacity to absorb CO₂ from the atmosphere, and that the resulting lowered pH levels in ocean waters can have serious cascading effects. In its 2010 report, “*Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean*,” the National Research Council (NRC, 2010f) concludes that ocean chemistry is changing at an unprecedented rate and magnitude due to human-made CO₂ emissions, and that there will be “ecological winners and losers.” The report also states that “while the ultimate consequences are still unknown, there is a risk of ecosystem changes that threaten coral reefs, fisheries, protected species, and other natural resources of value to society”.

Climate change impacts will in some respects be one more stressor that EPA’s partners and programs will try to absorb or accommodate into their practices and portfolios. It will be important for EPA and the NWP to avert or resolve as many of the foreseeable climate adaptation problems as possible, while also preventing harm from responses to climate change that inadvertently increase vulnerability rather than reducing it.



However, in some parts of the country, such as parts of the Pacific Northwest, sea level rise is negated by coastal uplift. Such relative sea level decreases can offset absolute sea level rise and present benefits that enhance wetland preservation in coastal zones.

How others respond to the inevitable climate change impacts on coastal and ocean waters will have a large impact on EPA's ability to achieve or fulfill its mission. EPA will have to cooperate with other interested parties and work to enhance the adaptive capacity of our partners to effectively meet the coming 21st century environmental tests. We will need to work in close concert with local, state, tribal, and regional organizations and other federal partners through the wide range of existing programs and partnerships like the National Estuary Program (NEP), Large Aquatic Ecosystems (LAE), Great Waterbodies, and regional ocean groups. Working cooperatively with Canada and Mexico will also be critical if we are to be successful in near ocean environments.

Integrated Water Resources Management

As changing climates affect the decisions of dam managers, coastal issues will be one more consideration. Managers are already balancing competing demands for ecological functions, water supply in reservoirs, water supply for downstream users, and power generation. Flows passing downstream have an effect on sediment delivery to coastal systems, the salinity structure of coastal estuaries, and how far upstream the salt front can push.

The management of coastal waters will need an IWRM perspective. The diversion of fresh surface water to recharge coastal aquifers is one issue. Where desalination is implemented to provide fresh water, discharging or disposing of residual brines will also need attention.

GOAL 8: The NWP works collaboratively with partners to ensure that the information and methodologies necessary to address climate change in ocean and coastal areas are collected or produced, analyzed or formatted, promoted, and easily available.

Protecting coastal and ocean environments from the impacts of climate change will require policy makers and managers to be informed to make effective decisions. As the problems of climate change emerge and multiply, the need for knowledge will become even more pressing. Further, the NWP and our partners will need to know where to find the necessary information and tools. Agencies cannot afford to duplicate efforts, and will need to work together to improve efficiency and leverage limited resources.

Strategic Action 20: To protect ocean and coastal areas, the NWP will collaborate within EPA and with other federal, tribal, and state agencies to ensure that synergy occurs whenever possible, that lessons learned are transferred, that federal efforts effectively help local communities and that they are not duplicative or working at cross-purposes.

Ensuring that lessons learned are transferred between the many partner federal agencies will maximize the utility and accessibility of new information and methodologies needed by tribal, state, and local communities to effectively prepare for climate change impacts.

Some federal agencies have already formalized cooperative mechanisms through written agreements. For example, EPA and the NOAA have signed a Memorandum of Agreement

(MOA) to work together on climate adaptation, resilience, and smart growth efforts. In the New England region, a “Statement of Common Purpose” exists between federal agencies working together on climate change adaptation and mitigation, and coastal and marine spatial planning. Similar agreements to coordinate with other federal agencies in the coastal zone would also be helpful, such as many DOI agencies (e.g., USGS, National Park Service (NPS), USFWS, and Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMR)), as well as Federal Emergency Management Agency (FEMA), USACE, Department of Transportation (DOT), and the Department of Agriculture (among others).

Strategic Action 21: The NWP will work within EPA and with the U.S. Global Change Research Program and other federal, tribal, and state agencies to be sure that knowledge and information needed to protect ocean and coastal areas is collected or produced, analyzed or formatted for users, and easily available.

The NWP will work within EPA, with the U.S. Global Change Research Program (USGCRP), and with other federal, tribal, and state agencies to make sure this knowledge and information is produced to inform decision making, and that it is made available in user-friendly formats through compendiums, web sites, and clearinghouses. Information needed that is specific to coastal and ocean planning includes:

- Projections of relative sea level change at finer scales, including Light Detection and Ranging (LIDAR) land elevations;
- Information on ocean acidification and warming;
- Monitoring of environmental effects and system thresholds specific to the coastal and marine environments; and
- Improvements in the ability to quantify real reductions of CO₂ due to salt marsh and coastal restoration.

EPA’s Large Aquatic Ecosystem Programs

- ❖ Chesapeake Bay Program
- ❖ Columbia River Basin
- ❖ Great Lakes
- ❖ Gulf of Mexico Program
- ❖ Lake Champlain Basin Program
- ❖ Long Island Sound Study
- ❖ Pacific Islands Office
- ❖ Puget Sound - Georgia Basin
- ❖ San Francisco Bay Delta Estuary
- ❖ South Florida Geographic Initiative

EPA will continue to share similar information through portals such as ocean.data.gov and federal climate clearinghouses such as the one under development by the USGCRP.

GOAL 9: Support and build networks of local, tribal, state, regional and federal collaborators that are knowledgeable about climate change effects and take effective adaptation measures for coastal and ocean environments through EPA’s geographically targeted programs.

A primary role of the federal government will be to work within our existing networks to build adaptive capacity at the regional, state, tribal, and local levels.

Strategic Action 22: The NWP will work with the NWP's larger geographic programs to incorporate climate change considerations focusing on both the natural and built environments.

Geographically-based programs in which EPA participates include ten Large Aquatic Ecosystems (LAEs), Regional Ocean Partnerships, and regional planning bodies established under the NOC. The NWP will work to ensure that these key geographic programs have the tools necessary to consider climate change effects in their plans and programs. EPA regional and geographic program offices and the Council of LAEs will all play key roles addressing climate change impacts to both the natural and built environments when making policies or decisions, and will work to ensure that best practices and lessons-learned from local projects are widely shared.

The NWP will continue working with Regional Ocean Partnerships that undertake planning for resiliency. According to the Coastal States Organization's web site, "[t]here is an ever-growing recognition that multi-state, regional approaches are one of the most effective and efficient ways to address many of our ocean and coastal management challenges. To meet these challenges, governors around the country have voluntarily established Regional Ocean Partnerships and are working in collaboration with federal agencies, tribes, local governments, and stakeholders to identify shared priorities and coordinate ocean and coastal management on a regional basis. While each partnership is unique in terms of its region's issues and concerns, they all share a desire for more effective management of ocean and coastal resources. This includes balancing ecological and economic needs, and addressing climate change, through such approaches as ecosystem based management, and coastal and marine spatial planning." [CSO, 2011]

Regional Ocean and Great Lakes Partnerships

- ❖ Great Lakes Regional Collaboration
- ❖ Governors' South Atlantic Alliance
- ❖ Gulf of Mexico Alliance (GOMA)
- ❖ Mid-Atlantic Regional Council on the Ocean (MARCO)
- ❖ Northeast Regional Ocean Council (NROC)
- ❖ West Coast Governors' Agreement on Ocean Health

The NWP will also collaborate with the National Ocean Council's Regional Planning Bodies established under the National Ocean Policy's framework for effective coastal and marine spatial planning (CMSP) (see Executive Order 13547, Stewardship of the Ocean, Our Coasts, and the Great Lakes). The regional planning bodies will implement the framework for CMSP, leading to the eventual development of regional coastal and marine spatial plans (CMS Plans) which will guide and inform agency decision-making under existing statutory authority. The NWP will inform the CMSP process and the development of CMS Plans to implement two Priority Objectives: (1) Coastal and Marine Spatial Planning (CMSP) (which is driven in some areas by the demand for offshore renewable energy development), and (2) Resiliency and Adaptation to Climate Change and Ocean Acidification.

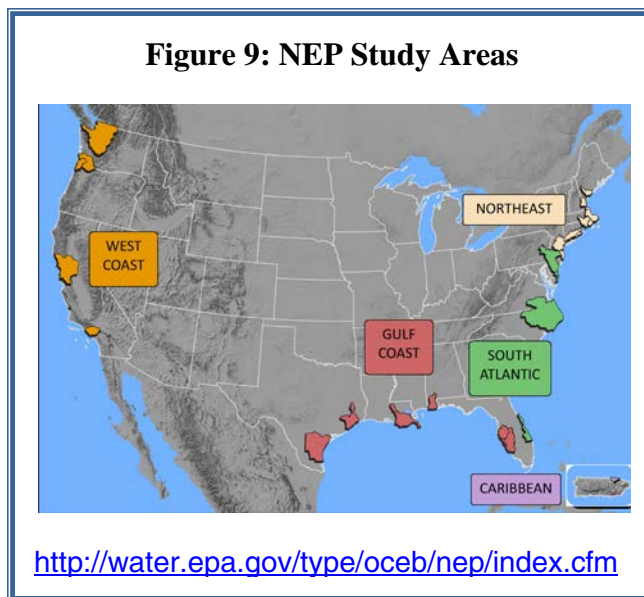
Strategic Action 23: Address climate change adaptation and build stakeholder capacity when implementing NEP Comprehensive Conservation and Management Plans and through the Climate Ready Estuaries Program. Each Program will build its stakeholders' adaptive capacity through funding, technical assistance, and coordination.

The 28 NEPs around the country improve the quality of estuaries of national significance through community-based programs. NEPs are strategically positioned to build the adaptive capacity of stakeholders because they work directly with and within communities. In fact, many of the NEPs have specific goals in their Comprehensive Conservation and Management Plans (CCMPs) addressing climate change adaptation.

The Climate Ready Estuaries (CRE) program, which is jointly administered by EPA's OW and Office of Air and Radiation, provides funding or direct technical assistance to help NEPs complete climate change vulnerability assessments and to build their adaptive capacity to respond to climate change. CRE will continue to expand its information and guidance offerings and to develop and share the lessons learned from its sponsored projects. Incorporating CRE tools and methods into the NEP base programs by mainstreaming climate change adaptation into planning documents (e.g., CCMP or annual work plans) will ensure that climate change is considered by all NEPs, and will help to prepare communities to respond to climate change impacts. Many other organizations also manage coastal and ocean resources in or near NEP watersheds, so CRE will work collaboratively with other EPA programs (e.g., CRWU), federal agencies (e.g., NOAA's National Estuarine Research Reserves and Sea Grant and USDA's conservation planning activities), land trusts, and other non-profit coastal organizations to build mutually supportive networks.

Strategic Action 24: The NWP will conduct outreach and education, and provide technical assistance to state and local watershed organizations and communities to build adaptive capacity in coastal areas outside the NEP and LAE programs.

All coastal areas, including regions outside NEP and LAE watersheds, need to build their adaptive capacity to reduce adverse effects of climate change. The NWP can support the work of states and local watershed organizations by providing technical assistance or educational support that leverages the work of EPA's CRE and other geographic programs and partnerships. Communication will also help minimize the selection of responses to climate change that may work at cross-purposes, or have unintended adverse consequences.



GOAL 10: The NWP addresses climate driven environmental changes in coastal areas and ensures that mitigation and adaptation responses to climate change are conducted in an environmentally responsible manner.

Impacts of climate change have greater consequences in coastal areas because so much of the country's population and economic infrastructure are located in those areas. Coastal areas will see greater demand for storm protection and erosion control. Strategies are needed to protect and enhance the natural environment while working toward a sustainable built environment that is prepared for climate impacts.

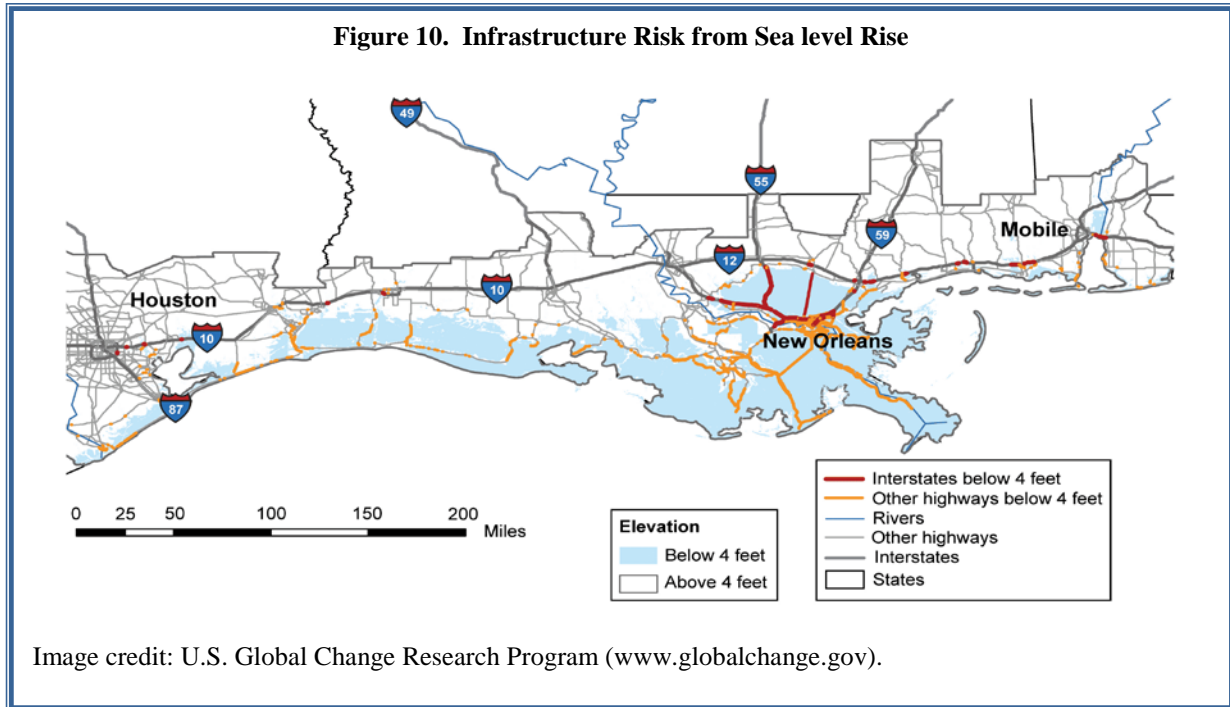
Coastal waters have the same potential problems with invasive species and water quality that all waters and watersheds have, in addition to marine-specific challenges such as ballast water discharges from commercial shipping. Changing precipitation patterns will affect runoff, nonpoint source pollution, and combined sewer systems and warmer waters may foster increases in algal blooms and hypoxic conditions, decreasing the quality of waters for recreational uses such as swimming and other water sports that are extremely important in coastal areas. Warmer water will also likely worsen the already increasing occurrences of harmful algal blooms and other aspects of water quality, including the expansion in the range of many invasive species already present in US waters such as zebra mussels. Increasing temperatures in water bodies such as Lake Superior may allow organisms that have established in the other four Great Lakes to more easily establish in Superior's waters. Water bodies that were previously not receptive to invasion by many transoceanic invaders may become more habitable to those organisms.

Coastal wetlands, like all wetlands, are dependent on suitable hydrologic conditions. Climate change will severely challenge the resilience of coastal wetlands. Altered salinity from sea level rise and changing hydrometeorology will threaten coastal ecology. Geologic history and geomorphic research suggest that coastal wetlands will have a very hard time surviving at accelerated rates of sea level rise. Where salt marshes have limited sediment supplies, they will probably not be able to accrete enough material to stay above rising water level. As the intertidal zone shifts upward and landward the area that can sustain salt marshes will shrink—in places where topography, coastal development, or insular layout prevents ecosystem shifts, marshes may disappear entirely. Some salt marshes may be able to become established upstream as the salinity changes; however they are likely to replace freshwater tidal marshes, not to establish new wetland habitats. Both freshwater and salt marshes also are subject to changing temperature and precipitation that may affect the ability of existing species to continue to thrive.

Sea grasses are another very important aquatic resource that is vulnerable to climate change. Sea grass beds serve as critical habitat for juvenile life stages of many marine species. Most sea grass species live in a narrow strip of shallow coastal water and are extremely sensitive to changes in water clarity that control how much sunlight they receive. Warmer water, increased water depth, and turbidity from soil erosion caused by extreme precipitation and other storm events can all reduce water clarity and adversely impact the survival of sea grasses.

Strategic Action 25: *The NWP will work collaboratively to support coastal wastewater, stormwater and drinking water infrastructure owners and operators in reducing climate risks and will encourage adaptation in coastal areas.*

Impacts of climate change will threaten all types of coastal infrastructure, but the water sector is particularly at risk. Sea level rise and coastal subsidence, storms and storm surge, flooding and coastal erosion, salt water intrusion into coastal aquifers, and increasing water temperatures all threaten wastewater and drinking water treatment facilities, conveyance systems, and utility operations.



EPA's CRWU and CRE programs will continue working together to provide coastal managers and infrastructure operators with planning support and technical assistance to help reduce climate risks and encourage adaptation. The NWP will also consider new approaches for ensuring that financial assistance to the water sector is used in ways that increase resiliency, reduce vulnerability, and avoid adverse unintended consequences.

Strategic Action 26: *The NWP will work collaboratively to support climate readiness of coastal communities, including hazard mitigation, pre-disaster planning, preparedness, and recovery efforts.*

Climate change impacts such as sea level rise and increased storm intensity will exacerbate existing coastal hazards. Flooding, wind, waves, and storm surge that damage coastal communities can directly affect water quality, as well as damage water infrastructure.

To avoid such problems and minimize the need for emergency response, the NWP will work within EPA and with other federal, tribal, and state agencies to provide technical assistance to coastal communities for hazard mitigation, and pre-disaster planning. After a disaster, recovery and rebuilding efforts should avoid choices that reproduce previous vulnerabilities. EPA's CRWU, CRE, and Sustainable Communities programs will collaborate to provide local communities with planning tools to improve resiliency to natural hazards as well as to bring other economic, environmental, and quality of life benefits. FEMA is a critical federal partner; in 2010, EPA and FEMA signed a MOA that will make it easier for the two agencies to collaborate to help communities recover from disasters and better plan for future resilience, including for climate change adaptation (EPA, 2011i). The NWP also will coordinate with NOAA's Storm Smart Coasts program to maximize efficiencies in delivering tools and other information to local communities. These programs will assist with vulnerability analyses, and help to develop and implement hazard mitigation strategies.

Stormsmartcoasts.org...

...was established by the Gulf of Mexico Governor's Alliance with startup funding from NOAA and a 3-year EPA grant to expand it. Smartcoasts provides a platform for the open exchange of information between states, communities, counties and others. A Community of Practice for Climate Change includes 100 members across the Gulf region from Sea Grant programs, NOAA, EPA, FEMA, the five Gulf of Mexico states, counties, parishes, communities, and universities.

Local projects supported by EPA grants may be affected by climate change impacts. EPA will provide advice on how funding recipients can include an assessment of adaptation and mitigation measures in their planning for federally funded projects.

Strategic Action 27: The NWP will support preparation and response planning for a diverse array of impacts to coastal aquatic environments.

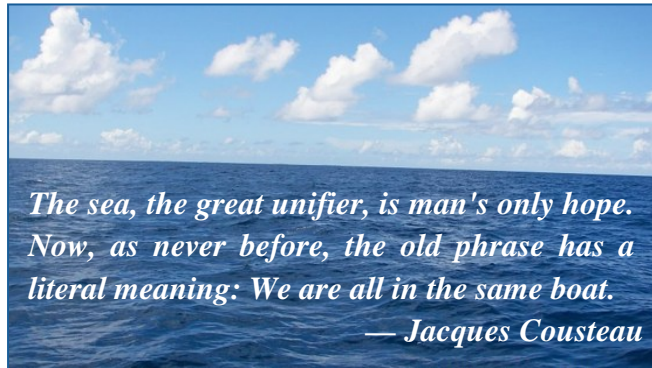
Coastal upland, wetland, and aquatic ecosystems and resources have evolved over centuries and millennia. They are stressed by human uses and human activities, invasive species, and now face further stress from a full range of climate change impacts, including threats such as sea level rise that are unique to coastal areas.

NWP base programs and initiatives will need to be cognizant of threats to coastal water quality. While extensive expertise in restoration planning resides within EPA and at other agencies and organizations, there is a need for decision support tools to help answer challenging questions about whether restoration is viable or whether alternative strategies should be pursued in certain places. Protecting water quality and aquatic habitats such as sea grass beds may require innovative actions like ensuring that the volume and quality of freshwater inflows into estuaries are maintained. In the context of coastal change and sea level rise, decisions must be made about whether some environmental restoration efforts, particularly for coastal marshes, are realistic or practical.

The NWP will utilize existing partnerships and networks such as the Interagency Coastal Wetlands Workgroup, Coastal America, the National Dredging Team, and other interagency planning groups, to promote the consideration of sea level change and other climate change

impacts in coastal habitat restoration planning. The National and Regional Dredging Teams will work to promote the beneficial use of suitable dredged material for maintaining and restoring coastal marshes and other habitats.

In addition, “Blue Carbon” is an emerging concept that refers to the ability of aquatic ecosystems to sequester CO₂. Should emissions trading practices take hold that include Blue Carbon, the use of external funding from private CO₂ emissions offsets might become a useful strategy for funding restoration or creation of sustainable coastal habitats. Care should be taken, however, to ensure other ecosystem services don’t suffer if some aquatic environments are managed strictly for their ability to sequester CO₂.



GOAL 11: Protect ocean environments by incorporating shifting environmental conditions and other emerging threats into EPA programs.

Protecting the ocean environment from adverse impacts of climate change is critical to human well-being because the ocean provides food, regulates our weather, and offers numerous opportunities for renewable energy, among many other benefits. Society will also be tempted to look to the oceans for seemingly simple solutions. We must ensure that strategies to reduce carbon dioxide levels in the atmosphere do not impose long-term costs on ocean waters, and that the many uses of marine spaces are responsibly balanced.

Strategic Action 28: The NWP will consider climate change impacts and associated impacts (e.g., ocean acidification, nitrogen and phosphorus pollution) on marine water quality in its ocean management authorities, policies, and programs.

Climate change impacts to the ocean environment, including temperature increases, increased pollutant runoff, hazardous algal blooms, as well as increases in ocean/coastal acidity, hazardous algal blooms, and spread of invasive species, add pressure to already stressed systems.

The National Coastal Conditions Report that describes the ecological and environmental conditions in U.S. coastal waters will incorporate climate change impacts into its evaluation.

EPA issued a Memorandum (EPA, 2010e) that recognized the seriousness of aquatic life impacts associated with ocean acidification, and described how States can move forward, where ocean acidification information exists, to address it during the CWA 303(d) listing cycle using the current 303(d) Integrated Reporting (IR) framework. Additional guidance may be necessary as improved monitoring and assessment information becomes available. If

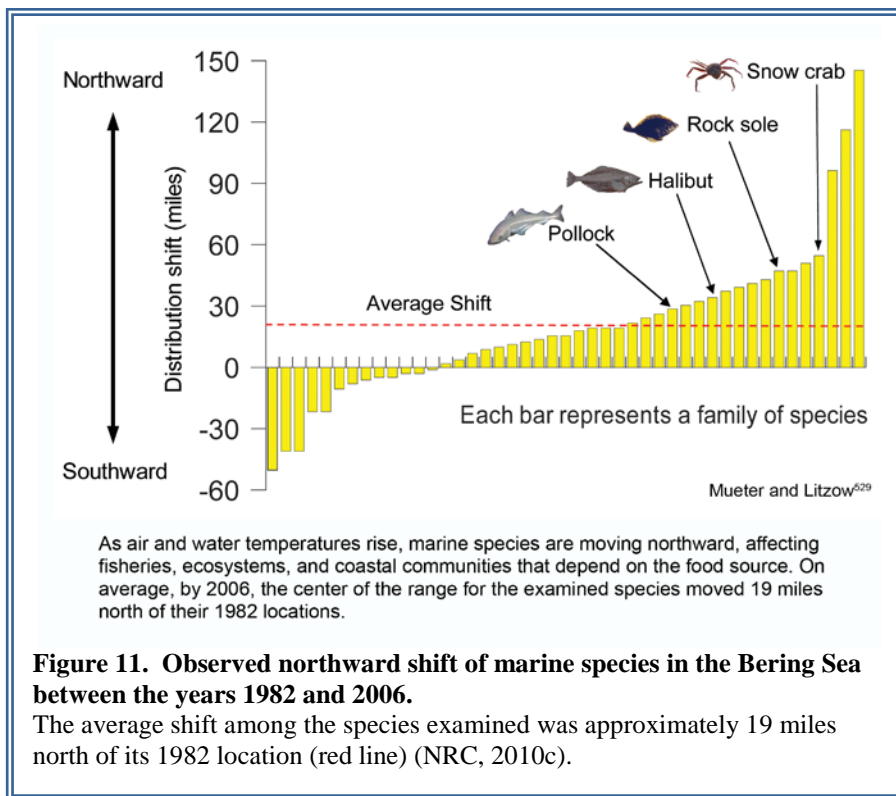


Figure 11. Observed northward shift of marine species in the Bering Sea between the years 1982 and 2006.

The average shift among the species examined was approximately 19 miles north of its 1982 location (red line) (NRC, 2010c).

other climate change impacts on ocean environments substantially affect water quality, such as dissolved oxygen and temperature, then the NWP will respond to them as well (USGCRP, 2008).

Strategic Action 29: *The NWP will utilize available authorities and will work with existing regional ocean governance structures and federal and state agencies and other networks to ensure offshore renewable energy production does not adversely affect the marine environment.*

Federal and state agencies are exploring offshore renewable energy production as a means to reduce the production of GHGs and increase energy independence. The NWP must ensure that the installation of renewable energy infrastructure (e.g., offshore wind turbines or wave energy systems, transmission cables, and shore-based facilities) is conducted in an environmentally responsible manner that does not result in unintended adverse consequences.

Authorities available to the NWP include the National Environmental Policy Act (NEPA), the Marine Protection Research and Sanctuaries Act (MPRSA), and the Clean Water Act (CWA).

It will be particularly important to partner with and engage Regional Ocean Partnerships and EPA's geographic programs (e.g., Chesapeake Bay, Long Island Sound, Gulf of Mexico, NEPs), as well as other federal agencies, states, and tribes, and to participate in Coastal and Marine Spatial Planning (CMSP). CMSP is a comprehensive, adaptive, integrated, ecosystem-based,

and transparent spatial planning process, based on sound science, to determine how the ocean, coasts, and Great Lakes should be sustainably used and protected now and for future generations. Various sections of the CWA may apply to offshore energy facilities.

Strategic Action 30: The NWP will support the evaluation of sub-seabed and ocean sequestration of CO₂.

EPA will work with other agencies and the international community to provide technical assistance on sub-seabed carbon sequestration and coordinate with federal partners in addressing proposals for carbon sequestration in the sub-seabed or other proposals such as potential fertilization of the ocean, including any permitting under the MPRSA or the underground injection control (UIC) program that may be required.

Carbon dioxide sequestration in sub-seabed geological formations, for example, involves separation of carbon dioxide from industrial and energy-related sources, transport to and injection into an offshore geological formation, and long-term isolation from the atmosphere. The NWP will need to ensure that the new technologies are responsibly deployed to protect the marine environment and to avoid risks to coastal populations and habitats.

Strategic Action 31: The NWP will participate in the interagency development and implementation of federal strategies through the National Ocean Council Strategic Action Plans and the ICCATF.

Many federal agencies manage or use coastal and ocean resources to support commerce, maintain national security, and ensure environmental sustainability. It is imperative that the NWP participate in development and implementation of federal strategies to ensure that coastal and ocean environments are protected and are prepared for climate change adaptation and mitigation, especially through the NOC. The National Ocean Policy identifies nine priority objectives, including to “strengthen resiliency of coastal communities and marine and Great Lakes environments and their abilities to adapt to climate change impacts and ocean acidification” and “increase knowledge to continually inform and improve management and policy decisions and the capacity to respond to change and challenges.” The NOC is developing a strategic action plan for this objective that will also serve as the National Action Plan (NAP) for Oceans and Coasts under the ICCATF. The NWP will continue to participate in writing and implementing this strategic action plan.

D. Water Quality

VISION: Our Nation’s surface water, drinking water, and ground water quality are protected, and the risks of climate change to human health and the environment are diminished, through a variety of adaptation and mitigation strategies.

This chapter focuses on the NWP’s response to climate change impacts on water quality, using both regulatory and non-regulatory controls. Regulatory controls include water quality standards (WQS), Total Maximum Daily Loads (TMDLs), and the National Pollutant Discharge Elimination System (NPDES), as well as drinking water regulations such as the UIC program. Non-

regulatory controls include promotion of Green Infrastructure (GI) and low impact development (LID) strategies, and other collaborative approaches. (Larger landscape strategies are covered in the Watersheds and Wetlands chapter). This chapter also includes strategies for maintaining water quality while encouraging the adoption of alternative sources of energy and fuel technologies that reduce greenhouse gas emissions.

GOAL 12: The NWP protects waters of the United States and promotes management of sustainable surface water resources under changing climate conditions.

As detailed in the *2008 Strategy*, climate change is expected to impact surface waters in several ways, affecting both human health and ecological endpoints. For example, it is projected that warmer air temperatures in many locations will heat surface water temperatures to levels that will decrease the water's ability to hold dissolved oxygen, leading to growth of harmful algal blooms and hypoxia. Warmer air temperatures may also lead to more evaporation, which could cause lower flows and higher salinity, as well as higher concentrations of other substances. Lower flows and greater salinity would likely cause an increase in impaired waters, even if actual pollutant loadings from dischargers do not increase. In many parts of the country, precipitation events are expected to become more extreme, increasing runoff with associated increases in pollutant loads, increasing variability of stream flow and associated sedimentation, and expanding flood risk.

Strategic Action 32: The NWP will encourage states and communities to incorporate climate change considerations into their water quality planning.

Sensitivity to impacts combined with adaptive capacity is a measure of vulnerability, and understanding vulnerability is necessary as the basis for adaptation planning. That is, the extent of climate change impacts upon different ecosystems, regions, and sectors will depend not only on their sensitivity to climate change, but also on their adaptive capacity or resiliency. In order to facilitate adaptation of water programs and increase resiliency of water resources, states and tribes can use existing water quality and watershed planning programs and resources (e.g., CWA sections 106, 604(b) and 319(h) planning funds) to conduct detailed assessments or develop plans to increase their adaptive capacity and prioritize adaptive responses. For example, agencies or local or interstate planning organizations can use section 604(b) funds to address climate change as part of comprehensive water quality planning efforts⁵.

Strategic Action 33: The NWP will encourage green infrastructure and low-impact development to protect water quality and to make watersheds more resilient.

Preserving the ability of the land to absorb water helps to preserve the natural function of wetlands and watersheds while also controlling pulses of stormwater. Both GI and LID

⁵ Section 604(b) of the CWA establishes a grant program to fund state, local and interstate water quality planning efforts under CWA sections 205(j) and 303(e). This provision requires states to reserve 1% of their Clean Water State Revolving Fund allotment or \$100,000, whichever is greater, for planning. Under section 205(j) many states pass through at least 40% of these funds to local or interstate planning organizations.

incorporate approaches to managing stormwater in a way that will reduce runoff. GI and LID management approaches and technologies use infiltration, evapotranspiration, and capture and reuse of stormwater to maintain or restore natural hydrologies (EPA, 2011j). They employ principles such as preserving and recreating natural landscape features, and minimizing imperviousness, to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product (EPA, 2011k).

❖ For more information on how NWP will work to protect the quality and resilience of watersheds, please see Goal 3, Strategic Action 10 in the Watersheds and Wetlands section, page 32.

The NWP will promote the use of GI and LID through stormwater permitting, outreach, and assistance programs to support states and permittees in evaluating benefits and co-benefits of GI and LID approaches. Efforts will be focused on not only new development, but also ongoing and re-development. This Strategic Action supports the Agency goal to incorporate climate change science and scenario information in five rulemaking processes by 2015.

Strategic Action 34: The NWP will promote the consideration of climate change impacts by NPDES permitting authorities.

As authorized by the CWA, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States (EPA, 2009c). To help NPDES permit writers prepare for possible climate change impacts to surface waters, the NWP will evaluate and develop, as needed, technical guidance documents for permit writers to improve their decision making processes related to the impacts of climate change, such as use of precipitation and stream flow data, and other data or models.

To promote water quality on a watershed scale, the NWP will continue to encourage the use of flexible watershed approaches, such as watershed-based permitting and water quality trading, for building surface water resiliency to climate change impacts. The NWP will also consider the need for, and appropriateness of, incorporating greater uncertainty into permit calculations, to reflect the uncertainty in climate projections related to NPDES permitting (e.g. precipitation projections).

The NWP will evaluate, when necessary, the use of critical low flow stream conditions considering climate change, and will encourage NPDES permitting authorities to incorporate revised low-flow stream estimates into NPDES permit effluent limit development where appropriate. The NWP will continue to encourage NPDES permitting authorities to consider inherent climate change impacts (e.g., warmer surface waters) when evaluating applications for 316(a) variances from thermal effluent limitations.

Strategic Action 35: For future TMDLs, the NWP will recommend that water quality authorities consider climate change impacts when developing waste load and load allocations, where appropriate.

Under section 303(d) of the CWA, states, territories, and authorized tribes are required to develop lists of impaired waters (i.e., “the 303(d) list”). These are waters that are too polluted or

otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes after the implementation of effluent limitations or other pollution control requirements. The law requires jurisdictions to develop TMDLs for these waters. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards (EPA, 2011).

For future TMDLs, the NWP will encourage use of models to evaluate impacts under a range of projected future climatic shifts using the best information and tools available. A possible place for incorporating this information would be in the margin of safety analysis which provides a buffer under the assumption of uncertainty in the quality of the receiving water and the level of pollutant in the discharge.

It is probable that most existing TMDLs do not take climate change considerations into account, and due to the number of TMDLs in existence (~40,000) it is not feasible to re-open each TMDL with the sole purpose of incorporating climate change considerations. However, the NWP will encourage that development of future TMDLs include evaluation of projected climate impacts and uncertainty and incorporate this information into the TMDL, as appropriate. This will be done in a way that recognizes the limitations of current modeling in predicting the pace and magnitude of localized climate change impacts.

The Chesapeake Bay TMDL and Climate Change

“EPA and USGS will work in conjunction with the states to conduct an analysis by 2017 to consider accounting for uncertainties of climate change in TMDL allocations. USGS has begun initial assessment of changes in pollution loads in the watershed under different climate and land-use scenarios. Initial results will be available in 2012 and be used to further plan assessments for TMDL allocations. Enhanced assessment will begin in 2016.”

❖ *Chesapeake Executive Order Strategy, p. 41 [CBPO, 2010]*

Strategic Action 36: The NWP will identify and work to protect designated uses that are at risk from climate change impacts.

A designated use establishes the water quality goals for a specific waterbody and serves as the regulatory basis for establishing controls beyond technology based requirements [40 CFR 131.2]. The water quality standards regulations, implementing CWA section 303(c), require that states and authorized tribes specify appropriate water uses to be achieved and protected. These uses are identified by taking into consideration the use and value of the water body for public water supply; for protection and propagation of fish, shellfish, and wildlife; and for recreational, agricultural, industrial, and navigational purposes. In addition, the CWA places additional emphasis on achieving, wherever attainable, “water quality which provides for the protection and propagation of fish, shellfish, and wildlife and for recreation in and on the water” [Section 101(a)(2)]. EPA’s regulation at 40 CFR part 131 interprets and implements these provisions through requirements that WQS protect the uses specified in section 101(a)(2) of the Act unless those uses have been shown to be unattainable, effectively creating a rebuttable presumption of attainability.

EPA’s regulations require that when removing a designated use, the state must provide an analysis (i.e., a Use Attainability Analysis (UAA)) to demonstrate that the designated use is not

feasible to attain based on one of the established regulatory factors [40 CFR 131.10(g)]. Additionally, States must conduct a review of their WQS at least once every three years [40 CFR 131.20]. As part of that triennial review, states must examine whether any new information has become available for water bodies where water quality standards specify designated uses that do not include the uses specified in section 101(a)(2) of the Act. If such new information indicates that the uses specified in section 101(a)(2) are attainable, the state shall revise its WQS accordingly [40 CFR 131.20(a)].

The water quality standards regulation specifies circumstances under which a designated use may, or may not, be removed or revised [40 CFR 131.10(g), (h), (j), and (k)]. If a designated use is an existing use (as defined in 40 CFR 131.3) for a particular water body, the designated use cannot be removed unless a use requiring more stringent criteria is added.

To target protective efforts, the NWP will identify designated uses that are important to states and tribes, necessary to meet the goals of the CWA, and vulnerable to climate change impacts. For example, recreational uses such as swimming, boating, and fishing may be affected by changes in precipitation levels, which may lead to increased impairments. Cold water fisheries may need particular consideration since such uses may be particularly susceptible to changes in water temperature. To protect existing uses and water quality, the NWP will work to ensure full implementation of antidegradation requirements, which, at a minimum, require maintenance and protection of existing uses and the level of water quality necessary to protect the existing uses.

The NWP will also work with stakeholders to better understand how a state could conduct UAAs, using the six attainability factors in EPA's current regulations, that will address designated use attainability where climate change may be the primary cause of non-attainment and where impacts cannot be remedied.

Strategic Action 37: The NWP will clarify how to re-evaluate aquatic life water quality criteria on more regular intervals. The NWP will also develop information to assist States and Tribes who are developing criteria that incorporate climate change considerations for hydrologic condition.

Section 304(a)(1) of the CWA requires EPA to develop criteria for water quality that accurately reflects the latest scientific knowledge regarding pollutant concentrations and environmental or human health effects (EPA, 2011p). From time to time, these criteria are updated to account for advances in the science. States, tribes, and territories may adopt these criteria or other scientifically defensible criteria into their water quality standards. The NWP will clarify how to update criteria on more regular intervals using the best and most accurate science and data related to both the changing climate conditions and how pollutants react to the changing conditions on a pollutant by pollutant basis.

In addition, since climate changes will affect hydrologic conditions, the NWP will incorporate the best available science in an informational document to assist states and tribes that are interested in protecting aquatic life from these impacts.

GOAL 13: As the nation makes decisions to reduce greenhouse gas emissions and develop alternative sources of energy and fuel, the NWP will work to protect water resources from unintended adverse consequences.

Alternative sources of energy and fuel are important for reducing emissions of GHGs, and offer a number of win-win energy choices. However, as energy policy decisions are made to take steps to mitigate GHGs, and as technologies go through the regulatory cycle, the NWP is responsible for providing perspective on how they affect water resources. As with conventional energy technologies, new technologies may also contribute to water quantity and quality problems. This goal identifies actions to reduce the adverse effects of new technologies on water resources; similarly, actions are identified to assure that new technologies to improve water quality are also energy efficient.

Strategic Action 38: EPA will seek opportunities to provide additional assistance to states and permittees to ensure that geologic sequestration of CO₂ is responsibly managed by states and permittees to protect and preserve underground sources of drinking water.

EPA finalized requirements for geologic sequestration in December 2010, under the authority of the SDWA's UIC Program (EPA, 2010e). These requirements are designed to protect underground sources of drinking water (USDWs). The rule builds on existing UIC Program requirements, with tailored requirements that address carbon dioxide injection for long-term storage to ensure that wells used for geologic sequestration are appropriately sited, constructed, tested, and monitored during and after injection, and closed including post injection site care in a manner that ensures USDW protection. The NWP will consider opportunities to provide additional assistance to protect USDWs.

Strategic Action 39: The NWP will work with ORD to better understand the risks of storing ethanol-blended transportation fuels and with the Office of Underground Storage Tanks to explore options to mitigate such risk through updated policies.

EPA finalized the Renewable Fuel Standard rulemaking in early 2010 (EPA, 2011m). The rulemaking implements a statutory provision that requires 36 billion gallons per year of biofuels be used by 2022. In order to adapt to the increased storage of biofuels such as ethanol and biodiesel in underground storage tanks (USTs), EPA is working with its partners to gain a better understanding of UST system materials compatibility, functionality of leak detection technologies, and the fate, transport, and remediation issues associated with biofuel releases.

The majority of ethanol-blended fuel sold in the U.S. is a mixture of approximately 10 percent ethanol and 90 percent gasoline by volume (E10). E85 fuel, a mixture of up to 85 percent ethanol and 15 percent gasoline by volume, is also being used for flexible-fuel vehicles. Unlike other fuel components, ethanol is corrosive and highly water soluble. As a result, special precautions must be taken to ensure that UST system components are both compatible and functional with ethanol blends (EPA, 2009a).

The Land Research Program in ORD provides methods, models, and tools needed to remediate leaking UST sites and address fate and transport issues of leaking contaminants. EPA also

proposed guidance (EPA, 2010f) that will clarify how UST owners and operators can comply with EPA's compatibility requirement (40 CFR §280.32), which states that owners and operators must use a system made of or lined with materials that are compatible with the substance stored in the UST system. EPA will continue to explore these and other options for mitigation of risk related to storage of ethanol-blended fuels in USTs and possible impacts to water quality.

Strategic Action 40: EPA will consider options to provide outreach materials for stakeholders to encourage the adoption of alternative sources of energy and fuels that are water efficient and maintain water quality.

Alternative energy sources provide decreased reliance on fossil fuels. However, they still require access to water, and may still place added stress on water supplies. EPA will develop a website that consolidates

EPA information on the energy/water nexus, as well as water and energy efficiency information for various sectors (forthcoming; includes EPA-OAR; EPA-R9, 2011). In order to reduce the possibility of adverse impacts to water quality and supply, EPA will seek opportunities and explore options to continue to develop and update outreach materials for stakeholders in concert with federal agencies such as DOE and its Renewable Energy Technology Program (DOE, 2012) and state water science agencies.

To learn more about how NWP plans to encourage energy efficiency for water utilities, please see Goal 1, Strategic Action 2 in the Infrastructure section.

Strategic Action 41: As climate change affects the operation or placement of reservoirs, the NWP will work with other federal agencies and EPA programs to understand the combined effects of climate change and hydropower on flows, water temperature, and water quality.

Hydropower generation is considered a renewable energy resource because the water supplying it is renewable. A hydroelectric power plant converts the downstream movement of water into electricity by directing the water, often held at a dam or reservoir, through a hydraulic turbine that is connected to a generator. Although power plants are regulated by federal and state laws to protect human health and the environment, there are a wide variety of environmental impacts associated with power generation technologies. In addition, climate change is likely to affect the amount, timing, and temperature of water used for hydropower, creating competition for water supply, affecting operational decisions, and altering the background condition of the aquatic system. The NWP will work with other federal agencies and programs to understand and address these combined impacts. For example, NWP could work with the DOE Wind and Water Power Program (DOE, 2011, DOE 2012) as well as with the Bureau of Reclamation and other signatories of the Federal Hydropower MOU (BOR, DOE, USACE) to further coordination and integration of hydropower and other water resource uses (BOR, 2010).

GOAL 14: The NWP will work to make hydrological and climate data and projections for water resource management available, when needed, in collaboration with other EPA programs and federal, state, tribal, and other partners.

Many of the NWP's programs are currently faced with a lack of sufficient data to assess national program effectiveness. Whether the data don't exist or are just not easily or publicly available differs by program, but lack of access to current data and consolidated analyses is a fundamental problem. As more climate models and vulnerability assessment tools become available, the NWP will work with partners from inside and outside EPA to collect, assimilate, and disseminate historic and projected information from the best sources available. The strategies in this section aim to gather, enhance, and improve access to the data that the NWP and its partners need for water resource management under changing climate conditions.

Strategic Action 42: Monitor climate change impacts to surface waters and ground water.

In order to respond to climate changes, the NWP will need to understand the impacts to surface and ground waters. The NWP will support interagency monitoring networks by coordinating and collaborating with the EPA/State National Aquatic Resource Surveys (EPA, 2011n) and other agencies' monitoring programs to encourage them to add the ability to track and evaluate changes to water resources availability and quality using historical, reliable, long-term monitoring networks.

Strategic Action 43: Develop new methods for use of updated precipitation, storm frequency, and observational streamflow data, as well as methods for evaluating projected changes in low flow conditions, in collaboration with other federal agencies.

EPA will work to update hydrological data and methods in collaboration with federal consortia ((e.g., the Interagency Climate Change Adaptation Task Force (ICCATF), the Office of Science and Technology Policy's Subcommittee on Water Availability and Quality (SWAQ), the USGCRP, the Climate Change and Water Working Group (CCAWWG), the Integrated Water Resources Science and Services (IWRSS) etc.) and will engage partners ((e.g., Federal Advisory Committee on Water Information (ACWI), Water Environment Research Foundation (WERF), the Water Research Foundation (WRF)), and others to develop and standardize a process to revise precipitation, temperature, and storm event data nationwide to incorporate expected changes in commonly used data.

Of particular concern are the storm frequency, duration, and intensity estimates (e.g., 10 year, 24 hour storm events; and 100-year, 24 hour storm events) and low flow conditions in rivers and streams at the HUC 12 watershed level.

Updating precipitation records and statistical methods, and developing projections of future precipitation patterns, will enable a fundamental shift in modeling methods, which currently rely on historical data that may no longer be representative of current and future conditions. These efforts will fully consider the uncertainty inherent in predictions of the pace and magnitude of future climate-change related effects, especially at a local level.

Strategic Action 44: The NWP will work to enhance flow estimation using NHDPlus.

The NHDPlus is a comprehensive set of digital spatial data that encodes information about naturally occurring and constructed bodies of water, paths through which water flows, and related entities (USGS, 2011). It provides full characterization of the flow network, identification of unregulated and regulated gages and reaches, and network-based interpolation and adjustment of flows. In order to enhance flow estimates in the face of climate change, the NWP will support enhancements to NHDPlus as a cost effective means of providing more accurate flow estimates for permitting, TMDLs, watershed planning, and other uses.

E. Working With Tribes

VISION: Tribes are able to preserve, adapt, and maintain the viability of their culture, traditions, natural resources, and economies in the face of a changing climate.

Native Americans have distinct cultural and spiritual connections to the water and land. The collective wisdom of elders and ancestors has allowed them to carefully use and manage the land for centuries. Changes to the earth’s climate provide a new set of challenges for tribes seeking to maintain and protect their resources and the safety and health of their people.

Indian tribes are responsible for protecting and restoring tens of thousands of square miles of rivers, streams, and lakes, as well as ground water in over 110,000 square miles of Indian country in the United States. Because tribes are co-regulators with EPA for water programs, and are water resource managers for their communities, it is important for EPA to ensure that tribes are able to provide ongoing input and participate in NWP strategies and actions on climate change. It will be important to understand and consider the impact of climate change on Native American communities and their traditional values and cultures, particularly as EPA invests in water management programs in Indian country.

Tribes often express a holistic perspective in viewing and understanding the environment, and seek to achieve “sustainability” in their lifestyle choices, both environmentally and economically, recognizing that ultimately, it is the environment that sustains us all. Tribal recommendations to EPA include seeing the “big picture” and not compartmentalizing environmental programs into separate media to address threats from climate change.

**Working with Tribes
Examples of EPA Adaptation
Activities**

- ❖ **Region 2** awarded a grant to the Saint Regis Mohawk Tribe to work together with all R2 tribal nations to discuss and design adaptation approaches during 2012.
- ❖ **Region 5:** The Great Lakes National Program Office is funding Great Lakes tribes to implement climate change adaptation projects and programs. Specifically, Lake Superior tribes and tribal organizations received Great Lakes Restoration Initiative (GLRI) funding through their tribal capacity grants to initiate priority climate change adaptation projects and initiatives; and tribes have been involved in the Lake Superior Sustainability Committee which is developing a Lake Superior climate change adaptation plan.



Much of the work with Tribes takes place within the EPA Regions, further described in Chapter IV, Geographic Climate Regions. This section describes broadly the kinds of activities the NWP intends to pursue with Tribes.

GOAL 15: The NWP incorporates climate change considerations in the implementation of its core programs for tribal Nations, and collaborates with other EPA Offices and federal Agencies to work with tribes on climate change issues on a multi-media basis to build sustainability.

Strategic Action 45: The NWP will ensure that the revised NWP Tribal Strategy and subsequent implementation of CWA, SDWA and other core programs incorporate climate change as a key consideration.

Principles to observe include ensuring:

- Tribes are involved in watershed-based strategies, integrated water resource management strategies, or other geographic strategies that affect tribal resources;
- Tribes participate in the development of EPA multi-media strategies for addressing climate change impacts on tribal lands;
- Actions taken are informed by and consistent with the EPA - Tribal Science Council's climate change priorities and research recommendations.

Strategic Action 46: The NWP will incorporate adaptation into tribal funding mechanisms, and will collaborate with other EPA and federal funding programs to support sustainability and adaptation in tribal communities, to the extent allowable by law.

Examples of actions for the NWP to pursue include:

- Provide guidance on the use of funding programs within the NWP to include mitigation and adaptation planning and implementation as eligible grant activities, as appropriate;
- Work with others in EPA to help clarify for tribes how funding mechanisms can be used for climate planning and implementation, such as the Tribal GAP program managed by the American Indian Environmental Office (AIEO) and Community Action for a Renewed Environment (CARE); and
- Work with federal partners to coordinate tribal adaptation planning and to conduct training and education for tribal members and environmental justice communities for building adaptive capacity.

GOAL 16: Tribes have access to information on climate change that they can use to inform and engage their communities for effective decision making.

Strategic Action 47: The NWP will collaborate to explore and develop climate change science, information and tools for tribes to understand local climate impacts and risks to inform adaptation solutions, and will incorporate local knowledge where possible.

Examples of information requested by Tribes include:

- Information on environmental conditions and long term trends;
- Risk assessment and management tools to help identify environmental risks and inform adaptation solutions;
- Assessments of watershed conditions and impacts using peer reviewed summaries of empirical data specific to geographic areas and water resources, to inform local action;
- Perspectives of tribal elders with historic information to inform understanding and adaptation responses;
- Management options that consider climate change factors to protect watershed resources;
- Case studies of Tribal Environmental Knowledge (TEK) incorporated into program delivery, and guidelines for incorporating TEK into science products; and
- Opportunities to leverage federal resources that can provide science information to Tribes

Strategic Action 48: The NWP will collaborate with others to develop communication materials relevant for tribal uses and tribal audiences.

Examples of materials requested by Tribes include:

- Information tailored to different climate regions;
- Information linked to tribal culture and traditions; and
- Information for use in elementary, high school, and tribal college and university curricula.

V. Geographic Climate Regions

A. Introduction

The USGCRP defines eight geographic regions that have broadly common climatological characteristics (USGCRP, 2009a). In evaluating the EPA water program for this revised *2012 Strategy*, we have included a discussion of particular issues by climate region. These regions are largely adopted from the USGCRP construct with a few amendments. The ‘Islands’ Region has been broken into two distinctive Island groups (Caribbean and Pacific Islands); and a Montane Region consisting of the glaciated ranges of the Rocky Mountains, the Sierra Nevada, and the Cascades, was added to reflect its unique geographic features and expected climate change impacts. Further, while the 2000 Assessment also considered ‘Native Peoples and Native Homelands’ as a ‘Region,’ we have included tribal issues in Chapter V, Programmatic Visions, Goals and Strategic Actions.

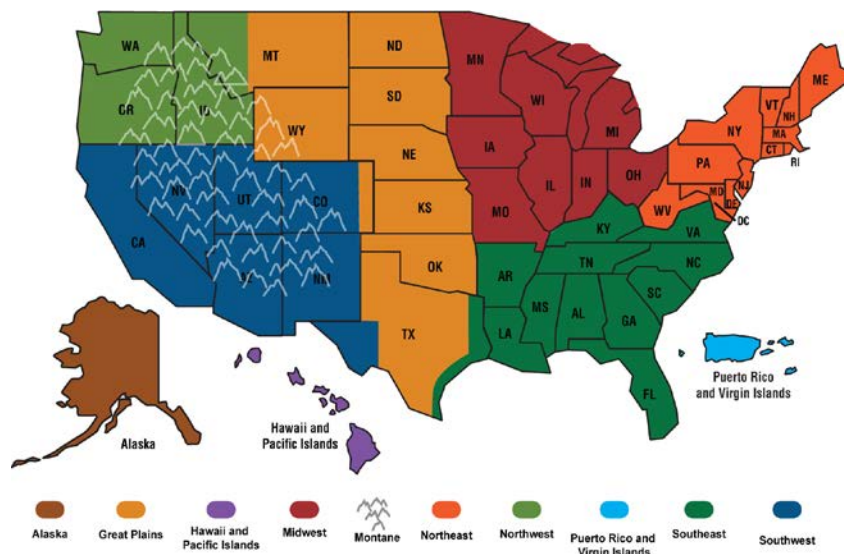


Figure 12.
Climate Regions as adapted from USGCRP

Several EPA Regions span multiple USGCRP regions (see Figure 12 and Table 1). Each EPA Region addresses a variety of climate impacts in their program implementation. This chapter

Table 1. USGCRP Climate Regions and EPA Regions

Climate Regions	EPA Regions
Northeast	1, 2, 3
Southeast	3, 4, 6
Midwest	2, 5, 7
Great Plains	6, 7, 8
Southwest	6, 8, 9
Pacific Northwest	8, 10
Montane	8, 9, 10
Alaska	10
Caribbean Islands	2
U.S. Pacific Islands and Territories	9

describes strategic issues and key actions that the EPA Regions will continue to focus on in the coming years, while the Regions also participate in the implementation of relevant strategic actions discussed in Chapter III above.

The federal government is working to deliver climate services not only at a national scale but also at regional scales. Examples of federal agencies working to develop localized climate-related

services include:

- DOI's Landscape Conservation Cooperatives (LCCs);
- DOI's Climate Science Centers;
- NOAA Regional Integrated Sciences and Assessments (RISAs);
- Interagency/NOAA-led National Integrated Drought Information System (NIDIS)
- NOAA National Climatic Data Centers; and
- National Park Service Climate Friendly Parks initiative.

Further, as described in the ICCATF 2010 Progress Report (CEQ, 2010), regional offices of federal agencies have been asked to coordinate to deliver services related to climate change. As a result, an effort is underway to develop regional hubs that can provide localized assistance, where a regional adaptation coordinator can offer a single point of entry for stakeholders to access federal adaptation science and services. These partnerships will be important for EPA Regions as they work towards achieving their long term goals.

B. Ongoing Programs Relevant to Climate Change across All Regions

There are a number of ongoing programs and activities, described throughout this report, that are important for protecting water resources irrespective of climate change, and that are also important for both adapting to climate change impacts and reducing GHG emissions. These core programs and principles being implemented by EPA across all climate regions include:

- Green Infrastructure (GI) and Low Impact Development (LID);
- Water efficiency and conservation through the WaterSense program;
- Building sustainability of water and wastewater infrastructure through the Climate Ready Water Utilities (CRWU) program;
- Improving energy efficiency through the Effective Utility Management (EUM) program;
- Promoting proactive, holistic aquatic ecosystem conservation and protection through the Healthy Watersheds Initiative (HWI);
- Developing tools for coastal resources via the Climate Ready Estuaries (CRE) program and the National Estuaries Program (NEP);
- Protecting underground sources of drinking water by implementing the Geologic Sequestration (GS) rule; and
- Coordinating federal funding and programs through the Partnership for Sustainable Communities between HUD, DOT, and EPA, to align infrastructure investments, such as for water, housing, or transportation that will help reduce pollution and build resilience.

As EPA continues to develop approaches to mitigate GHG emissions and adapt to climate change, they will be adopted across the climate regions as guided by Regional priorities.

C. EPA and Climate Regions – Goals and Strategic Actions

EPA's Regional programs provide a platform for integrating activities across media, including air, water, and land. Many of the Regions, in fact, have developed, or are developing, Regional energy and/or climate change adaptation plans or strategies. In addition, after EPA's agency-wide adaptation plan is finalized in 2012, each region will be preparing an implementation plan providing more detail on how it will carry out the work called for in the agency-wide plan, per the Administrator's June 1, 2011 Policy Statement on Adaptation (EPA, 2011a). This Chapter provides a synopsis of the water-related activities in the Regions, and identifies long term goals and strategic actions that EPA Regions plan to take in the coming years to build resilience at the national, state, tribal, and local level. Links are provided to Regional web sites where more information can be found.

Northeast Region

- **Region 1:** <http://www.epa.gov/region1/climatechange/index.html>.
- **Region 2:** <http://www.epa.gov/region2/climate/>.
- **Region 3:** <http://www.epa.gov/region03/index.htm>.

The Northeast climate region extends from West Virginia and Maryland in the south to the Canadian border in the north, and is bounded by the northern terminus of the Appalachian Mountain range to the west and the Atlantic Ocean to the east. The region includes 12 states in three EPA Regions (1, 2, and 3) and is home to 63 million people, representing 21 percent of the population of the United States. The population is concentrated along the coast, with a generally more rural interior, and therefore addressing sea level rise and other coastal issues is of particular importance.

Goal

EPA programs in the Northeast Region will work to make coastlines and watersheds more resilient to changes in water temperature, precipitation, and sea level.

Strategic Issues

- Flooding from increasingly frequent and intense rain events as well as intense tropical storm will tax aging infrastructure, including combined sewer systems, and adversely impact water quality;
- Dense coastal development and shoreline armoring prevents wetland migration and leads to loss of wetlands as sea level rises;
- Increases in the extent of storm surge and coastal flooding will cause erosion and property damage to the densely populated coasts. The State of New York has more than \$2.3 trillion in insured coastal property (USGCRP, 2009b);
- Sea level rise may increase saltwater intrusion to coastal freshwater aquifers, resulting in water resources unusable without desalination. Increased evaporation or reduced recharge into coastal aquifers exacerbates saltwater intrusion;

- Sea level rise will lead to direct and indirect losses for the region's energy infrastructure (e.g., power plants and oil refineries located along the coast, facilities that receive oil and gas deliveries), including equipment damage from flooding or erosion. Damaged energy facilities also may be a source of pollution;
- Sea level rise, increased water temperatures, salinity distribution and circulation, changes in precipitation and fresh water runoff, and acidification will change aquatic ecosystem species composition and distribution. This will also result in potential for new or increased prevalence of invasive species;
- Impacts from increasingly diverse types of energy development (e.g., hydraulic fracturing, biomass, land based and offshore renewable energy development) may negatively impact the region's water resources; and
- Despite the increased precipitation that most climate change models predict for the Chesapeake watershed, initial estimates of watershed models are that increases in temperature and consequent increases in evapotranspiration cause a decrease in annual river flows in the mid-Atlantic. Considering the Baltimore, DC, Richmond axis is the southern portion of the densely populated Boston - DC megalopolis, concern is warranted for securing safe and adequate drinking water supplies under climate change conditions in both the Northeast and Southeast climate regions.

Strategic Actions

In addition to promoting the core climate programs (discussed in Section IV.B), EPA is working with the New England Federal Partners group, the Mid-Atlantic Regional Council on the Ocean, and other regional networks to support the development of consistent scientific methods and robust datasets to inform long-term policy decisions on climate change vulnerability assessments and adaptation planning. This involves:

- Standardizing regional assumptions regarding future climate change impacts; and
- Informing a framework for local, state, and regional decision-making that accommodates existing and emergent data sources for adaptation planning efforts.

Additionally, EPA in the Northeast Region will serve as a leader, coordinator, and facilitator within the region on mitigation and adaptation activities, which include:

- Promote water and energy efficiency at water and wastewater utilities, and encourage sustainability by promoting WaterSense, CRE, and water sustainability initiatives;
- Support the NEP and CRE programs in the development of tools and the implementation of sea level rise adaptation measures;
- Continue to engage the National Ocean Policy/National Ocean Council in addressing sea level rise adaptation and mitigation measures;
- Support emergency preparedness/response capabilities in the water sector, such as the mutual aid and assistance networks in New England;
- Promote adoption of GI and LID approaches through nonpoint source and stormwater management and funding programs (e.g., Municipal Separate Storm Sewer Systems (MS4) permits that include flexibility for use of LID approaches; and

- Support federally recognized tribes and environmental justice populations that are already acutely impacted by water issues that may be aggravated by climate change, and may require targeted technical assistance. For example, Region 2 awarded a grant to the Saint Regis Mohawk Tribe to work together with all Region 2 tribal nations to discuss and design adaptation approaches during 2012.

Southeast Region

- **Region 3:** <http://www.epa.gov/region03/index.htm>.
- **Region 4:** <http://www.epa.gov/region4/water>.
- **Region 6:** <http://www.epa.gov/region6/climatechange/water.htm>.

The Southeast climate region extends from Virginia to the Texas border with Mexico. It includes the South Atlantic Coast, the Piedmont Coastal Plain, the Southern Appalachian Mountains, the Gulf Coast and the southern Mississippi River Watershed. All of EPA Region 4 and parts of Regions 3 and 6 are included in the Southeast region.

The region includes a wealth of ecological and economic resources, such as barrier islands, extensive estuaries, busy shipping ports, and important commercial and recreational fishing resources. Given the continuing population and business growth in the southeastern coastal states and the ensuing pressures on the coastal zones of this region, there are compounded pressures from decreased water supply as well as increased flooding; sea level rise and intense tropical storms compounded by land subsidence; and heat-related stress on aquatic ecosystems and human health.

Goals

Region 4 established a cross-program multi-media Energy and Climate Change Steering Committee and Workgroup that developed and is implementing an Energy and Climate Change Strategy. Similarly, Region 6 developed a Clean Energy and Climate Change Strategy through a cross program, multi-media workgroup. These workgroups will work to achieve the following long term goals:

- **Sea Level Rise:** Work with coastal states, tribes, counties, cities, and federal partners to enhance adoption of adaptive measures to lessen or avoid significant adverse effects and to increase resiliency.
- **Current Data:** Ensure that changing precipitation patterns, stream hydrology, and available water resources data are updated and reflected in core water program implementation, as appropriate and taking uncertainty into consideration.
- **Water Utility Energy and Water Use Efficiency:** Promote energy and water use efficiency by working with partner utilities.
- **Geological Sequestration:** Ensure ample State program capacities and technical skills for implementing the Geological Sequestration (GS) Rule for Class VI wells and related permitting program.

- **Vulnerable Populations:** Work with vulnerable and historically under-represented communities to build climate change adaptation and mitigation capacities.

Strategic Issues

- Decreased water availability due to increased temperature, increased evaporation, and longer periods of time between rainfall events, coupled with an increase in societal demand, is very likely to affect many sectors of the Southeast's economy.
- Increasing evaporation and plant water loss rates alter the balance of runoff and ground water recharge, which (along with sea level rise) is likely to lead to saltwater intrusion into shallow aquifers in certain coastal areas of the Southeast.
- As sea level rises, barrier island configurations will change and coastal shorelines will retreat. Wetlands will be inundated and eroded, and low-lying areas, including some communities, will be inundated more frequently – some permanently – by the advancing sea.
- As sea level rises, temperature increases and rainfall patterns change the salinity of estuaries, coastal wetlands, and tidal rivers, which are likely to become more variable. There will likely be longer periods of high salinities destroying coastal ecosystems or displacing them farther inland over time.
- Higher intensity and potentially more frequent storm surge flooding of coastal ecosystems and communities are likely in some low-lying areas. This concern is particularly acute along the central Gulf Coast and in south Florida and coastal North Carolina. Combined with up to two feet or more of sea level rise, increased storm surge is likely to result in significant human and natural resource consequences for this region.
- Hurricane intensity may increase with climate change and pose an increasingly severe risk to people, personal property, and public infrastructure in the Southeast. Hurricanes have their greatest impact at the coastal margin where they make landfall, causing storm surge, severe beach erosion, inland flooding, and wind-related damage to both cultural and natural resources.

The warming projected for the Southeast during the next 50 to 100 years will create heat-related stress for fish and aquatic ecosystems, and may result in a decline in dissolved oxygen in stream, lakes, and shallow aquatic habitats leading to fish kills and loss of aquatic species diversity. Other effects of the projected increases in temperature may include more frequent outbreaks of shellfish-borne diseases in coastal waters and altered distribution of native aquatic plants and animals.

Strategic Actions

Regions 3, 4 and 6 intend to support the above long-term goals through the following strategic actions:

- Sea Level Rise
 - ❖ Support National NEPs, focusing on the development of tools and implementing sea level adaptation measures.

- ❖ Engage with the South Atlantic Alliance and the Gulf of Mexico Alliance, to promote resilience and mitigate the impacts of (and adapt to) climate change.
- ❖ Continue to engage with the National Ocean Policy/National Ocean Council and the Gulf Coast Ecosystem Restoration Task Force to assist in adapting to and mitigating for the effects of sea level rise.
- ❖ Develop pilot regional partnerships with FEMA's Long Term Community Recovery Program to encourage pre-disaster planning and to promote incorporation of sustainable, resilient reconstruction and energy management improvements into water/wastewater facilities damaged in declared disaster areas.
- Current Data
 - ❖ Work with EPA Headquarters, states, and tribes to incorporate changing temperatures and hydrologic data into EPA and delegated state programs.
- Energy
 - ❖ Recruit additional WaterSense partners, providing technical assistance, and utilizing applicable grant programs.
 - ❖ Host GI training workshops and installation of GI demonstration projects. Region 4 has an ongoing project with the City of Jacksonville, FL to promote implementation of GI projects and principles. Region 6 is working with Dallas on a series of GI and urban heat island mitigation and adaptation projects.
 - ❖ Build internal capacity to assist water/wastewater facilities in the assessment of energy use and ways to reduce energy demands, and in identifying willing partners for which results can be measured to serve as models.
 - ❖ Develop Regional capacity for and implementation of a Regional Pilot Energy Management Program for Water/ Wastewater Facilities.
- Geologic Sequestration
 - ❖ Host training and other technical assistance activities for states on implementation of the GS Rule for Class VI wells, and exercise regulatory oversight of UIC permits for CO₂ sequestration.
- Vulnerable Populations
 - ❖ Work with vulnerable and historically under-represented communities to ensure information, access, and attention exists for building the needed climate change adaptation and mitigation capacities.
 - ❖ Through a newly established EPA-Tribal Climate Change Network, EPA Region 6 will continue to work with tribal communities to ensure timely and effective access to and sharing of climate change information for building mitigation and adaptation capacities in Indian Country.

Midwest Region

- **Region 2:** <http://www.epa.gov/region2/climate/>.
- **Region 5:** <http://www.epa.gov/r5water/>.
<http://www.epa.gov/r5climatechange/>.
- **Region 7:** <http://www.epa.gov/region7/water/index.htm>.

The Midwest's climate is shaped by the presence of the Great Lakes and the region's location in the middle of the North American continent. This location, far from the temperature-moderating effects of the oceans, experiences large seasonal swings in air temperature from hot, humid summers to cold winters. Areas from EPA Regions 5 and 7 are included in the Midwest climate region. In addition, Region 2 is connected ecologically to this climate region through the Great Lakes and the St. Lawrence Seaway. The Great Lakes are a natural resource of tremendous significance in the Midwest, containing 20 percent of the planet's fresh surface water. Much of the region, outside of the Great Lakes Basin, drains to the Mississippi River, and as such, contributes to long range impacts in the Gulf of Mexico. Issues of particular concern in this Region include extreme variability in precipitation and temperature, and preserving the ecological integrity of the Great Lakes.

Goals

The long term goals of EPA in the Midwest region include:

- Use knowledge gained from downscaled climate models and other data to integrate climate considerations regarding precipitation into NPDES permits and long term control plans (LTCPs), taking into account the uncertainty in model results;
- Understand vulnerability of water-related infrastructure and work with partners to increase resilience of the region's critical infrastructure from extreme storm events;
- Improve the Great Lakes community's understanding of how their ecosystems and populations will be impacted by climate change and their ability to plan and implement adaptation measures for those impacts;
- Protect groundwater and surface water quality and quantity; and
- Protect vulnerable populations.

Strategic Issues

- Variability in precipitation patterns will be a challenge for both drinking water and wastewater utilities and their systems. More intense rainfall can overload drainage systems and water treatment facilities, increasing the risk of waterborne diseases. This is of particular concern for combined sewer overflow (CSO) communities. Increases in such events are likely to cause greater property damage, higher insurance rates, a heavier burden on emergency management, increased clean-up and rebuilding costs, and a growing financial toll on businesses, homeowners, and insurers;
- In the summer, with increasing evaporation rates and longer periods between rainfalls, the likelihood of drought will increase and water levels in rivers, streams, and wetlands are

likely to decline. Water levels in the Great Lakes are projected to fall between one and two feet by the end of the century (USGCRP, 2009), which may result in significant lengthening of the distance to the lakeshore in many locations, impacting beaches, coastal ecosystems, dredging requirements, infrastructure, and shipping. Declining water levels in the Great Lakes will cause the migration of coastal habitats. Additionally, climate change impacts may also have profound effects on agriculture, and significant resulting impacts on water quantity and quality;

- Increased water temperatures will lead to an increased risk of oxygen-poor or oxygen-free “dead zones” that kill fish and other living organisms. Warmer water and lower oxygen conditions can more readily mobilize mercury and other persistent pollutants, which is of concern for lakes with contaminated sediment. In cases where increasing quantities of contaminants are taken up in the aquatic food chain, the potential for health hazards will increase for species that eat fish from the lakes, including humans; and
- The Great Lakes are a bi-national resource, shared and managed jointly with Canada. Great Lakes climate change work, therefore, has a bi-national management and collaboration component.

Strategic Actions

In addition to continuing efforts in core climate change programs such as GI, WaterSense and CRWU, specific actions to achieve the long term goals in the Midwest region include:

- Work with the agriculture community to consider and promote approaches, such as agriculture drainage management, to improve resilience and lessen water quality impacts;
- Review permit applications and issue UIC permits for CO₂ in UIC Direct Implementation states. Review primacy packages (SDWA § 1422 revision applications/GS Class VI applications) and complete the Class VI primacy approval process;
- Work with water utilities to promote energy and water efficiency;
- Engage tribes in federal climate change conversations and continue efforts to work with tribes and tribal organizations to initiate climate change adaptation projects and initiatives; and
- Continue working with environmental justice populations, especially in CSO communities, to improve access to climate change information and to ensure consideration of adaptation strategies.

Great Plains Region

- **Region 6:** <http://www.epa.gov/region6/climatechange/water.htm>.
- **Region 7:** <http://www.epa.gov/region7/water/index.htm>.
- **Region 8:** <http://www.epa.gov/region8/climatechange/>.

The Great Plains climate region extends from the Dakotas and eastern half of Montana in the north to Texas in the south. On the west, it is bounded by the Rocky Mountains and the Basin and Range geographic provinces, and the central lowlands and coastal plain provinces to the east and to the south. Parts of ten states in three EPA Regions (6, 7, and 8) are located in this

vast grassland prairie, which is home to some nine million people, with the population expected to grow to about 14 million by 2050. The population gains will largely be in urban areas.

Key issues in this Region relate to general population growth; loss of snowpack and declining surface and groundwater quality and quantity; competition for water between energy, agriculture and public supply; and vulnerability of prairie wetlands, prairie potholes, and playa lakes.

Goals

The long term goal of EPA in the Great Plains region is to work to ensure long term availability and high quality of water resources and related aquatic habitat and function through:

- Water quality protection and restoration;
- Water conservation and efficiency promotion; and
- Protection of vulnerable populations.

Working specifically with partners in the agricultural sector, the renewable energy sector, the oil and gas sector, as well as land developers and land trusts, will be important in achieving this goal.

Strategic Issues

- General population growth, and shifts in population from the region's rural to urban centers, will continue to create demands for water storage to maintain sustainable water supplies and increase competition among water users (e.g., agricultural and municipal uses);
- Loss of snowpack in the western portion of the region will further impact water use, storage, and irrigation practices. This must be taken into consideration as infrastructure is added in the region;
- Declining surface and ground water quantity and quality, coupled with more frequent and severe droughts, will continue to exacerbate water shortages in the region;
- Unique aquatic ecosystems such as prairie wetlands, prairie potholes, and playa lakes will continue to be stressed as changes occur in ground water and surface water sources;
- Increased nonpoint source pollution (e.g., sediments, phosphorus, and nitrogen) is expected as increases in storm intensity are observed. This could result in changes to natural stream morphology and related hydrographs, and negatively impact the biological function of aquatic ecosystems; and
- Water quality impacts will be amplified by increases in precipitation intensity and longer periods of low flow in streams.

Strategic Actions

In addition to promoting the core climate programs, EPA's efforts in the Great Plains region will include:

- Water Quality Protection and Restoration

- ❖ Work to reduce nonpoint sources of pollution to rivers and streams by leveraging the OW's National Nutrients Strategy;
 - ❖ Work with partners to incorporate changing precipitation patterns, temperature, and hydrology into EPA and delegated state program decision frameworks;
 - ❖ Build geosequestration evaluation, modeling, and permitting expertise within EPA Regions through technical workshops, seminars, and related training to enhance staff capacity; and
 - ❖ Exercise regulatory oversight of UIC permitting for carbon sequestration
- Water Conservation and Efficiency
 - ❖ Promote water efficiency and energy efficiency at water and wastewater utilities, and encourage sustainability by promoting WaterSense, CRE, and water sustainability initiatives such as GI initiatives workshops and related outreach efforts in major cities and along the United States-Mexico border.
 - Vulnerable Populations
 - ❖ Work with vulnerable and historically under-represented communities to ensure the same level of information and access exists for building the needed climate change adaptation and mitigation capacities; and
 - ❖ Continue to work with tribal communities to provide access to climate change information, mitigation and adaptation strategies and funding options to ensure the long term viability of natural and cultural resources that support Native American populations.

Southwest Region

- **Region 6:** <http://www.epa.gov/region6/climatechange/water.htm>.
- **Region 8:** <http://www.epa.gov/region8/climatechange/>.
- **Region 9:** <http://www.epa.gov/region09/climatechange/>.

The Southwest climate region includes California, Nevada, Utah, Arizona, New Mexico and the westernmost portions of Colorado and Texas. EPA Regions 6, 8, and 9 are located in this area. To the west of the region lies the Pacific Ocean; Mexico borders the southern edge; and the Rocky Mountains border a large part of the region to the east. The population of this region, now approximately 54 million, has the fastest growth rate in the nation. The Southwest has multiple climatic zones, each facing somewhat different climate changes impacts. Much of the region is arid with relatively high air temperatures. Several mountain ranges as well as the Pacific Ocean influence climate and water resources in certain parts of the Region. Water is stored as snowpack during the winter and released to streams in the spring and early summer, helping to meet increasing water demands. There are three major river systems: the Sacramento-San Joaquin, the Colorado and the Rio Grande. Several huge water storage and conveyance projects also divert water from rivers for more widespread use by agriculture and growing cities. The lack of rainfall and the prospect of future droughts becoming more severe is a significant concern, especially because the Southwest continues to lead the nation in population growth.

Goals

The long term goals of EPA in the Southwest region are to work with federal, state, tribal and local partners to:

- Increase infiltration;
- Protect water quality to reduce stress on the ecosystem;
- Encourage communities and utilities to conduct vulnerability assessments and implement resulting recommendations; and
- Work with partners and stakeholders to evaluate future drought and flood impacts on water resources as well as infrastructure resilience.

Strategic Issues

- Warmer temperatures will reduce mountain snow packs, and peak spring runoff from snow melt will shift to earlier in the season, leading to and increasing the shortage of fresh water during the summer. A longer and hotter warm season will likely result in longer periods of extremely low flow and lower minimum flows in late summer. Water supply systems that have no storage or limited storage (e.g., small municipal reservoirs) may suffer seasonal shortages in summer;
- The magnitude of projected temperature increases for the Southwest, particularly when combined with urban heat island effects for major cities such as Phoenix, Albuquerque, Las Vegas, and many California cities, represents significant stresses to health, energy, and water supply in a region that already experiences very high summer temperatures;
- Reduced ground water supply due to a lack of recharge will be of concern;
- Warmer ocean temperatures may decrease productivity by stopping entrainment of deep supplies of nutrients. The resulting reductions in commercial species will need to be addressed to support continued production of fisheries and aquatic life;
- Increased frequency and altered timing of flooding will increase risks to people, ecosystems, and infrastructure. Increased flood risk is likely to result from a combination of decreased snow cover on the lower slopes of high mountains, and an increased percentage of winter precipitation falling as rain and therefore running off more rapidly;
- Sea levels are rising and contributing to the loss of wetlands and infrastructure located along coastal corridors; and
- The magnitude and frequency of wildfires have increased over the last 30 years which severely impacts water quality in streams, creeks, rivers, lakes, and estuaries.

Strategic Actions

In addition to continuing to implement the ongoing climate programs, EPA's effort in the Southwest will include the following:

- Encourage funding programs to fund green infrastructure, energy and water-efficient upgrades to infrastructure, and water conservation;

- Work through the California Water and Energy Project (an interagency partnership) as well as the California Financing Coordinating Committee, to leverage funding to support sustainable water infrastructure and water use efficiency projects;
- Continue to provide funding for tribal sustainable water infrastructure projects in coordination with the Indian Health Services; and
- Build partners' and stakeholders' understanding of, and the capacity to respond to, risks of climate change and water.

Pacific Northwest Region

- **Region 8:** <http://www.epa.gov/region8/climatechange/>.
- **Region 10:** <http://yosemite.epa.gov/r10/water.nsf/homepage/water>.

The Pacific Northwest climate region includes Washington, Oregon, Idaho, and the western third of Montana. It is bounded by the Pacific Ocean on the west and the Rocky Mountains on the east and includes EPA Region 10 and part of Region 8. Canada borders the region to the north. Of primary concern are impacts related to changes in snowpack, stream flows, sea level, forests, and other important aspects of life in the Northwest that are already underway, with more severe impacts expected over the coming decades in response to continued and more rapid climate change.

Goals

The long term goals of the EPA in the Northwest region are to work with federal, state, tribal, and local partners to increase sustainability and reduce vulnerability of communities and infrastructure, including by conserving water and increasing infiltration; and partner with other federal agencies and the regional Climate Science Center to coordinate and leverage climate research and other activities.

Strategic Issues

- Salmon and other coldwater species will experience additional stresses as a result of rising water temperatures and declining summer streamflows;
- Sea level rise along vulnerable coastlines will result in increased erosion and loss of land;
- Declining springtime snowpack will lead to reduced summer streamflows, straining water availability for all uses;
- Increased insect outbreaks, wildfires, and changing species composition in forests will pose challenges for ecosystems and the forest products industry;
- Water supplies will become increasingly scarce, calling for trade-offs among competing uses, and potentially leading to conflict;
- Increased frequency of flooding will increase risk to people, ecosystems, and infrastructure;
- Projected heavier winter rainfall may cause an increase in saturated soils and therefore an increased number of landslides, particularly where there have been intensive development or forest practices on unstable slopes; and

- Agriculture, ranching, and natural lands, already under pressure due to an increasingly limited water supply, are very likely to be further stressed by rising temperatures.

Strategic Actions

In addition to continuing to implement the ongoing climate programs, EPA's efforts in the Northwest will include:

- Sustainability
 - ❖ Encourage sustainable infrastructure approaches;
 - ❖ Implement water conservation measures;
 - ❖ Expand use of GI; and
 - ❖ Encourage communities and utilities to conduct vulnerability assessments and implement resulting recommendations.
- Water Quality
 - ❖ Implement water quality programs factoring in climate change to reduce stress on the ecosystem.
- Collaboration
 - ❖ Collaborate with DOI's LCCs;
 - ❖ Engage in Western Governors Association climate adaptation activities;
 - ❖ Partner with the Climate Science Center and other federal agencies; and
 - ❖ Engage Tribes in Federal climate conversations and activities.

Montane Region (Intermountain West)

- **Region 8:** <http://www.epa.gov/region8/climatechange/>.
- **Region 9:** <http://www.epa.gov/region09/climatechange/>.
- **Region 10:** <http://yosemite.epa.gov/r10/water.nsf/homepage/water>.

The Montane region, in EPA Regions 8, 9 and 10, includes three glaciated mountain ranges: the Rocky Mountains, Sierra Nevada and Cascades. These areas are unique in that they rely on winter snow accumulation for their water supply. Sensitive ecological communities include bogs and fens. Montane glaciers and snowfields are reservoirs of water for the human populations and ecological communities at lower elevations.

Most ecosystems in the North American Montane Region are predicted to slowly migrate and shift their distribution towards the north in response to warming temperatures. However, the alpine areas are often distributed as small, isolated regions surrounded by other habitats. These areas can be disconnected from each other by wide stretches of land used for timber production, ranching, or other uses. Instead of shifts in latitude, alpine vegetation and animals will be limited to shifts in altitude, unless connections between suitable habitats can be made. [Jackson, 2006]

Goals

The goal of EPA in the Montane region is to protect the water quality and biological integrity of the Montane region and increase the region's resilience to climate change, through water quality and habitat protection and restoration.

Strategic Issues

- A warmer climate will cause lower-elevation habitats to move into higher zones, encroaching on alpine and sub-alpine habitats;
- High-elevation plants and animals will lose habitat area as they move higher with some “disappearing off the tops of mountains;”
- Rising temperatures will increase the importance of connections between mountain areas;
- Rising temperatures may cause mountain snow to melt earlier and faster in spring, shifting the timing and distribution of runoff. This in turn affects the availability of freshwater for natural systems and for human uses. Earlier melting leads to drier conditions for the balance of the water year, with increased fire frequency and intensity;
- Water supplies will become increasingly scarce, calling for trade-offs among competing uses, and leading to conflict;
- Increased frequency and altered timing of flooding will increase risks to people, ecosystems, and infrastructure;
- Projected increases in temperature, evaporation, and drought frequency add to concerns about the region's declining water resources; and
- Climate change is likely to affect native plant and animal species by altering key habitats such as the wetland ecosystems known as montane fens or playa lakes.

Strategic Actions

In addition to continuing efforts in core climate change programs, specific actions relative to the Montane region include:

- Increase protection and restoration of wetlands to optimize percolation of surface water into ground water;
- Increase protection and restoration of riparian areas to reduce erosion during storm events and snow melt periods and thereby protect water quality;
- Increase protection of headwater streams and wetlands to protect the quality of montane water sources in the midst of precipitation and runoff-timing uncertainties;
- Collaborate with DOI's LCCs, the USFWS, and other DOI agencies in efforts to develop landscape-scale strategies to address climate change issues on a bio-regional basis;
- Coordinate climate change adaptation actions with federal agencies (given the large amount of federal agency holdings in the Montane region), landholders and others,;
- Partner with other federal agencies to coordinate and leverage climate research and other activities; and
- Engage tribes in federal climate conversations and activities.

Alaska Region

- **Region 10:**
<http://yosemite.epa.gov/r10/water.nsf/homepage/water>.

Over the past 50 years, Alaska has warmed at more than twice the average rate of the rest of the United States. Its annual average temperature has increased 3.4 °F, while winters have warmed by 6.3 °F. The higher temperatures are already causing earlier spring snowmelt, reduced sea ice, widespread glacier retreat, and permafrost warming. The observed changes are consistent with climate model projections of greater warming over Alaska, especially in winter, as compared to the rest of the country. Climate models also project increases in precipitation over Alaska. Simultaneous increases in evaporation due to higher air temperatures, however, are expected to lead to drier conditions overall, with reduced soil moisture. Average annual temperatures are projected to rise between 5 and 13 °F by late this century. Increasing acidification of Alaskan waters presents a clear threat to Alaska's commercial fisheries and subsistence communities (USGCRP, 2009a).

Goals

- Design and build infrastructure that can withstand warmer conditions and thawing permafrost, flooding, and fire;
- Ensure adequate water supplies for communities dependent on disappearing sources; and
- Protect water quality to reduce stress on the ecosystems.

Strategic Issues

- Longer summers and higher temperatures are causing drier conditions, despite trends in increased precipitation. Insect outbreaks and wildfires are increasing with warming;
- A warmer climate will cause freshwater and saltwater species to move further north or into higher zones;
- As permafrost continues to thaw and temperatures rise, some lakes and ponds are beginning to disappear. This impacts drinking water sources and reduces wetland habitat while presenting a challenge for the ecosystem and the people who depend on its natural resources;
- Permafrost thaw has also caused numerous land slumps along riverbanks which can have an impact on water quality (increasing turbidity) with documented impacts to drinking water in some Alaskan communities;
- Coastal storms increase risks to villages and fishing fleets. The combination of losing their protective sea ice buffer, increasing storm activity, and thawing coastal permafrost is causing some coastal communities to crumble into the sea. Increasing storm activity delays barge operations that supply coastal communities with fuel. The increased storm intensity puts fishing fleets at higher risk;
- Displacement of marine species will affect key fisheries. Thawing sea ice is moving the location and limiting the extent of plankton blooms. As plankton moves to deeper waters, it

is less available to species and the food chain that depends on it, including humans dependent on these species for subsistence or economic livelihood;

- Thawing permafrost damages roads, runways, water and sewer systems, and other infrastructure; and
- Opening of the Arctic from melting sea ice will create new opportunities for shipping, resource exploration and extraction, and tourism; there may be challenges caused by the increased traffic. Other key issues are the potential for the introduction of invasive species, impacts on subsistence activities, and national security concerns.

Strategic Actions

In addition to continuing to implement the ongoing climate programs, EPA's work in Alaska will include the following efforts.

- Infrastructure
 - ❖ Encourage sustainable infrastructure approaches;
 - ❖ Encourage communities and utilities to conduct vulnerability assessments and implement resulting recommendations; and
 - ❖ Encourage energy-efficient motors and pumps in infrastructure to reduce GHG emissions.
- Water Quality and Water Supply
 - ❖ Expand use of GI to delay stormwater runoff, mimic timing closer to the natural regime, and increase infiltration.
- Collaboration
 - ❖ Collaborate with the Alaska Climate Change Executive Roundtable, , and the DOI's LCCs and Climate Science Center in Alaska;
 - ❖ Partner with other federal agencies to coordinate and leverage climate research and other activities; and
 - ❖ Engage Tribes in federal climate conversations and activities.

Caribbean Islands Region

- **Region 2:** <http://www.epa.gov/region2/climate/>.

Puerto Rico and the U.S. Virgin Islands, part of EPA Region 2, are located in the northeastern Caribbean Sea and are of volcanic origin. Puerto Rico (PR), including its offshore islands, covers a total area of 3,435 square miles. The main island of PR has three principal physiographic areas: the alluvial coastal plains, karst, and the central mountainous interior. Land surface elevations range from mean sea level to 4,389 feet above mean sea level. PR is home to approximately 3.9 million people, 70% of whom reside in coastal areas. Annual rainfall in PR ranges from about 30 inches in the western end of the south coast to about 160 inches near the top of the El Yunque Rainforest. Surface water provides approximately 75% of the

population's freshwater needs. However, aquifers also play an important role in providing freshwater, especially to populations in the south coast and to the industrial sector.

The U.S. Virgin Islands (USVI), including the islands of St. John, St. Thomas, and St. Croix, cover a total area of 133 square miles. St. Thomas and St. John are characterized by steep topography while St. Croix is characterized by lower hills. Precipitation is the only natural source of freshwater on the islands. The population of the USVI relies on rooftop-rainfall catchments, large-scale desalination of seawater, and ground water.

The sensitive coastal ecosystems and critical infrastructure of the Caribbean Islands face difficulty due to sea level rise, tropical storms and flooding from heavy rain. Coral reefs are under stress from warmer temperatures and ocean acidification. Water supplies are threatened due to both drought and saline contamination of aquifers.

Goals

The long term goals of the EPA in the Caribbean region include:

- Work with partners to understand the vulnerability of coastal wetlands and their migration potential, and to protect the most vulnerable areas;
- Work with partners to understand the vulnerability of coastal communities and water-related infrastructure and to increase their resilience to extreme storm events; and
- Increase understanding of the role of multiple stressors plus climate change on ecosystems and water-related infrastructure.

Strategic Issues

- Areas with limited ability for wetlands migration will see marked reductions in their ability to provide ecosystem services and will be increasingly vulnerable to intense storm damage in the future;
- Critical infrastructure (e.g., ports, airports, power plants, and sewage treatment facilities) in PR and the USVI located in the coastal zone will be vulnerable to storm surges, sea level rise, and the simultaneous occurrence of both;
- Many hurricanes and coastal inundations are accompanied by heavy rains and river/stream floods, which impact water quality and stream morphology;
- Rising sea levels cause intrusion of saltwater into the underground freshwater lens, contaminating the supply of usable ground water and reducing the freshwater supply for the Caribbean islands;
- Higher ambient water temperatures and degradation of water quality, including adjustments in pH due to acidification, may affect production rates of aquaculture facilities and their susceptibility to diseases such as microbial infections and parasitic infestations. Presently, there are no aquaculture facilities operating in the Caribbean although a few NPDES permits have been issued;
- Recent events of increased sea surface temperatures have caused stress to coral reefs in the USVI and PR. Increasing sea surface temperatures have the potential to reduce the

stability of corals, especially in the presence of stresses from the existing land-based sources of pollution;

- Ocean acidification may potentially diminish the quality of the reefs by impeding the calcification process, increasing carbon in the water, altering ocean chemistry, and making calcium less available for calcification. Lower pH could also accelerate erosion of existing structures; and
- Longer periods of drought are expected to occur and may produce an increase in the energy and costs associated with the production of drinking water. This will be particularly pertinent in the USVI where desalination is one of the main sources of drinking water.

Strategic Actions

- Support the development of LIDAR images for the Caribbean Region in order to provide more refined data for modeling purposes;
- Support the integration of climate change considerations into FEMA, Commonwealth, and municipal hazard mitigation plans;
- Promote increased use of GI in the Caribbean to enhance resilience by absorbing and infiltrating stormwater and preventing flooding and pollution impacts by providing outreach and education to the public and to design and building professionals. Support PR in the development of tsunami-ready communities;
- Partner with the Caribbean Coastal Ocean Observing System (CariCOOS) and the National Weather Service, and other relevant federal and Commonwealth agencies, to disseminate information and provide outreach to managers of PR's water infrastructure in regard to current trends;
- Support and encourage increased resilience of water infrastructure through physical upgrades, geomorphic feature protection (e.g., barrier islands, mangrove islets, eolianites, beach rock, and dunes), building code revisions, and working with insurance companies to ensure they implement disaster risk reduction measures in the underwriting criteria of their policies; and
- Engage Environmental Justice (EJ) populations in education on climate change impacts and planning for climate change adaptation.

Pacific Islands Region

- **Region 9:** <http://www.epa.gov/region09/climatechange/>.

The Pacific Islands region in EPA Region 9 encompasses the Hawaiian Islands, as well as the United States affiliated Pacific islands, including the territories of American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), and Guam.

The Pacific Islands are more vulnerable to climate change than nearly any other region in the United States. Key vulnerabilities include availability of freshwater, adverse impacts to coastal and marine ecosystems, and exposure to hazards including sea level rise and inundation.

Goals

- Design and build infrastructure that can withstand storms, flooding, salt spray, and fire;
- Protect existing drinking water supplies and ensure adequate supplies for communities dependent on disappearing sources;
- Encourage communities and utilities to conduct vulnerability assessments and implement resulting recommendations;
- Work with local governments on disaster planning and response, and long term plans to protect infrastructure and human safety;
- Protect coral reefs, mangroves and other sensitive ecosystems; and
- Educate local and cultural leaders on the impacts of climate change and engage them in planning for climate change adaptation.

Strategic Issues

- Rising sea levels, higher sea temperatures, and ocean acidification associated with climate change are further degrading coral reefs already stressed by overfishing and pollution. Their loss diminishes ecological heritage, shoreline protection, food supply from the sea, and results in a decline in income from ecotourism in the Pacific Island communities where tourism is one of the largest industries;
- The western Pacific already experiences the highest rate of Category 4 and 5 storms. Climate change may bring more frequent and higher energy storms resulting in potentially catastrophic damage to island infrastructure. This degree of damage could cripple the economies of Pacific Island communities for significant periods of time, not only impairing economic development but also the ability of local government to ensure delivery of basic water and sewer and other public health services; and
- Sea level rise has multiple implications for Pacific Island communities:
 - ❖ For the low-lying atolls, entire islands may be submerged within a generation and may result in environmental refugees seeking new homes;
 - ❖ For some low-lying islands, sea level rise can result in “wash over,” in which islands, or portions of islands, are submerged by waves during large storm events. This results in salt water contamination of agricultural lands, significantly decreasing the productivity of those lands. This loss of agricultural productivity has an acute impact on the largely subsistence-based economies of these communities;
 - ❖ For many of the islands, sea level rise has an immediate, and accelerated impact on coastal erosion, which affects water quality, coral reef health, coastal infrastructure, available land, and culturally significant sites; and
 - ❖ Sea level rise increases the potential for salt water intrusion into the sole source aquifers upon which many Pacific Islands rely for drinking water. There are few or no readily accessible alternative drinking water options when a community is confronted with the loss of productivity of a sole source aquifer.

Strategic Actions

- Work with local, state, and federal agencies, as well as local educational institutions, to ensure protocols are in place to identify key drinking water resources, monitor water quality, and develop long-term drinking water protection and management plans;
- Work with local, state, and federal agencies to leverage capital improvement funds to develop water and wastewater infrastructure designed to be resilient to the effects of climate change;
- Develop biological criteria as a component of water quality standards as a tool for coral reef protection;
- Use permitting authorities and enforcement to protect drinking water and near-shore water quality consistent with the requirements of the Clean Water Act;
- Work with local, state, and federal agencies to invest in local utility managers and employees for the long-term to ensure they have the skills and resources to consistently protect public health and safety, even in the event of catastrophic storm events. Collaboratively identify best management practices that are institutionalized through standard operating procedures;
- Work with local, state, and federal agencies to reduce reliance on fossil fuels through energy audits, conservation incentives, and investment in renewable energy sources. This approach will reduce water quality impacts associated with oil spills and develop an energy infrastructure that may be more resilient to severe storm events;
- Work with local, state, and federal agencies, as well as local educational institutions, to reduce stressors to coral reef health (e.g., sedimentation and impacts from fishing and recreation) and to protect coral reef ecosystems in perpetuity;
- Work with local, state, and federal agencies to build awareness of the potential effects of climate change and opportunities to reduce GHG emissions and adapt to impacts; and
- Engage cultural leaders and EJ populations in education on climate change impacts and planning for climate change adaptation.

VI. Cross-Cutting Program Support

A. Goal 17: Communication, Collaboration, and Training

Strategic Action 49: *Continue building the communication, collaboration, and training mechanisms needed to effectively increase adaptive capacity at the federal, tribal, state, and local levels.*

The NWP will continue building the communication, collaboration, and training mechanisms needed to effectively increase adaptive capacity at the federal, tribal, state, and local levels.

Communicating Effectively

Communication involves three elements: the audience, the message, and the medium. This *2012 Strategy* describes the messages, including:

- Climate change poses threats to water resources and the NWP's mission;
- Ecosystem services are valuable resources for modulating climate impacts;
- Programmatic actions are being taken to address climate change;
- Information and tools are needed to inform action; and
- Collaboration is essential for shared learning and problem solving.

As described earlier, there are many stakeholders with interests and responsibilities for protecting the nation's water resources. Some of the audiences the NWP intends to communicate with include:

- State and tribal co-regulators who need information and tools to adapt their programs;
- The water utility operators who need tools to calibrate their design and management practices for protecting infrastructure from climate change impacts;
- Natural resource professionals who protect water quality and ecological integrity from compounding stressors, including climate change;
- Tribal communities that have geographically and culturally specific challenges for protecting and preserving their fresh water resources and communities;
- Communities that are at risk from sea level rise, flood and drought;
- The public and stakeholders who want to know how the federal government is addressing climate change; and
- Federal agencies with which EPA collaborates.

In addition to the avenues discussed above throughout this document for training and tool development, the NWP will provide communication outlets including:

- NWP Climate Change Website;
- Climate Ready Water Utilities website and toolbox;
- Water and Climate Change E-Newsletter;

- Webcasts and Webinars – to provide opportunities for targeted training;
- Ongoing dialogue forums with stakeholder groups and co-regulators such as the State-Tribal Climate Change Council (STC3);
- Speaker Series – for EPA employees to hear from experts; and
- Annual reports and periodic updates.

The NWP will continue working with partners and stakeholders to develop communication mechanisms to expand access to information and resources for general and targeted audiences.

Working in Collaboration

Existing EPA partnership programs provide ready access to networks of key entities and can be leveraged to address the challenges posed by climate change while minimizing the ‘overhead’ involved in collaboration. Examples of existing programs and initiatives are referenced throughout this document, some of which are noted in the adjacent text box.

Examples of Collaborative Partnership Programs

- Infrastructure:
 - Source Water Collaborative
 - Rural Community Assistance Partnership
 - Capacity Development Program
 - Effective Utility Management
- Ocean and Coastal Waters:
 - National Ocean Council
 - National Estuary Programs
- Watersheds and Wetlands:
 - Healthy Watersheds Initiative
- Water Quality:
 - Green Infrastructure Initiative

Examples of Regional Collaborations

- Region 1 Federal Partners Group
 - <http://www.epa.gov/region1/eco/energy/adaptation-efforts-epane.html>
- Region 4 Southeast Natural Resources Leadership Group
 - <http://www.epa.gov/region4/topics/envmanagement/senrlg/index.htm>
- Region 9 – Water-Energy Team of the California Climate Action Team ((WET-CAT)
 - <http://www.climatechange.ca.gov/wetcat/index.html>
- Great Lakes Statement of Common Purpose
 - <http://collaborate.csc.noaa.gov/nroc/default.aspx>
- Gulf of Mexico Alliance Action Plan II for Healthy and Resilient Coasts, 2009-2014
 - http://www.gulfofmexicoalliance.org/pdfs/ap2_final2.pdf?#Page=8

The NWP will work to expand opportunities for dialogue through both formal and informal discussion. For example, the Advisory Committee on Water Information (ACWI) and the National Drinking Water Advisory Committee (NDWAC) are key Federal Advisory Committee (FACAs). The NWP’s State-Tribal Climate Change Council (STC3) is an important discussion forum with state and tribal co-regulators. Collaboration with sector partnerships are particularly important avenues for promoting research, pilots, and communication, including associations such as the Water Utility Climate Alliance (WUCA), WRF and the WERF.

Climate impacts are local as are adaptation strategies – hence many EPA Regions are building collaborations with state, Tribal, and local government

Examples of Federal Collaborative Forums

- Interagency Climate Change Adaptation Task Force, Freshwater Workgroup
- OSTP Subcommittee on Water Availability and Quality
- U.S. Global Change Research Program
- Climate Change and Water Working Group

agencies as well as with other federal agencies to more effectively deliver services. Information on Regional partnerships can be found in Section IV, *Geographic Climate Regions*.

Federal partnerships are also essential to leverage resources and build national capability for

adaptation. The NWP will continue to strengthen and expand our coordination on climate change adaptation and mitigation with other federal agencies at both the national and regional levels.

Delivering Tools and Training

Many of the Strategic Actions throughout this *2012 Strategy* are driven by the over-riding need to improve the translation of climate impact projections into materials tailored for NWP partners and constituents, including regionally specific information. The NWP will work to make available information, including training to help practitioners apply new tools. The NWP will collaborate with various forums for delivering the information and training.

National Water Program Implementation

- The core CWA, SDWA and other statutorily authorized programs within the NWP have training forums that reach out to practitioners, such as the NPDES Permit Writers training, the Watershed Academy, the Water Quality Standards Academy, and the Drinking Water Capacity Development Program.
- Partner organizations host and co-sponsor training sessions, such as those based on the *Clean Water and Safe Drinking Water Infrastructure Sustainability Policy* to promote best practices for effective utility management, energy management, and advanced asset management, and related topics such as GI and LID.

Federal Sources of Climate Change Information

- EPA
 - Water & Climate: <http://water.epa.gov/scitech/climatechange>
 - Climate Ready Water Utilities: <http://www.water.epa.gov/crwu>
 - Climate Ready Estuaries: <http://www.epa.gov/cre/>
 - Climate Change: <http://www.epa.gov/climatechange/>
- NOAA
 - Climate Service: <http://www.climate.gov>
 - RISAs: http://www.research.noaa.gov/climate/t_regional.html
 - Coasts: <http://www.csc.noaa.gov/digitalcoast/tools/index.html>
- Interagency
 - USGCRP: <http://www.globalchange.gov>
 - Smartcoasts: <http://stormsmartcoasts.org/>
<http://www.epa.gov/adr/index.html>

- Conflict Resolution is a field that can help to build skills for collaborating and consensus building for working effectively with stakeholders. The NWP will work with partners and stakeholders to draw upon the expertise and resources of the Conflict Prevention and Resolution Center (CPRC) within EPA's Office of General Counsel as well as the Regional Alternative Dispute Resolution (ADR) Specialists to conduct training.

Decision Support

- The USGCRP delivers science and science translation to inform adaptation planning.
- Federal partners are building regional capabilities, such as the National Integrated Drought Information System (NIDIS), NOAA RISAs, and the DOI LCCs and CSCs.
- The interagency Climate Change and Water Working Group (CCAWWG), under the leadership of the Bureau of Reclamation, is working to establish a training program for water resource managers.

Table 2 2011-2015 EPA Strategic Plan National Water Program Commitments

Goal 1: Taking Action on Climate Change and Improving Air Quality. Reduce greenhouse gas emissions and develop adaptation strategies to address climate change, and protect and improve air quality.

Objective 1.1: Address Climate Change. Reduce the threats posed by climate change by reducing greenhouse gas emissions and taking actions that help communities and ecosystems become more resilient to the effects of climate change.

Water-Related Strategic Measures:

- ❖ By 2015, additional programs from across EPA will promote practices to **help Americans save energy and conserve resources**, leading to expected greenhouse gas emissions reductions of 740.1 MMTCO₂ Eq. from a baseline without adoption of efficient practices.

The WaterSense Program will contribute to achieving greenhouse gas reduction goals through 2015

- ❖ By 2015, EPA will integrate climate change science trend and scenario information into **five major scientific models and/or decision-support tools** used in implementing Agency environmental management programs to further EPA's mission, consistent with existing authorities.

Under the CRWU initiative, the NWP will deploy an upgraded version of the CREAT, as well as a comprehensive toolbox of water-related climate resources by the end of 2012, to better assist water and wastewater utilities in becoming more resilient to climate change.

- ❖ By 2015, EPA will account for climate change by integrating climate change science trend and scenario information **into five rule-making processes** to further EPA's mission, consistent with existing authorities.

The NWP will incorporate climate change considerations in the development and implementation of a rulemaking by 2015.

- ❖ By 2015, EPA will build resilience to climate change by integrating considerations of climate change impacts and adaptive measures **into five major grant, loan, contract, or technical assistance programs** to further EPA's mission, consistent with existing authorities.

The NWP will help NEP grantees consider as a potential priority climate adaptation and resilience in their Comprehensive Conservation and Management Plans and develop climate adaptation plans and implementation strategies where considered a priority.

B. Goal 18: Tracking Progress and Measuring Outcomes

Strategic Action 50: *Adopt a phased approach to track programmatic progress towards Strategic Actions; achieve commitments reflected in the Agency Strategic Plan; work with the EPA Work Group to develop outcome measures.*

Tracking and measuring progress towards a stated goal provides information about the efficacy of the actions taken to inform adaptive management; provides a way to share information and lessons learned with others working toward similar ends; and provides transparency to stakeholders who have an interest in the process or outcome. Devising meaningful and practical indicators for tracking progress, however, is complex. It is preferable to measure *outcomes* rather than *outputs*, but outcomes often take many years to realize and may be hard to quantify. Tracking progress for climate change adaptation poses its own challenges, including how to evaluate avoided losses.

In addition, the 2011-2015 EPA Strategic Plan includes measures for climate change adaptation and mitigation actions (see Table 2, above) and this *2012 Strategy* reflects the NWP's commitment to achieve these measures. The EPA Climate Work Group has undertaken a process to refine and update the Agency's measures to reflect *outcomes* towards desired objectives. The NWP will work with the Agency Work Group to develop outcome measures applicable to the NWP.

NWP Phased Approach for Indicators of Progress

Currently, the most amenable approach for evaluating progress is to assess institutional progress toward becoming a resilient and adaptive program. The NWP proposes to adopt a phased approach that uses indicators of progress which emphasizes peer-to-peer learning rather than a top-down mandate. A similar approach is in use in the United Kingdom (UK DEFRA 2010).

Initially, the NWP Phased Approach will track the NWP's institutional *process* and *progress* in incorporating climate change considerations into EPA programs. *Outputs* will not be counted per se; rather, the collectivity of actions and their products will demonstrate *the weight of evidence* for determining the status of adaptation. An annual internal reporting process will assemble information for evaluating and reporting progress. The elements to be assessed include progress toward achieving the stated Goals and Strategic Actions (headquarters programs); and progress toward implementing Regional strategies. The NWP will work with its State-Tribal Climate Change Council and other partners to refine this approach, and develop a model that could be useable by others at their discretion.

Table 3 below presents a summary of the proposed phases and includes an initial assessment of the progress towards adapting the NWP as a whole. Recognizing that it may take years or decades to achieve adaptive preparedness and resilience, the NWP designed phases for which progress could be demonstrated within a relatively short time frame (1-3 years) .

Table 3. Phase of Adaptive Management



Full Progress



Substantial Progress



Initiated

NWP Phases	Explanation	Examples of Evidence of Achievement	NWP Status
1. Initiation	<ul style="list-style-type: none"> Conduct a screening assessment of potential implications of climate change to mission, programs, and operations. 	<ul style="list-style-type: none"> Preliminary information is developed to evaluate relevance of climate change to the mission or program; a decision is made as to whether to prepare a response to climate change; further exploration of climate change implications has been authorized. Accountabilities and responsibilities are assigned at appropriate levels within the organization and resources are available to develop a more in-depth assessment. 	
2. Assessment	<ul style="list-style-type: none"> Conduct a broader review to understand how climate change affects the resources in question. Work with stakeholders to develop an understanding of the implications of climate change to the mission, programs, and operations. 	<ul style="list-style-type: none"> Review science literature and assessments to understand how climate change affects the resources being protected (threat to mission); Engage internal staff and external stakeholders in evaluation. Identify climate change issues and concerns and communicate with internal and external stakeholders and partners. Identify which specific programs are threatened and what specific information or tools need to be developed. Communicate findings to partners and stakeholders and engage them in dialogue on building adaptive capacity. 	
3. Response Development	<ul style="list-style-type: none"> Identify changes necessary to continue to reach program mission and goals; Develop initial action plan. Identify and seek the research, information and tools needed to support actions. Begin to build the body of tools, information and partnerships needed to build capacity internally and externally. 	<ul style="list-style-type: none"> Develop initial program vision and goals for responding to climate change. Identify needed response actions or changes that will allow the organization to begin to address climate impacts on its mission. Initiate strategies and actions in a few key areas to begin to build organizational ability to use climate information in decision processes. Identify program partners' needs for building adaptive capacity. Begin working with an external 'community of practice' to engage in tool and program development. Rudimentary methods are put in place to track progress. Develop a research strategy and partnerships to obtain additional needed research. 	

Table 3. Phase of Adaptive Management







Full Progress



Substantial Progress



Initiated

NWP Phases	Explanation	Examples of Evidence of Achievement	NWP Status
4. Initial Implementation	<ul style="list-style-type: none"> Initiate actions in selected priority programs or projects. 	<ul style="list-style-type: none"> Make it clear within the organization that incorporating climate change into programs is critical Initiate actions and plans identified in Step 3. Initiate cooperative projects with partners. Develop a range of needed information and tools. Begin to institute changes to incorporate climate change into core programs. Some program partners have begun to implement response actions. 	
5. Robust Implementation	<ul style="list-style-type: none"> Programs are underway and lessons learned are being applied to additional programs and projects. 	<ul style="list-style-type: none"> Lessons learned are evaluated and strategies are refined. Efforts are initiated to consider climate change in additional, or more complex, program elements. Continue to institute institutional changes to incorporate climate change into core programs. External communities of practice are in place to support ongoing capacity development. 	
6. Mainstreaming	<ul style="list-style-type: none"> Climate is an embedded, component of the program. 	<ul style="list-style-type: none"> The organization's culture and policies are aligned with responding to climate change. All staff have a basic understanding of climate change causes and impacts. All relevant programs, activities, and decisions processes intrinsically incorporate climate change . Methods for evaluating outcomes are in place. 	
7. Monitoring and Adaptive Management	<ul style="list-style-type: none"> Continue to monitor and integrate performance, new information, and lessons learned into programs and plans. 	<ul style="list-style-type: none"> Progress is evaluated and needed changes are implemented. As impacts of climate change unfold, climate change impacts and organizational responses are reassessed. 	

C. Goal 19: Climate Change and Water Research Needs

Strategic Action 51: *Work with ORD, other water science agencies, and the water research community to further define needs and develop research opportunities to deliver the information needed to support implementation of the 2012 Strategy, including providing the decision support tools needed by water resource managers.*

This section describes the types of research questions that need to be addressed to support the Strategic Actions in this *2012 Strategy*. In general, research for adaptation should provide decision support to manage risk in an evolving context under ranges of uncertainty.

The NWP collaborates with and relies on the broader research community including EPA ORD, federal science agencies (e.g., USGS, NOAA, and the USGCRP), drinking water and water quality research associations (e.g., WRF and WERF), academia, and others. The NWP is also a member of CCAWWG, a “working level” forum to share expertise and planning to build climate adaptation tools and methods across federal agencies. These collaborations have already produced a range of reports and inventories on research needs and activities. (See: CCAWWG, 2011; WRF, 2011; EPA-ORD 2012.) The NWP will continue to work with the water research community to further define needs and develop collaborative and coordinated research opportunities to deliver the information needed by water resource managers.

Cross-Cutting Research Needs

- A. **Data:** Update data for precipitation, storm frequency, and streamflow, and develop new methods for analyzing projected changes, in collaboration with other federal agencies.
 - 1. Of particular concern are the storm frequency, duration, and intensity estimates and low flow conditions in rivers and streams at the HUC 12 watershed level;
 - 2. Improve methods to address non-stationarity, particularly improving clarity of precipitation data used in wastewater, drinking water and stormwater management systems design, operation and planning (e.g. TP40, Atlas 14); and
 - 3. Enhance flow estimation using NHDPlus.
- B. **Decision Support:** Integrate non-stationarity and recent data into decision support tools for water utilities and water quality managers to use in planning across a range of plausible climate change scenarios.
 - 1. Research Translation: Produce annual or biennial synthesis reports of recent research and implications for decision makers to inform the water resource management community.
 - 2. Modify climate model outputs that can be used as inputs for hydrologic and management models at the spatial and temporal scales relevant to decision makers;
 - 3. Develop regionally-specific information (include description of observed and projected impacts, scenarios, etc.) for communicating with communities and tribes;

4. Develop models that integrate hydrology, land cover, air quality and economics for comprehensive assessment and comparison of climate change mitigation and adaptation policies for local, state and federal governments; and
 5. Develop a rapid response protocol to incorporate the results of the ongoing monitoring data into permitting, planning, and resource allocation decisions.
- C. Metrics:** Develop measures and metrics to track and determine progress in climate change adaptation and preparedness.

Research to Support Infrastructure

- A. Water Demand Management:** Design metrics for water and energy efficiency in key sectors (e.g. municipal use; energy production and agriculture). Produce methods and technology transfers in various sectors to reduce water demand.
- B. Water Supply Management:** Develop alternative and nonconventional water supplies that will relieve pressure on fresh water sources and ensure the protection of current and future sources of drinking water.
- C. Energy-Water Nexus:** Develop zero-net energy strategies through Life Cycle Analysis of water/energy consumption and optimization and co-generation.
- D. Aquifer Storage and Recharge:** Research into technologies to minimize mobilization of geologic chemicals/radionuclides and the formation of new drinking water contaminants by injectate that is already treated to national drinking water standards. Consider natural attenuation of microbes in different soil and geologic profiles and disinfectant byproducts from treated injectate. Also identify configurations that minimize adverse effects on surface water/ground water interchange, e.g., that maintain healthy instream flows to support aquatic habitats.
- E. Economics:** Conduct cost-benefit analysis of climate change adaptation strategies. Evaluate the cost of adapting versus the comparative costs of business-as-usual approaches. Calculate the value of built infrastructure at risk from climate change especially from sea level rise and flooding and use this information in economic assessments of potential adaptation strategies.

Research to Support Watersheds and Wetlands

- A. Monitoring:** Identify aquatic ecosystem responses to changes in temperature, precipitation and sea level rise. Identify water chemistry changes including possible acidification effects that may be occurring in freshwater and estuarine systems. Develop water monitoring designs to track parameters relevant to climate change impacts. Identify and measure shifts over time in the condition of water resources attributed to climate change.
- B. Hydrology:** Improve the understanding of climate change on the hydrologic function of wetlands and in providing ecological services. Increase the understanding of the hydrological connections between surface water and groundwater to inform IWRM. Model potential changes to flood regulation, ground water recharge, and surface water base flow given scenarios of wetlands loss. Assess different types of wetlands' capacity to adapt to climate change.
- C. Co-benefits:** Characterize co-benefits of healthy watersheds, green infrastructure and site conditions where GI is cost effective and where it is not:

1. Identify climate change mitigation and adaptation strategies that lead to water quality improvements such as increased groundwater recharge and stormwater runoff mitigation and reduced cost for stormwater management and green space connectivity; and.
2. Develop method to measure carbon sequestration potential for aquatic ecosystems (e.g., wetland types and forested watersheds).

Research to Support Coastal and Ocean Planning

- A. **Ocean Acidification:** Understand likely impacts of ocean acidification to coastal systems/system components, and identify and fill information gaps. Assess relative vulnerabilities in order to identify sites appropriate for action to increase coral reef resiliency.
- B. **Sea Level Rise:** Accurate mapping of relative historic and projected sea level rise and its impacts. Determine which coastal wetlands and ecosystems to protect or restore and those that are “lost”.
- C. **Temperature:** Investigate potential impacts of climate change such as warming water temperatures on eutrophication and ecology.

Research to Support Water Quality

- A. **Pathogens:** Evaluate potential changes in exposure factors and assessment methods for waterborne pathogens that result from climate change. Develop models to better understand how increased water temperature affects pathogen survival and proliferation, drinking water treatment and sanitary waste treatment requirements based on WQBELs or ELGs. Identify contaminants that may more greatly affect PWS non-compliance by increases or decreases in precipitation or ground water levels.
- B. **Precipitation:** Identify impacts from changes, such as extreme precipitation events, that may increase sediment loading or scouring, nutrient, pathogen and toxic contaminant loads to water bodies.
- C. **Nitrogen Cycle:** Assess air-water interactions (i.e., sources and sinks) of nitrogen and develop strategies to reduce impacts to aquatic ecosystems and ground and surface drinking water sources.
- D. **Flow:** Characterize ecological flow criteria for aquatic species to protect designated uses given climate change intensifying the competition for finite water resources. The criteria may be useful in developing TMDLs.

Research to Support Tribes

- A. **TEK:** Strengthen the ability to incorporate tribal traditional knowledge into adaptation strategies relevant to tribes.
- B. **Overall:** Include development of tribal-specific elements in overall research strategies to understand climate change impacts and to develop adaptation strategies.

Appendix A: List of Abbreviations

ACWI	Advisory Committee on Water Information
ASR	Aquifer Storage & Recovery
AWWA	American Water Works Association
BLM	Bureau of Land Management
BOEMR	Bureau of Ocean Energy Management, Regulation & Energy
CCAWWG	Climate Change Adaptation Work Group
CCL	Contaminant Candidate List
CEQ	White House Council on Environmental Quality
CMSP	Coastal Marine Spatial Planning
CRE	Climate Ready Estuaries
CREAT	Climate Resilience Evaluation and Awareness Tool
CRWU	Climate Ready Water Utilities
CT4CW	Coming Together for Clean Water
CWA	Clean Water Act
DMR	Discharge Monitoring Report
DOE	Department of Energy
DOT	Department of Transportation
DWSRF	Drinking Water State Revolving Fund
EAT	Energy Audit Tool
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
GHG	Greenhouse gas
GI	Green Infrastructure
HAB	Harmful algal bloom
HWQS	Hydrologic and Water Quality System
ICCATF	Interagency Climate Change Adaptation Task Force
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
LCCs	Landscape Conservation Cooperatives
LID	Low Impact Development
LIDAR	Light Detection And Ranging
MPRSA	Marine Protection, Research and Sanctuaries Act
MWDs	Municipal Water Districts
NAP	National Adaptation Plan
NDWAC	National Drinking Water Advisory Council
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NHDPlus	National Hydrography Dataset Plus
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOC	National Ocean Council
NPDES	National Pollutant Discharge Elimination System

Appendix A: List of Abbreviations

NPDWR	National Primary Drinking Water Regulations
NPS	National Park Service
NRC	National Research Council
NWCA	National Wetland Condition Assessment
NWI	National Wetland Inventory
NWP	National Water Program
OAR	Office of Air and Radiation
OCSPP	Office of Chemical Safety and Pollution Prevention
OGC	Office of General Counsel
OGWDW	Office of Ground Water and Drinking Water (OW)
OITA	Office of International and Tribal Affairs
OM&R	Operations, maintenance and replacement
OP	Office of Policy
ORD	Office of Research and Development
OST	Office of Science and Technology (OW)
OSTP	White House Office of Science & Technology Policy
OSWER	Office of Solid Waste and Emergency Response
OUST	Office of Underground Storage Tanks (OSWER)
OW	Office of Water
OWM	Office of Wastewater Management (OW)
OWOW	Office of Wetlands, Oceans and Watersheds (OW)
RISAs	Regional Integrated Sciences and Assessments
SAP	Synthesis and Assessment Product
SDWA	Safe Drinking Water Act
SWAQ	Subcommittee on Water Availability and Quality
TMDLs	Total Maximum Daily Loads
USFWS	U.S. Fish and Wildlife Service
UIC	Underground Injection Control
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USDW	Underground source of drinking water
USFS	U.S. Forest Service
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
WQS	Water quality standards
WUE	Water Use Efficiency

Appendix B: Principles for an Energy Water Future

The Foundation for a Sustainable America

The nexus between energy and water is an increasingly important area for focus. There are significant societal and environmental benefits to be derived from improving coordination between the two sectors. Government should take a leadership role in this relationship and lead by example. EPA is proposing principles for government, service providers, and ratepayers to foster valuable collaboration in both the water and energy sectors to work together to meet our water and energy needs nationally and locally. The principles also serve as a reminder that necessary tradeoffs within one decision, e.g., stricter water treatment levels, can be mitigated by efforts elsewhere, e.g., reducing demand for energy/water.

Efficiency in the use and generation of energy and water should form the foundation of how we develop, distribute, recover, and use energy and water. EPA supports:

- Encouraging energy and water efficiency by the ratepayer through the use of efficient products, like ENERGY STAR- and WaterSense-certified products, supplemented by informed and wise use of resources;
- Improving system-level energy and water efficiency by water, wastewater, stormwater, and energy utilities and encourage strategic investments in efficiency;
- Using full cost rate structures while ensuring access to clean and safe water for low income households;
- Recognizing and reducing the embedded water and energy in manufactured and agricultural products; and
- Relying on education and outreach, in collaboration with local communities, to be at the forefront of encouraging efficiency.

The generation, transmission and use of energy should have the smallest impact on water resources as possible, in terms of water quality and water quantity possible. EPA supports:

- Reducing consumption or use of water for producing energy and fuels: reduce, recover, reuse, and recycle;
- Analyzing, recognizing and minimizing any impacts on downstream water quality, water quantity, and the aquatic environment including wetlands when choosing between sources of energy; and
- Practicing good stewardship to minimize potential impacts and avoid contaminants that reduce water's value or require high amounts of energy for treatment.

The pumping, treating, distribution, use, collection, reuse and ultimate disposal of water should have the smallest impact on energy resources as possible. EPA supports:

- Creating an energy efficiency management plan using established energy auditing tools;
- Addressing leaks in the water distribution system;

- Using nearby water sources where available, including rain harvesting and recycled water;
- Treating water to a level that matches the end use; and
- Avoiding unnecessary transport of water and wastewater for treatment or disposal.

Waste water treatment facilities, which treat human and animal waste, should be viewed as renewable resource recovery facilities that produce clean water, recover energy and generate nutrients. EPA supports:

- Using wastewater and associated organic solids and treatment byproducts as a source of renewable energy, such as methane gas, that can be used by treatment plants to reduce net 'on-grid' energy use;
- Using wastewater for irrigation, accounting for the nutrients in the water as way to reduce the need for additional fertilizers;
- Recycling or reusing water for appropriate uses, minimizing energy used for treatment, and becoming a reliable source for the future; and
- Extracting and using nutrients, fats, oils and grease from wastewater.

The water and energy sectors – government, utility, manufacturers, and consumers – should move toward integrated resource management for energy and water from source, production and generation to end user. EPA supports:

- Encouraging the water and energy sectors – both governments and utilities –to continue to align themselves to breakdown institutional barriers, improve transparency, and maximize efficiencies;
- Encouraging government agencies to look across missions and private utilities to look across sectors to achieve integrated resource management, maximize efficiencies and avoid unintended consequences;
- Encouraging government and service providers to leverage and expand upon existing successes and institutions; and
- Promoting transparency and collaboration related to research, funding and policy within institutions and across sectors, which are essential and will help to leverage lessons learned and expand successes.

Maximize comprehensive, societal benefits. EPA supports:

- Articulating and recognizing the benefits for the larger sphere of influence of public and private investment – beyond direct cost savings – in energy and water efficiencies;
- Enhancing, promoting, and targeting financial incentives and other societal benefits, including market-based benefits such as rebates and government programs such as state revolving funds, taxes and tax credits; and
- Planning to build resiliency for climate change impacts on water infrastructure and water quality to minimize vulnerabilities.

Appendix C: References

BOR, 2010. Memorandum of Understanding for Hydropower, Among the Department of Interior, Department of Energy, and the Army, March 24, 2010. Available at: <http://www.usbr.gov/power/SignedHydropowerMOU.pdf>

BOR, 2011. SECURE Water Act Section 9503(c) - Reclamation Climate Change and Water 2011, April 2011. Available at: <http://www.usbr.gov/climate/SECURE/>.

Brekke, 2009. *Climate change and water resources management—A federal perspective: U.S. Geological Survey Circular 1331*, Brekke, L.D., Kiang, J.E., Olsen, J.R., Pulwarty, R.S., Raff, D.A., Turnipseed, D.P., Webb, R.S., and White, K.D., 2009. Available at: <http://pubs.usgs.gov/circ/1331/>.

CA, 2011a. IWRM Handbook, California Department of Water Resources, available at: www.water.ca.gov/irwm/.

CA, 2011b. *Embedded Energy in Water - Pilot Programs Impact Evaluation Final Report*, ECONorthwest, March 9, 2011. Prepared for the California Public Utilities Commission Energy Division. Available at: http://www.energydataweb.com/cpucFiles/33/FinalEmbeddedEnergyPilotEMVReport_1.pdf.

CBPO, 2010. Chesapeake Bay Executive Order Strategy, May 12, 2010. Available at: <http://executiveorder.chesapeakebay.net/post/New-Federal-Strategy-for-Chesapeake-Launches-Major-Initiatives-and-Holds-Government-Accountable-for-Progress.aspx>.

CCAWWG, 2011. *Addressing Climate Change in Long-Term Water Resources Planning and Management: User Needs for Improving Tools and Information*. Available at: <http://www.usbr.gov/research/climate/>.

CEQ, 2009. Executive Order 13514 *Federal Leadership in Environmental, Energy, and Economic Performance*,” Section 16. October 5, 2009. Available at: http://www.whitehouse.gov/assets/documents/2009fedleader_eo_rel.pdf.

CEQ, 2010. Interagency Climate Change Adaptation Task Force, report to the President, October 4, 2010, and Water Workgroup Report, October 5, 2010. Available at: <http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation>.

CEQ, 2011a. *National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate*, Report of the Freshwater Workgroup, Interagency Climate Change Adaptation Task Force, October 28, 2011. Available at: http://www.whitehouse.gov/sites/default/files/microsites/ceq/2011_national_action_plan.pdf.

CEQ, 2011b . *Instructions for Implementing Climate Change Adaptation Planning In Accordance With Executive Order 13514, Federal Agency Climate Change Adaptation Planning - Implementing Instructions*, March 4, 2011. Available at: http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_final_implementing_instructions_3_3.pdf.

CSO, 2011. Coastal States Organization web site, accessed January, 2011. Available at: <http://www.coastalstates.org/>

DOE, 2011. U.S. Department of Energy, Energy Efficiency and Renewable Energy, available at: <http://www.eere.energy.gov/>.

DOE, 2012. Secure Water Act of 2009 (Public Law 111-11), Section 9505 Report to Congress on the effects of climate change on federal hydropower systems. *Forthcoming*. Available at: <http://nhaap.ornl.gov/content/climate-change-impacts>

Dore, M. and I. Burton, 2001. *The Costs of Adaptation to Climate Change in Canada: A Stratified Estimate by Sectors and Regions—Social Infrastructure*. Climate Change Laboratory, Brock University, St. Catharines, Ontario. 117 pp.

EPA. Environmental Protection Agency Climate Change website. Accessed June 13, 2011. Available at: <http://www.epa.gov/climatechange/>.

EPA, 2004. *Guidelines for Water Reuse*. Environmental Protection Agency, EPA/625/R-04/108, September 2004. Available at: <http://www.epa.gov/ord/NRMRL/pubs/625r04108/625r04108.pdf>.

EPA, 2007. *Distribution System Inventory, Integrity and Water Quality*. Environmental Protection Agency, January 2007. Available at: http://www.epa.gov/ogwdw/disinfection/tcr/pdfs/issuepaper_tcr_ds-inventory.pdf.

EPA 2008a. *National Water Program Strategy: Response to Climate Change*. Environmental Protection Agency, EPA 800-R-08-001, September 2008. Available at: <http://water.epa.gov/scitech/climatechange/strategy.cfm>.

EPA, 2008b. *Ensuring a Sustainable Future: An Energy management Guidebook for Wastewater and Water Utilities*. Environmental Protection Agency, January 2008. Available at: http://water.epa.gov/infrastructure/sustain/cutting_energy.cfm.

EPA, 2009a. *Biofuels Compendium*. Environmental Protection Agency, July 21, 2009. Available at: <http://www.epa.gov/oust/altfuels/bfcompend.htm>.

EPA, 2009b. *National Pollutant Discharge Elimination System (NPDES)*. Environmental Protection Agency, March 12, 2009. Available at: <http://cfpub.epa.gov/npdes/>.

EPA, 2009c. National Drinking Water Advisory Council Request for Climate Ready Water Utilities Working Group Nominations. Federal Register, July 8, 2009 (Volume 74, Number 129, pp. 32595 – 32596. Available at: <http://www.epa.gov/fedrgstr/EPA-WATER/2009/July/Day-08/w16006.htm>.

EPA, 2009d. U.S. EPA Proceedings: *First National Expert and Stakeholder Workshop on Water Infrastructure Sustainability and Adaptation to Climate Change*. Environmental Protection Agency. Available at: <http://www.epa.gov/nrmrl/wswrd/wq/wrap/workshop.html>.

EPA, 2010a. FY 2011-2015 Strategic Plan. Environmental Protection Agency, September 30, 2010. Available at: <http://www.epa.gov/planandbudget/strategicplan.html>.

EPA, 2010b. EPA Guidelines for Preparing Economic Analyses, Dec. 2010. Available at: <http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html>.

EPA, 2010c. *Clean Water and Drinking Water Infrastructure Sustainability Policy*, Oct. 4, 2010. Available at: <http://water.epa.gov/infrastructure/sustain/Clean-Water-and-Drinking-Water-Infrastructure-Sustainability-Policy.cfm>.

EPA, 2010d. *Control and Mitigation of Drinking Water Losses in Distribution Systems*. Environmental Protection Agency, EPA 816-R-10-019, November 2010. Available at: <http://www.epa.gov/region9/waterinfrastructure/waterenergy.html>.

EPA, 2010e. Underground Injection Control Program. Environmental Protection Agency, December 13, 2010. Available at: <http://water.epa.gov/type/groundwater/uic/>.

EPA, 2010f. *Compatibility of Underground Storage Tank Systems with Biofuel Blends*. Federal Register, November 17, 2010 (Volume 75, Number 221, pp. 70241 – 70246. Available at: <http://www.gpo.gov/fdsys/pkg/FR-2010-11-17/pdf/2010-28968.pdf>.

EPA, 2011a. Policy Memo from Lisa Jackson establishing the EPA Climate WG. <http://www.epa.gov/climatechange/effects/downloads/adaptation-statement.pdf>.

EPA, 2011b. *Coming Together for Clean Water: EPA's Strategy To Protect America's Waters*. April 2011. Available at: <https://blog.epa.gov/waterforum/wp-content/uploads/2011/04/ComingTogether-for-Clean-Water-FINAL.pdf>.

EPA, 2011c. Climate Ready Water Utilities Toolbox. Available at: <http://www.epa.gov/safewater/watersecurity/climate/toolbox.html>.

EPA, 2011d. Sustainable Infrastructure: Energy Efficiency & Renewable Energy Opportunities, Environmental Protection Agency. Accessed June 12, 2011. Available at: <http://water.epa.gov/infrastructure/sustain/energyefficiency.cfm>.

EPA, 2011e. WaterSense Program Accomplishments, Environmental Protection Agency. Available at: http://www.epa.gov/WaterSense/about_us/program_accomplishments.html.

EPA, 2011f. WaterSense, Environmental Protection Agency. Available at: <http://www.epa.gov/WaterSense/>.

EPA, 2011g. Healthy Watersheds. Environmental Protection Agency, April 5, 2011. Available at: <http://water.epa.gov/polwaste/nps/watershed/index.cfm>.

EPA, 2011h. *Rolling Easements Primer*. Environmental Protection Agency, June, 2011. Available at: www.epa.gov/cre/downloads/rollingeasementsprimer.pdf.

EPA, 2011i. Memorandum of Agreement. DHS (FEMA and EPA. Environmental Protection Agency, May 12, 2010. Available at : http://www.epa.gov/dced/pdf/2011_0114_fema-epa-moa.pdf.

EPA, 2011j. *Managing Wet Weather With Green Infrastructure*. Environmental Protection Agency, January 4, 2011. Available at: http://cfpub.epa.gov/npdes/home.cfm?program_id=298.

EPA, 2011k. Low Impact Development. Environmental Protection Agency, March 18, 2011. Available at: <http://www.epa.gov/owow/NPS/lid/>.

EPA, 2011l. Impaired Waters and Total Maximum Daily Loads. Environmental Protection Agency, March 21, 2011. Available at: <http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/index.cfm>.

EPA, 2011m. Renewable Fuels: Regulations and Standards. Environmental Protection Agency, March 23, 2011. Available at: <http://www.epa.gov/oms/fuels/renewablefuels/regulations.htm>.

EPA, 2011n. National Aquatic Resource Surveys. Environmental Protection Agency, April 8, 2011. Available at: <http://water.epa.gov/type/watersheds/monitoring/nationalsurveys.cfm>.

EPA, 2012. Energy Audit Tool available at: <http://www.epa.gov> [forthcoming].

EPA-OAR. Energy Efficiency & Renewable Energy Opportunities. Website, accessed June 18, 2011. Available at: <http://water.epa.gov/infrastructure/sustain/energyefficiency.cfm>.

EPA-ORD. Science Inventory. Searchable database available at: <http://cfpub.epa.gov/si/>

EPA-R9, 2011. Sustainable Water Infrastructure. Environmental Protection Agency, Region 9, December 31, 2010. Available at: <http://www.epa.gov/region9/waterinfrastructure/index.html>.

EPRI, 2002. *Water & Sustainability (Volume 4): U.S. Electricity Consumption for Water Supply & Treatment – the next half century*. Electric Power Research Institute (EPRI) (2002).

Frederick, 2000. Frederick, K. and G. Schwarz. 2000. Socioeconomic Impacts of Climate Variability and Change on U.S. Water Resources. Washington, DC: Resources for the Future.

FWP, 2011. Fish, Wildlife and Plants Climate Adaptation Workgroup. Available at: <http://www.wildlifeadaptationstrategy.gov/index.php>.

Hayhoe, K., C.P. Wake, T.G. Huntington, L. Luo, M. Schwartz, J. Sheffield, E. Wood, B. Anderson, J. Bradbury, A. DeGaetano, T. Troy, and D. Wolfe. Climate Dynamics. *Past and Future Changes in Climate and Hydrological Indicators in the U.S. Northeast*. 2007. Available at: http://www.northeastclimateimpacts.org/pdf/tech/hayhoe_et_al_climate_dynamics_2006.pdf.

Jackson, 2006. Jackson, S. *Vegetation, environment, and time: the origination and termination of ecosystems*. Journal of Vegetation Science 17: 549-557. Available at: [http://www.bioone.org/doi/abs/10.1658/1100-9233\(2006\)17%5B549:VEATTO%5D2.0.CO%3B2](http://www.bioone.org/doi/abs/10.1658/1100-9233(2006)17%5B549:VEATTO%5D2.0.CO%3B2)

Kirshen, 2006. Kirshen, R., M. Ruth and W. Anderson. 2006. "Climate's Long term Impacts on Urban Infrastructures and Services: The Case of Metro Boston." In: Regional Climate Change and Variability: Impacts and Responses, Eds. M. Ruth, K. Donaghy, and P. Kirshen.

Kirshen, 2008. Kirshen, P., C. Watson, E. Douglas, A. Gontz, J. Lee, and Y. Tian. Mitigation and Adaptation Strategies for Global Change, *Coastal Flooding in the Northeastern United States Due to Climate Change*. 2008. Available at: http://www.northeastclimateimpacts.org/pdf/miti/kirshen_et_al.pdf.

MEA, 2005. Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Synthesis. Washington, DC: Island Press.

MWDSC, 2008. Integrated Resources Plan (IRP). Metropolitan Water District of Southern California, October 2008. Available at: http://www.mwdh2o.com/mwdh2o/pages/yourwater/irp/More_Water_Resources.html.

Neumann, 2010. Neumann, J., Hudgens, D., Herter, J., Martinich, J. *The economics of adaptation along developed coastlines*. Published Online: Dec 08 2010. Available at: <http://wires.wiley.com/WileyCDA/WiresArticle/wisld-WCC90.html>.

NDWAC, 2010. *Climate Ready Water Utilities Working Group, Final Report to the National Drinking Water Advisory Council*. Dec. 9, 2010. Available at: <http://water.epa.gov/infrastructure/watersecurity/climate/upload/NDWAC-overview-of-CRWU-10.pdf>.

NOC, 2011. The National Ocean Council. Available at: <http://www.whitehouse.gov/administration/eop/oceans>.

NRC 2009. *Ecological Impacts of Climate Change*. National Academy of Sciences. http://dels-old.nas.edu/dels/rpt_briefs/ecological_impacts.pdf.

NRC, 2010a-d. *America's Climate Choices. Four Volumes: a) Limiting the Magnitude of Future Climate Change; b) Adapting to the Impacts of Climate Change; c) Advancing the Science of Climate Change; d) Informing Effective Decisions and Actions Related to Climate Change.* National Academies of Sciences, 2010. Available at: <http://americasclimatechoices.org/>.

NRC, 2010e. *Climate Stabilization Targets: Emissions, Concentrations, and Impacts Over Decades to Millennia.* http://books.nap.edu/catalog.php?record_id=12877.

NRC, 2010f. *Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean.* National Academies Press, ISBN: 978-0-309-15359-1. Available at: http://www.nap.edu/catalog.php?record_id=12904.

NRC, 2011a. *Warming World: Impacts by Degree. Based on the National Research Council report, Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia (2011).* . <http://dels.nas.edu/materials/booklets/warming-world>.

OCWD, 2008. Orange County Water District Programs and Projects Overview. Accessed June 13, 2011. Available at: <http://www.ocwd.com/Programs---Projects/ca-17.aspx>.

TNC, 2008. Smith, M.P., Schiff, R., Olivero, A., & MacBroom, J. *The Active River Area: A Conservation Framework for Protecting Rivers and Streams.* Boston: The Nature Conservancy, 2008. Available at: http://www.floods.org/PDF/ASFPM_TNC_Active_River_%20Area.pdf.

UK DEFRA, 2010. Adapting to Climate Change: Guidance notes for NI188, March 2010. Available at: <http://www.defra.gov.uk/environment/climate/sectors/local-authorities/>; and <http://archive.defra.gov.uk/corporate/about/with/localgov/indicators/documents/ni188-guidance.pdf>.

USACE, 2010a. *Building Strong Collaborative Relationships for a Sustainable Water Resources Future: National Report Responding to National Water Resources Challenges, August, 2010.* U.S. Army Corps of Engineers. Available at: http://www.building-collaboration-for-water.org/Documents/nationalreport_final.pdf.

USACE, 2010b. Federal Support Toolbox for IWRM. Available at: <http://www.building-collaboration-for-water.org/>.

USBR, 2011. WaterSMART: Sustain and Manage America's Resources for Tomorrow. U.S. Department of the Interior, Bureau of Reclamation, March 22, 2011. Available at: <http://www.usbr.gov/WaterSMART/>.

USGCRP, 2008. Synthesis and Assessment Product 4.4: *Preliminary review of adaptation options for climate-sensitive ecosystems and resources.* U.S. Global Change Research Program. Available at: <http://www.climate-science.gov/Library/sap/sap4-4/final-report/>.

USGCRP, 2009a. *Global Climate Change Impacts in the United States*, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009. Available at: <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts>.

USGCRP, 2009b. Synthesis and Assessment Product 4.1: *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*. U.S. Global Change Research Program. Available at: <http://www.globalchange.gov/publications/reports/scientific-assessments/saps/302>.

USGCRP, 2011. National Climate Assessment Workshop, Draft Report: *Valuation Techniques and Metrics for Climate Change Impacts, Adaptation, and Mitigation Options*, available at: <http://www.nesdis.noaa.gov/NCADAC/pdf/15b.pdf>.

USGS, 2011. National Hydrography Dataset Plus website. Accessed June 13, 2011. Available at: <http://www.horizon-systems.com/nhdplus/>.

WERF, 2010. *Sustainable Treatment: Best Practices from the Strass im Zillertal Wastewater Treatment Plant*, March, 2010. Water Environment Research Foundation, Stock No. OWSO4R07b. Available at: <http://www.werf.org/AM/Template.cfm?Section=Search&Template=/CustomSource/Research/PublicationProfile.cfm&id=OWSO4R07b>.

WRF, 2011. The Future of Research on Climate Change. Impacts on Water. A Workshop Focusing on Adaptation Strategies and Information Needs. Available at: <http://www.waterrf.org/projectsreports/publicreportlibrary/4340.pdf>

World Resources Institute. Millennium Ecosystem Assessment (MEA), 2005. Available at: <http://www.maweb.org/documents/document.358.aspx.pdf>.

Appendix D: Goals and Strategic Actions: Lead Offices⁶

Goals and Strategic Actions		Lead Office (& Partners)
<p>❖ Infrastructure: <i>In the face of a changing climate, resilient and adaptable drinking water, wastewater and stormwater utilities (water sector) ensure clean and safe water to protect the nation's public health and environment by making smart investment decisions to improve the sustainability of their infrastructure and operations and the communities they serve, while reducing greenhouse gas emissions through greater energy efficiency.</i></p>		
<p>Goal 1: Build the body of information and tools needed to incorporate climate change into planning and decision making.</p>	<ul style="list-style-type: none"> • SA1: The CRWU program will work to improve access to vetted climate and hydrological science, modeling, and assessment tools. 	OGWDW (OWM)
	<ul style="list-style-type: none"> • SA2: Assist water utilities to reduce GHG emissions and increase long-term sustainability with a combination of energy efficiency, co-generation, and renewable energy resources. 	OWM (OGWDW)
	<ul style="list-style-type: none"> • SA3: Explore climate change challenges to drinking water safety and assist public water systems in meeting health-based drinking water standards. 	OGWDW
	<ul style="list-style-type: none"> • SA4: Promote sustainable design approaches to ensure the long-term sustainability of infrastructure and operations 	OWM (OGWDW)
<p>Goal 2: Support IWRM to sustainably manage water resources.</p>	<ul style="list-style-type: none"> • SA5: Understand and promote through technical assistance the use of water supply management strategies. 	OWM (OGWDW)
	<ul style="list-style-type: none"> • SA6: Evaluate and provide technical assistance on the use of water demand management strategies. 	OWM (OGWDW)
	<ul style="list-style-type: none"> • SA7: Increase cross-sector knowledge of water supply climate challenges and develop watershed specific information to inform decision making. 	OW IO (All OW Offices)
<p>❖ Watersheds & Wetlands: <i>Watersheds are protected, maintained and restored to ensure climate resilience and to preserve the social and economic benefits they provide; and the nation's wetlands are maintained and improved using integrated approaches that recognize their inherent value as well as their role in reducing the impacts of climate change.</i></p>		
<p>Goal 3: Identify, protect, and maintain a network of healthy watersheds and supportive habitat corridor networks.</p>	<ul style="list-style-type: none"> • SA8: Develop a national framework and support efforts to protect remaining healthy watersheds and aquatic ecosystems. 	OWOW
	<ul style="list-style-type: none"> • SA9: Collaborate with partners on terrestrial ecosystems and hydrology so that effects on water quality and aquatic ecosystems are considered. 	OWOW
	<ul style="list-style-type: none"> • SA10: Integrate protection of healthy watersheds throughout the NWP core programs. 	OWOW

⁶ OGWDW=Office of Groundwater and Drinking Water; OWM=Office of Wastewater Management; OWOW=Office of Wetlands, Oceans and Watersheds; OST=Office of Science and Technology; OW IO=Office of Water Immediate Office

Goals and Strategic Actions		Lead Office (& Partners)
	<ul style="list-style-type: none"> • SA11: Increase public awareness of the role and importance of healthy watersheds in reducing the impacts of climate change. 	OWOW
Goal 4: Incorporate climate resilience into watershed restoration and floodplain management.	<ul style="list-style-type: none"> • SA12: Consider a means of accounting for climate change in EPA funded and other watershed restoration projects. 	OWOW
	<ul style="list-style-type: none"> • SA13: Work with federal, state, tribal, and local partners to protect and enhance buffers to rivers, streams, lakes, wetlands, and coastal resources as a means of building resiliency. 	OWOW
Goal 5: Watershed protection practices incorporate Source Water Protection to protect drinking water supplies.	<ul style="list-style-type: none"> • SA14: Encourage states to consider updating their source water delineations, assessments or protection plans to address anticipated climate change impacts. 	OGWDW
	<ul style="list-style-type: none"> • SA15: Continue to support collaborative efforts to increase state and local awareness of source water protection needs and opportunities, and encourage inclusion of source water protection areas in local climate change adaptation initiatives. 	OGWDW
Goal 6: Incorporate climate change considerations into the CWA 404 regulatory program as they relate to permit reviews and compensatory mitigation.	<ul style="list-style-type: none"> • SA16: Consider climate change effects in relation to significant degradation determinations in the CWA Section 404 program. 	OWOW
	<ul style="list-style-type: none"> • SA17: Evaluate, in conjunction with the USACE, how wetland and stream compensation projects could be selected, designed, and sited to aid in reducing the effects of climate change. 	OWOW
Goal 7: Improve baseline information on wetland extent, condition and performance to inform effective adaptation to climate change.	<ul style="list-style-type: none"> • SA18: Expand wetland mapping by supporting wetland mapping coalitions and training on use of the new federal Wetland Mapping Standard. 	OWOW
	<ul style="list-style-type: none"> • SA19: Produce a statistically valid, ecological condition assessment of the nation's wetlands. 	OWOW
<p>❖ Coastal and Ocean Waters: <i>Adverse effects of climate change and unintended adverse consequences of responses to climate change have been successfully prevented or reduced in the ocean and coastal environment. Federal, tribal, state, and local agencies, organizations, and institutions are working cooperatively; and information necessary to integrate climate change considerations into ocean and coastal management is produced, readily available, and used.</i></p>		
Goal 8: Collaborate to ensure information and methodologies for ocean and coastal areas are collected, produced, analyzed, and easily available.	<ul style="list-style-type: none"> • SA20: Collaborate to ensure that synergy occurs, lessons learned are transferred, federal efforts effectively help local communities, and efforts are not duplicative or at cross-purposes. 	OWOW
	<ul style="list-style-type: none"> • SA21: Work to be sure that knowledge and information needed to protect ocean and coastal areas is collected, produced, analyzed, or formatted for users, and is easily available. 	OWOW

Goals and Strategic Actions		Lead Office (& Partners)
Goal 9: EPA geographically targeted programs support and build networks of local, tribal, state, regional and federal collaborators to take effective adaptation measures for coastal and ocean environments.	<ul style="list-style-type: none"> • SA22: Work with the NWP’s larger geographic programs to incorporate climate change considerations, focusing on both the natural and built environments. 	OWOW (Regions)
	<ul style="list-style-type: none"> • SA23: The National Estuary Programs will address climate change adaptation in implementing their Comprehensive Conservation and Management Plans (CCMP) and through the Climate Ready Estuary Program, and will build stakeholder capacity. 	OWOW
	<ul style="list-style-type: none"> • SA24: Conduct outreach and education, and provide technical assistance to state and local watershed organizations and communities to build adaptive capacity in coastal areas outside the NEP and LAE programs. 	OWOW
Goal 10: Address climate driven environmental changes in coastal areas and ensure that mitigation and adaptation are conducted in an environmentally responsible manner.	<ul style="list-style-type: none"> • SA25: Support coastal wastewater, stormwater, and drinking water infrastructure owners and operators in reducing climate risks and encourage adaptation in coastal areas. 	OWOW
	<ul style="list-style-type: none"> • SA26: Support climate readiness of coastal communities, including hazard mitigation, pre-disaster planning, pre-disaster planning, preparedness, and recovery efforts. 	OWOW
	<ul style="list-style-type: none"> • SA27: Support preparation and response planning for impacts to coastal aquatic environments. 	OWOW
<p>❖ Water Quality: <i>Our Nation’s surface water, drinking water, and ground water quality are protected, and the risks of climate change to human health and the environment are diminished, through a variety of adaptation and mitigation strategies.</i></p>		
Goal 11: Ocean environments are protected by EPA programs that incorporate shifting environmental conditions, and other emerging threats.	<ul style="list-style-type: none"> • SA28: Consider climate change impacts on marine water quality in NWP ocean management authorities, policies, and programs. 	OWOW
	<ul style="list-style-type: none"> • SA29: Utilize NEPA, CWA, MPRSA, and other authorities and work with the Regional Ocean Organizations and other federal and state agencies through regional ocean groups and other networks to ensure offshore renewable energy production does not adversely affect the marine environment. 	OWOW (Regions)
	<ul style="list-style-type: none"> • SA30: Support the evaluation of sub-seabed and ocean sequestration of CO2. 	OWOW
	<ul style="list-style-type: none"> • SA31: Participate in interagency development and implementation of federal strategies through the National Ocean Council and the NOC Strategic Action Plans. 	OWOW
Goal 12: Protect waters of the United States and promote management of sustainable surface water resources.	<ul style="list-style-type: none"> • SA32: Encourage states and communities to incorporate climate change considerations into their water quality planning. 	OWOW
	<ul style="list-style-type: none"> • SA33: Encourage green infrastructure and low-impact development to protect water quality and make watersheds more resilient. 	OWM (OWOW)

Goals and Strategic Actions		Lead Office (& Partners)
	<ul style="list-style-type: none"> • SA34: Promote consideration of climate change impacts by NPDES permitting authorities. 	OWM
	<ul style="list-style-type: none"> • SA35: For future TMDLs, recommend that water quality authorities consider climate change impacts when developing waste load and load allocations. 	OWOW
	<ul style="list-style-type: none"> • SA36: Identify and protect designated uses that are at risk from climate change impacts. 	OWM (OWOW)
	<ul style="list-style-type: none"> • SA37: Clarify how to re-evaluate aquatic life water quality criteria on more regular intervals; and develop information to assist States and Tribes who are developing criteria that incorporate climate change considerations for hydrologic condition. 	OST
<p>Goal 13: As the nation makes decisions to reduce its greenhouse gas emissions and develop alternative sources of energy and fuel, the NWP will work to protect water resources from unintended adverse consequences.</p>	<ul style="list-style-type: none"> • SA38: Seek opportunities to provide additional assistance to states and permittees to assure that geologic sequestration of CO2 is responsibly managed. 	OGWDW (OWOW)
	<ul style="list-style-type: none"> • SA39: Work with ORD to better understand the risks of storing ethanol-supplemented transportation fuels and with the Office of Underground Storage Tanks to explore options to mitigate such risk through updated policies. 	OGWDW
	<ul style="list-style-type: none"> • SA40: Provide outreach materials for stakeholders to encourage the adoption of alternative sources of energy and fuels that are water efficient and maintain water quality. 	OWM (OW IO)
	<ul style="list-style-type: none"> • SA41: As climate change affects the operation or placement of reservoirs, EPA will work with other federal agencies and EPA programs to understand the combined effects of climate change and hydropower on flows, water temperature, and water quality. 	OWM
<p>Goal 14: Collaborate to make hydrological and climate data and projections available.</p>	<ul style="list-style-type: none"> • SA42: Monitor climate change impacts to surface waters and ground water. 	OWOW
	<ul style="list-style-type: none"> • SA43: Collaborate with other federal agencies to develop new methods for use of updated precipitation, storm frequency, and observational streamflow data, as well as methods for evaluating projected changes in low flow conditions. 	OW IO
	<ul style="list-style-type: none"> • SA44: Enhance flow estimation using NHDPlus. 	OWOW
<p>❖ Working With Tribes: Tribes are able to preserve, adapt, and maintain the viability of their culture, traditions, natural resources, and economies in the face of a changing climate.</p>		
<p>Goal 15: Incorporate climate change considerations in the implementation of</p>	<ul style="list-style-type: none"> • SA45: Ensure that the revised NWP Tribal Strategy and subsequent implementation of CWA, SDWA, and other core programs incorporate climate change as a key consideration. 	OW IO

Goals and Strategic Actions		Lead Office (& Partners)
core programs, and collaborate with other EPA Offices and federal Agencies to work with tribes on climate change issues on a multi-media basis.	<ul style="list-style-type: none"> • SA46: Incorporate adaptation into tribal funding mechanisms, and collaborate with other EPA and federal funding programs to support sustainability and adaptation in tribal communities. 	OW IO
Goal 16: Tribes have access to information on climate change for decision making.	<ul style="list-style-type: none"> • SA47: Collaborate to explore and develop climate change science, information and tools for tribes, and incorporate local knowledge. 	OW IO
	<ul style="list-style-type: none"> • SA48: Collaborate to develop communication materials relevant for tribal uses and tribal audiences. 	OW IO
❖ Cross-Cutting Goals		
Goal 17: Communication, Collaboration, and Training	<ul style="list-style-type: none"> • SA49: Continue building the communication, collaboration, and training mechanisms needed to effectively increase adaptive capacity at the federal, tribal, state, and local levels. 	OW IO
Goal 18: Tracking Progress And Measuring Outcomes	<ul style="list-style-type: none"> • SA 50: Adopt a phased approach to track programmatic progress towards Strategic Actions; achieve commitments reflected in the Agency Strategic Plan; work with the EPA Work Group to develop outcome measures. 	OW IO
Goal 19: Climate Change and Water Research Needs	<ul style="list-style-type: none"> • SA51: Work with ORD, other water science agencies, and the water research community to further define needs and develop research opportunities to deliver the information needed to support implementation of the <i>2012 Strategy</i>, including to provide the decision support tools needed by water resource managers. 	OST (OW IO)

Appendix E: Acknowledgments

This *2012 Strategy* is the collective product of many people. Special thanks go to the following people who contributed significantly to the development of this document.

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Special Acknowledgments for Partners and Stakeholders

The NWP owes a debt of gratitude to the many people who have engaged in the dialogue on climate change and water resources. While there are too many to name them all, we especially want to express our appreciation to the following organizations and individuals whose ideas have informed our thinking in the process of developing this *2012 Strategy*, and who have created a collaborative problem solving environment that serves the nation well in tackling this complex issue.

State-Tribal Climate Change Council

Association of State Drinking Water Administrators (ASDWA)

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Association of State and Inter State Water Pollution Control Administrators (ASIWPCA)

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Association of State Wetland Managers (ASWM)

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Association Partners

The *Water Environment Research Foundation (WERF)* and the *Water Research Foundation (WRF)* who conduct research and development activities related to wastewater treatment utilities and drinking water utilities, respectively.

The *American Water Works Association (AWWA)* and the *Association of Metropolitan Water Agencies (AMWA)* who provided valuable input and support throughout this process.

The *Water Utility Climate Alliance (WUCA)* members who have provided leadership on this issue Climate Ready Water Utilities Working Group of the National Drinking Water Advisory Committee.

