How to Use the Adaptation Strategies Guide for Water Utilities

An overview of the Guide's content and functionality for drinking water and wastewater utilities and stakeholders

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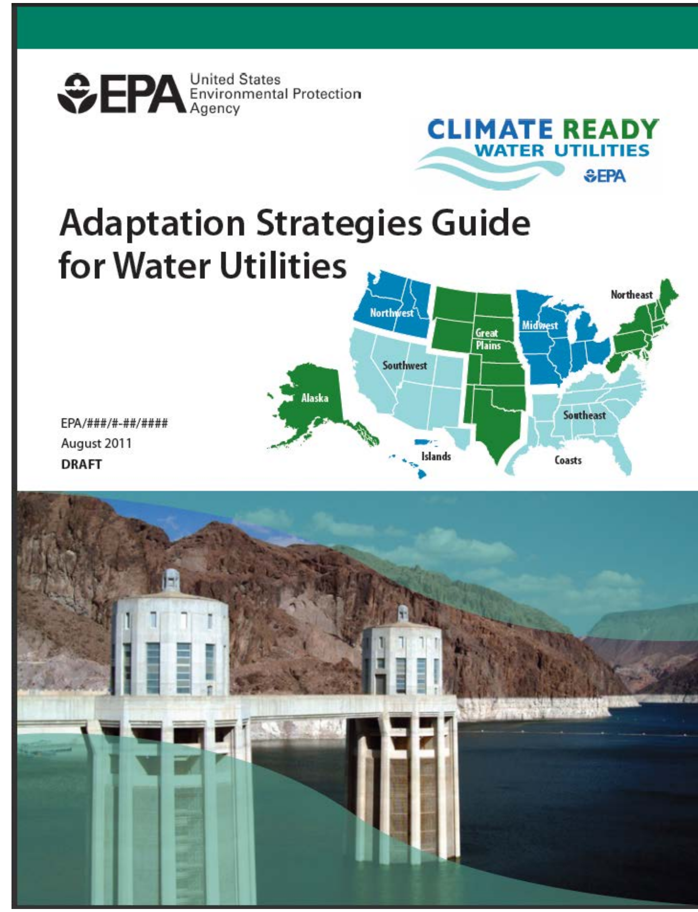
Presentation Outline

Part I—Guide Overview

- Purpose and objectives
- Guide outline
- Adaptation overview

Part II—Utility Example

- Illustrative example
- Conclusion
- For more information



Download Guide & Contact Information

To download the Adaptation Strategies Guide or for more information on the Climate Ready Water Utilities initiative, please visit water.epa.gov/infrastructure/watersecurity/climate.

If you have any questions or would like to provide feedback or suggest additional content (i.e., examples) for the Adaptation Strategies Guide, please email CRWUhelp@epa.gov .

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Part I—Adaptation Strategies Guide Overview

An overview of the Guide's content and functionality

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Purpose and Use

The purpose of the Guide is to provide drinking water and wastewater utilities and stakeholders with:

- Easy to understand, regionally-relevant climate science,
- An overview of what impacts (referred to as "challenges") changes in the climate may have on utilities, and
- Adaptation options currently being implemented at utilities and additional options for consideration.

Information in this Guide can be used to help jump start the adaptation planning process at a utility or in a community.

Guide Outline

About the Guide—Explains sources of climate information

Introduction—Gives an overview of the adaptation planning process

Climate Region Briefs—Contain regionally relevant climate information

Challenge Group Briefs—Provide climate information and adaptation strategies on groups of related climate impacts

Challenge Briefs—Provide specific climate information and adaptation strategies on a single climate impact

Glossary—Offers a more detailed explanation of adaptation options found in the challenge group and challenge briefs

Adaptation Planning Worksheet—Helps identify adaptation options of interest and assist in implementation planning at the utility level

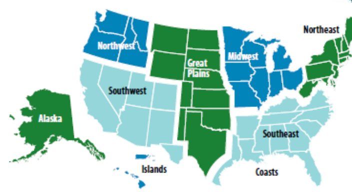
How to navigate the Guide

You can click links in different areas of the Guide, similar to how a website works

The following buttons and icons are links to other parts of the Guide:

- Links within text (i.e., *Worksheet for Adaptation Planning*)
- Return to Introduction button

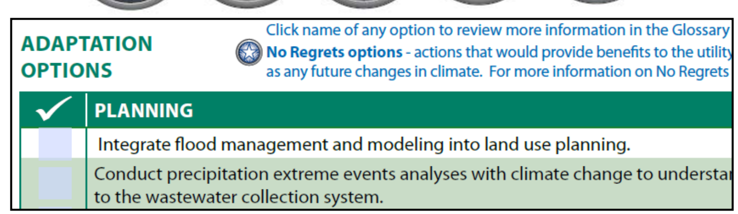
- Regional location



- Challenge Brief water droplets

- Challenge Group Icons

- Adaptation options


ADAPTATION OPTIONS

Click name of any option to review more information in the Glossary
No Regrets options - actions that would provide benefits to the utility
as any future changes in climate. For more information on No Regrets

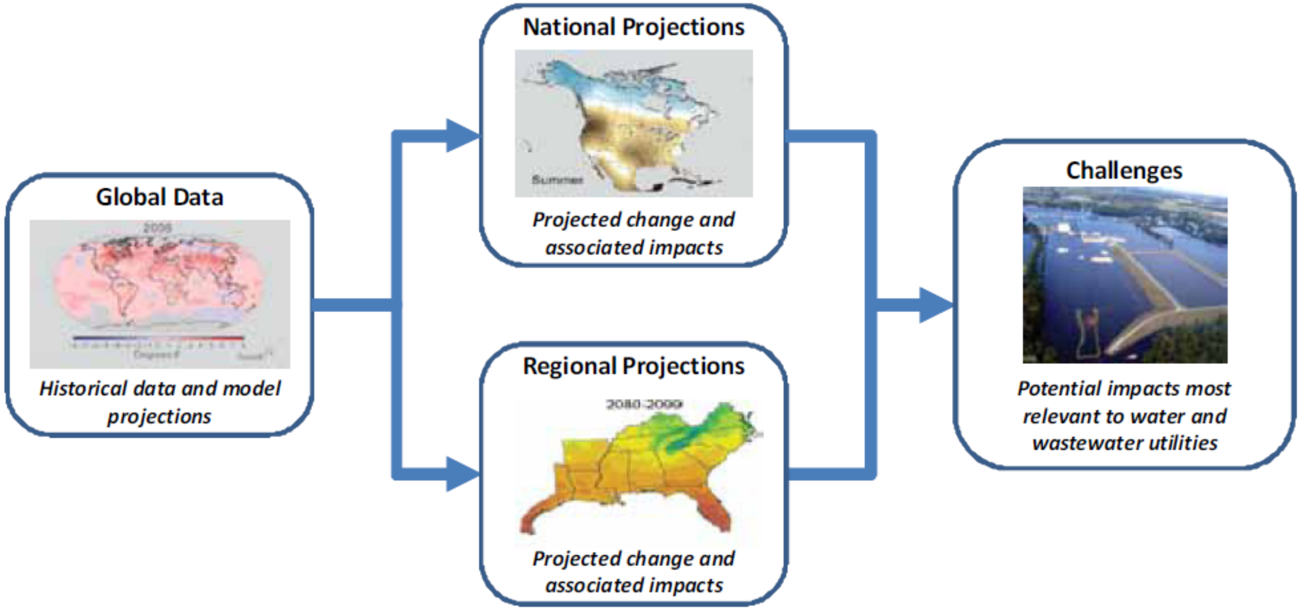
	PLANNING
	Integrate flood management and modeling into land use planning.
	Conduct precipitation extreme events analyses with climate change to understa to the wastewater collection system.

Translating Global Data into Challenges

Climate models are used to help understand and quantify potential changes in climate. These models simulate potential future changes for the globe. These global simulations can then be used to develop national and regional simulations.

The diagram below shows how global climate information was used to create national and regional projections, and then used to define climate challenges for drinking water and wastewater utilities in the Guide.

All data, projections, and challenges in the Guide were drawn from US Global Change Research Program 2009 Report.



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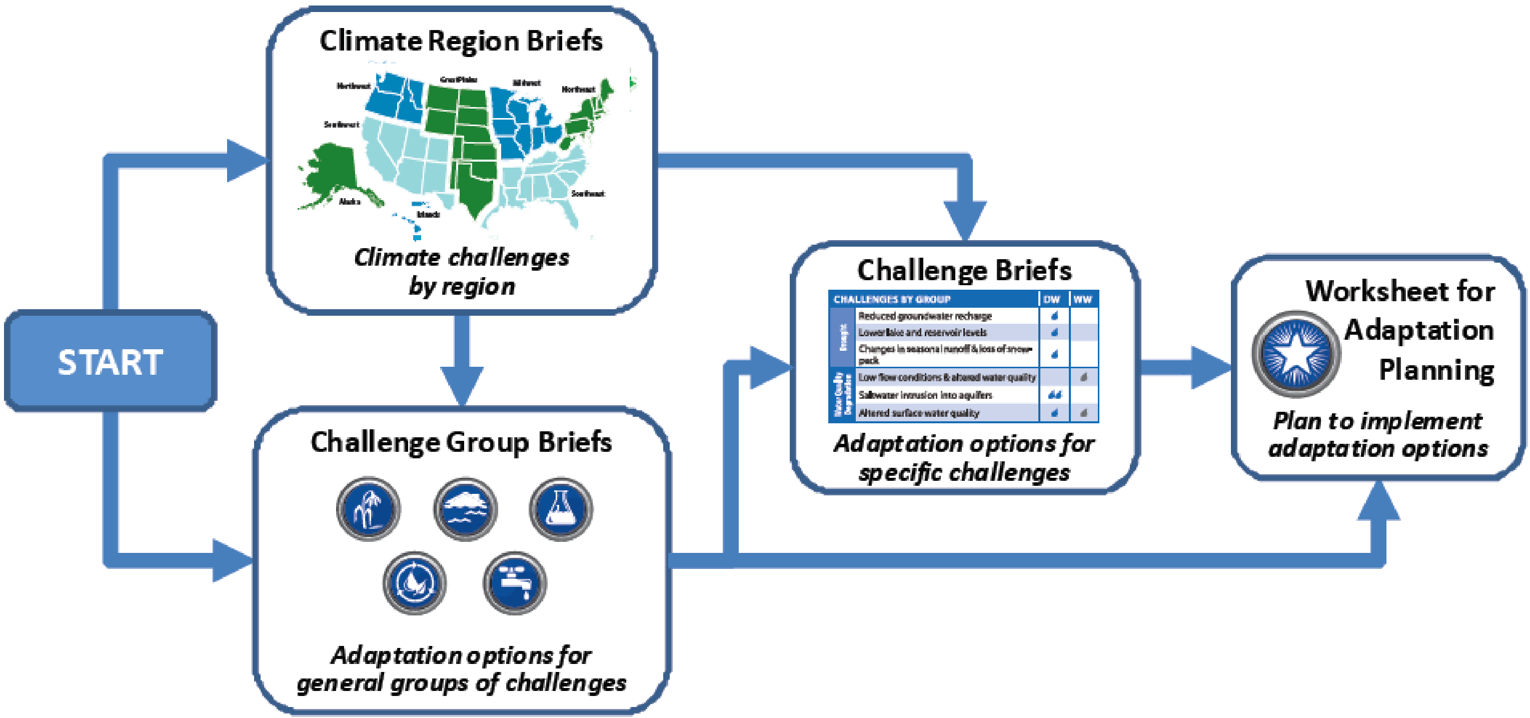
Guide Flowchart



After reviewing the introductory material, select either a Climate Region or Challenge Group Brief to identify specific Challenge Briefs for review.

Adaptation options from the Challenge Briefs can be cataloged in the Adaptation Planning Worksheet to support planning efforts.

Adaptation Options

Adaptation options are actions that can be taken to offset potential impacts of climate change. These actions can range from monitoring current conditions to constructing new infrastructure.

Three different kinds of adaptation options are included in the Guide:

- **Planning Strategies**, which include the use of models, research, training, supply and demand planning, natural resource management, land use planning, and collaboration at the watershed and community level.
- **Operational Strategies**, which include efficiency improvements, monitoring, inspections, conservation, demand management, and sustainable strategies.
- **Capital/Infrastructure Strategies**, which include construction, water resource diversification, repairs and retrofits, upgrades, new technology adoption, and green infrastructure.

Adaptation Options

Adaptation options in the Guide are categorized in terms of relative anticipated cost of implementation into three relative cost levels:

- **$** (low): Costs associated with adaptation options may be minimal. Many utilities will try to cope with change by assessing their options to expand operational flexibility to meet the changed operating parameters driven by the climate challenge.
- **$$** (med): These options may result in higher operations and maintenance costs. Some systems can operate beyond design or current capacity without making large, more costly infrastructure changes.
- **$$$** (high): A higher level of capital investment is typically associated with these options. After the existing system has reached the limit of its capacity to absorb climate impacts, it becomes necessary to augment or optimize capacity through adoption of new practices and resources.

Adaptation Options

Some adaptation options are labeled with a star icon: , these options are ***No Regrets*** strategies.

In the ASG, No Regrets is defined as those adaptation options that provide benefits regardless of future climate conditions. These options would build resilience to the potential impacts of climate change while yielding other, more immediate, economic, environmental, or social benefits. However, No Regrets does not mean cost-free; No Regrets options still have real or opportunity costs or represent trade-offs that should be considered by utility owners and operators.

Only implementing No Regrets strategies at your utility may not be enough to ensure resilience to extreme impacts. However, many adaptation options will yield benefits to the utility other than increased resilience. It is important to understand all of the benefits and costs associated with an adaptation option prior to its implementation.

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Part II—Utility Example

A step-by-step illustration of how a hypothetical utility would use the Guide

User Example Overview

The following illustrative example will be used to walk through the Guide:

- Dan Frialini is an operator at the Big Creek Water Utility, a combined utility located in Cicero, Illinois.
- He and his management are interested in learning more about how climate change can impact their utility and if there is anything they should be doing now to prevent future infrastructure damage or system interruptions due to climate change.
- Dan is mostly concerned about water quality and supply issues and how future changes in precipitation patterns will impact his utility.

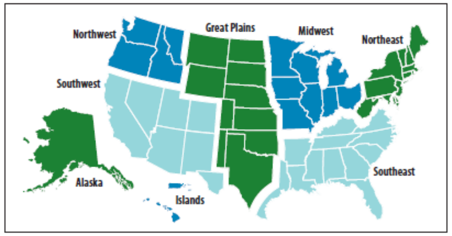
Selecting a Climate Region

After reading the Introduction, Dan is ready to select his climate region from page 9 of the Guide.

He sees that Illinois is located in the Midwest Climate Region.

projections in each geographic region, along with associated impacts (i.e., challenges) drinking water and wastewater utilities will face. Clicking on a region will bring you to that particular Regional Brief.

LINKS TO CLIMATE REGION BRIEFS



Challenge Group and Challenge Briefs —Summaries of general impacts that drinking water and wastewater utilities may face are contained in the Challenge Group Briefs, which can be accessed by clicking on an impact group in the table below. These briefs contain a comprehensive list of adaptation options to address a group of similar potential impacts.

These briefs also include links to the more specific Challenge Briefs that provide more detailed information on potential climate change-related impacts for both water, stormwater, and wastewater utilities. Each Challenge Brief provides general climate information related to the challenge, options for adaptation strategies to address them, relative cost information, and an example describing how a specific utility has implemented at least one of the options listed. Clicking on a water drop in any challenge table will bring you to that Challenge Brief. Most briefs apply to either drinking water (DW) or wastewater and stormwater (WW) utilities. In the case of the ecosystem-related challenges and energy sector needs, briefs apply to DW and WW together.

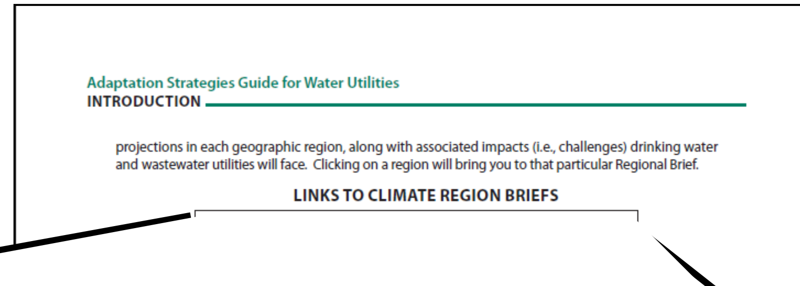
LINKS TO CHALLENGE BRIEFS

CHALLENGES BY GROUP		DW	WW
Drought	Reduced groundwater recharge	💧	
	Lower lake and reservoir levels	💧	
	Changes in seasonal runoff & loss of snowpack	💧	
Water Quality Degradation	Low flow conditions & altered water quality		💧
	Saltwater intrusion into aquifers	💧	
	Altered surface water quality	💧	💧
Floods	High flow events & flooding	💧	💧
	Flooding from coastal storm surges	💧	💧
Ecosystem Changes	Loss of coastal landforms / wetlands	💧	💧
	Increased fire risk & altered vegetation	💧	💧
Service Demand & Use	Volume & temperature challenges	💧	💧
	Changes in agricultural water demand	💧	
	Changes in energy sector needs	💧	
	Change in energy needs of utilities	💧	💧

Click on a group name above to read more about these challenges or click on a water drop above to read more about a specific challenge.

Select a Climate Region

Clicking in the Midwest Climate Region on the map will bring you to the Midwest Climate Region Brief.


Adaptation Strategies Guide for Water Utilities
INTRODUCTION

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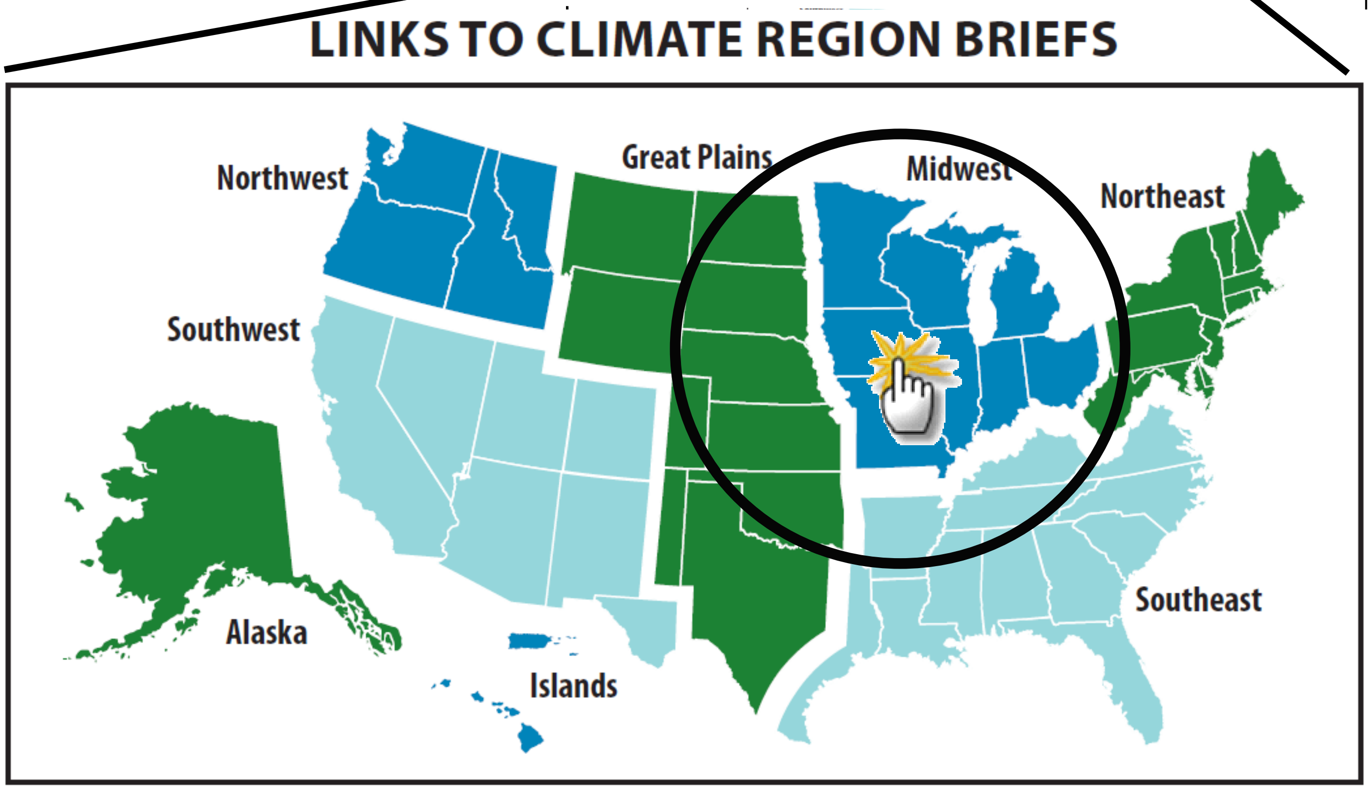
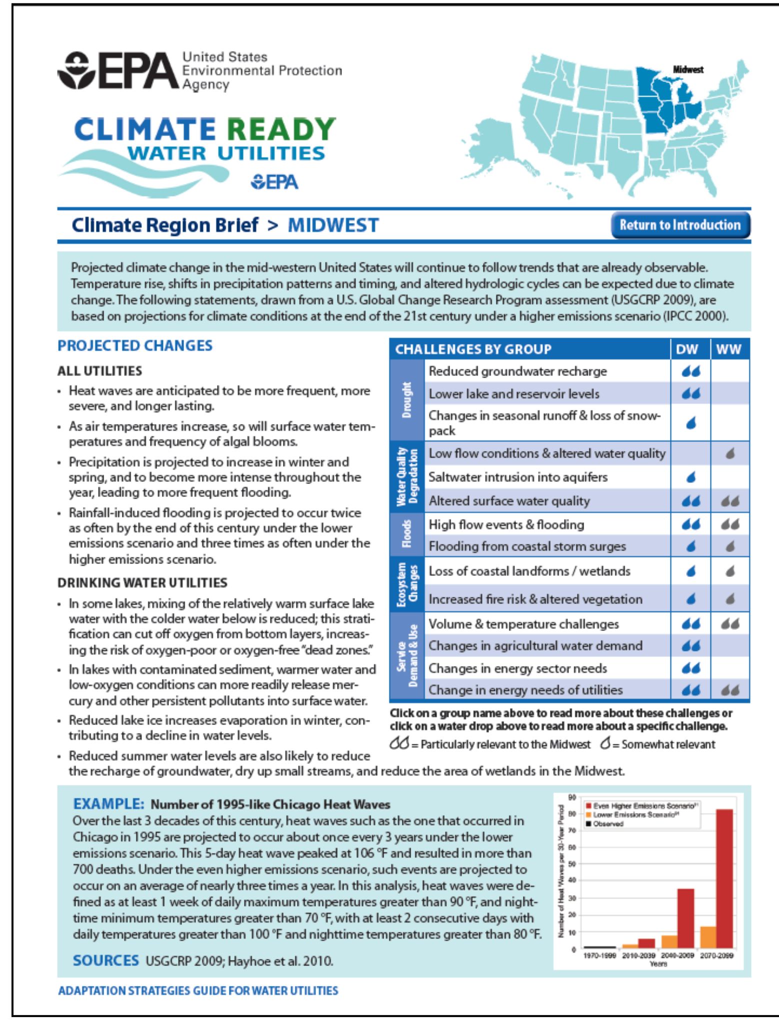
LINKS TO CLIMATE REGION BRIEFS



Climate Region Brief

All Climate Region Briefs contain:

- Projected changes
- Climate science example
- Challenge table



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CLIMATE READY WATER UTILITIES

Climate Region Brief > MIDWEST

Return to Introduction

Projected climate change in the mid-western United States will continue to follow trends that are already observable. Temperature rise, shifts in precipitation patterns and timing, and altered hydrologic cycles can be expected due to climate change. The following statements, drawn from a U.S. Global Change Research Program assessment (USGCRP 2009), are based on projections for climate conditions at the end of the 21st century under a higher emissions scenario (IPCC 2000).

PROJECTED CHANGES

ALL UTILITIES

- Heat waves are anticipated to be more frequent, more severe, and longer lasting.
- As air temperatures increase, so will surface water temperatures and frequency of algal blooms.
- Precipitation is projected to increase in winter and spring, and to become more intense throughout the year, leading to more frequent flooding.
- Rainfall-induced flooding is projected to occur twice as often by the end of this century under the lower emissions scenario and three times as often under the higher emissions scenario.

DRINKING WATER UTILITIES

- In some lakes, mixing of the relatively warm surface lake water with the colder water below is reduced; this stratification can cut off oxygen from bottom layers, increasing the risk of oxygen-poor or oxygen-free "dead zones."
- In lakes with contaminated sediment, warmer water and low-oxygen conditions can more readily release mercury and other persistent pollutants into surface water.
- Reduced lake ice increases evaporation in winter, contributing to a decline in water levels.
- Reduced summer water levels are also likely to reduce the recharge of groundwater, dry up small streams, and reduce the area of wetlands in the Midwest.

CHALLENGES BY GROUP		DW	WW
Drought	Reduced groundwater recharge	💧💧	
	Lower lake and reservoir levels	💧💧	
	Changes in seasonal runoff & loss of snowpack	💧	
Water Quality Degradation	Low flow conditions & altered water quality		💧
	Saltwater intrusion into aquifers	💧	
	Altered surface water quality	💧💧	💧💧
Floods	High flow events & flooding	💧💧	💧💧
	Flooding from coastal storm surges	💧	💧
Ecosystem Changes	Loss of coastal landforms / wetlands	💧	💧
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Service Demand & Use	Volume & temperature challenges	💧💧	💧💧
	Changes in agricultural water demand	💧💧	
	Changes in energy sector needs	💧💧	
	Change in energy needs of utilities	💧💧	💧💧

Click on a group name above to read more about these challenges or click on a water drop above to read more about a specific challenge.

💧💧 = Particularly relevant to the Midwest 💧 = Somewhat relevant

EXAMPLE: Number of 1995-like Chicago Heat Waves

Over the last 3 decades of this century, heat waves such as the one that occurred in Chicago in 1995 are projected to occur about once every 3 years under the lower emissions scenario. This 5-day heat wave peaked at 106 °F and resulted in more than 700 deaths. Under the even higher emissions scenario, such events are projected to occur on an average of nearly three times a year. In this analysis, heat waves were defined as at least 1 week of daily maximum temperatures greater than 90 °F, and nighttime minimum temperatures greater than 70 °F, with at least 2 consecutive days with daily temperatures greater than 100 °F and nighttime temperatures greater than 80 °F.

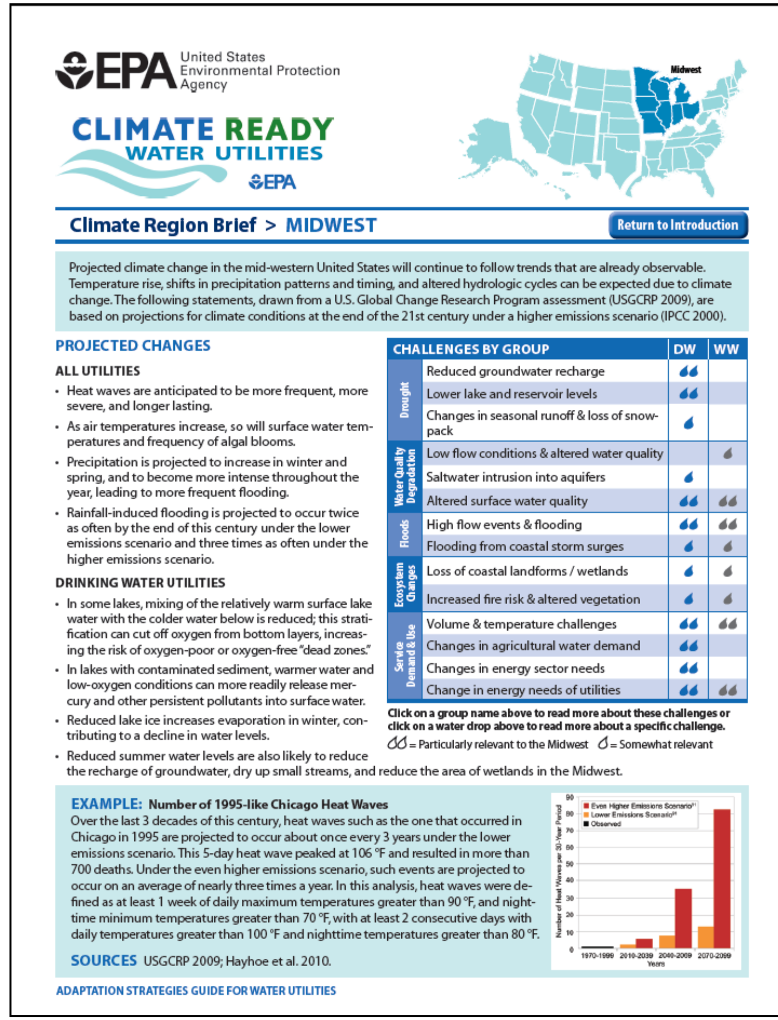
SOURCES USGCRP 2009; Hayhoe et al. 2010.

ADAPTATION STRATEGIES GUIDE FOR WATER UTILITIES

CLIMATE READY WATER UTILITIES EPA

Climate Region Brief

By looking at the challenge table, Dan sees that the “Altered Surface Water Quality” challenge is particularly relevant to the Midwest to both drinking water and wastewater utilities, and is housed under the “Water Quality Degradation” challenge group.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Climate Region Brief > MIDWEST

Return to Introduction

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	Altered surface water quality	💧💧	💧💧
Floods	High flow events & flooding	💧💧	💧💧
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	Increased fire risk & altered vegetation	💧	💧
Service Demand & Use	Volume & temperature challenges	💧💧	💧💧
	Changes in agricultural water demand	💧💧	
	Changes in energy sector needs	💧💧	
	Change in energy needs of utilities	💧💧	💧💧

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EXAMPLE: **Number of 1995-like Chicago Heat Waves**

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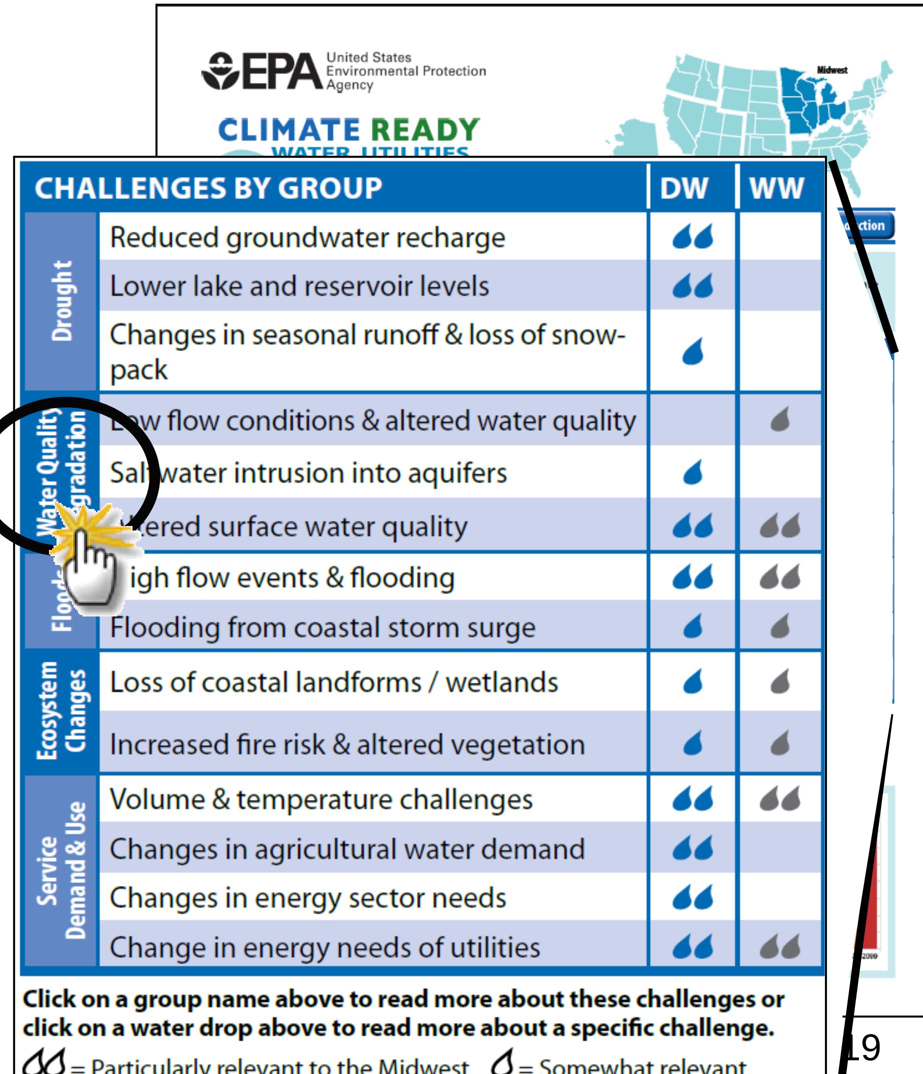
SOURCES USGCRP 2009; Hayhoe et al. 2010.

ADAPTATION STRATEGIES GUIDE FOR WATER UTILITIES

CLIMATE READY WATER UTILITIES

Climate Region Brief

Dan will first click on the “Water Quality Degradation” challenge group to view that brief so he can learn more about the impacts.



CHALLENGES BY GROUP		DW	WW
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Challenge Group Brief

Each Challenge Group Brief contains:

- Summaries of the challenges within that group
- Lists of adaptation options with relative costs

United States Environmental Protection Agency

CLIMATE READY WATER UTILITIES

Climate Challenge Group:
WATER QUALITY DEGRADATION (DW/WW)

Return to Introduction

Changes in water quality associated with climate change may be driven or forced by saline intrusion into aquifers and altered surface water quality. Clicking on either the drinking water or wastewater icon next to each challenge will bring you to that particular Challenge Brief.

Low Flow Conditions and Altered Water Quality WW

Many areas are projected to receive less annual total precipitation concentrated in fewer, more extreme rainfall events. Lower annual precipitation will lead to lower streamflows in many locations, which may lead to diminished water quality. Turbidity from sediment washing downstream following storm events also impacts water quality, particularly in areas where fires have diminished the ability of landscapes to hold sediment. Diminished water quality in receiving waters may lead to more stringent requirements for wastewater discharges and impacts to ecosystems that are sensitive to temperature.

Saltwater Intrusion into Aquifers DW

Projected sea-level rise, combined with higher water demand from coastal communities, can lead to saltwater intrusion in both coastal groundwater aquifers and estuaries. This combination may reduce water quality and increase treatment costs for water treatment facilities drawing from coastal aquifers or surface intakes in tidal estuaries near the saltwater line. Desalination plants may have to treat water with higher salt content, which would also increase costs.

Altered Surface Water Quality DW WW

Climate models project that the average temperature in the United States is going to increase, as will the number of extreme hot days. Higher temperatures can lead to algal blooms, which compromise source water quality and may require more advanced treatment. These water quality impacts will drive additional treatment processes for drinking water utilities, potentially leading to higher energy demand and capital and operating costs. For wastewater utilities, the change in receiving water quality may lead to more stringent discharge requirements and the need for more advanced effluent treatment.

ADAPTATION OPTIONS

Click to left of name to check off options for consideration; $'s indicate relative costs
Click name of any option to review more information in the Glossary
No Regrets options - actions that would provide benefits to the utility under current climate conditions as well as any future changes in climate. For more information on No Regrets options, see Page 7 in the Introduction.

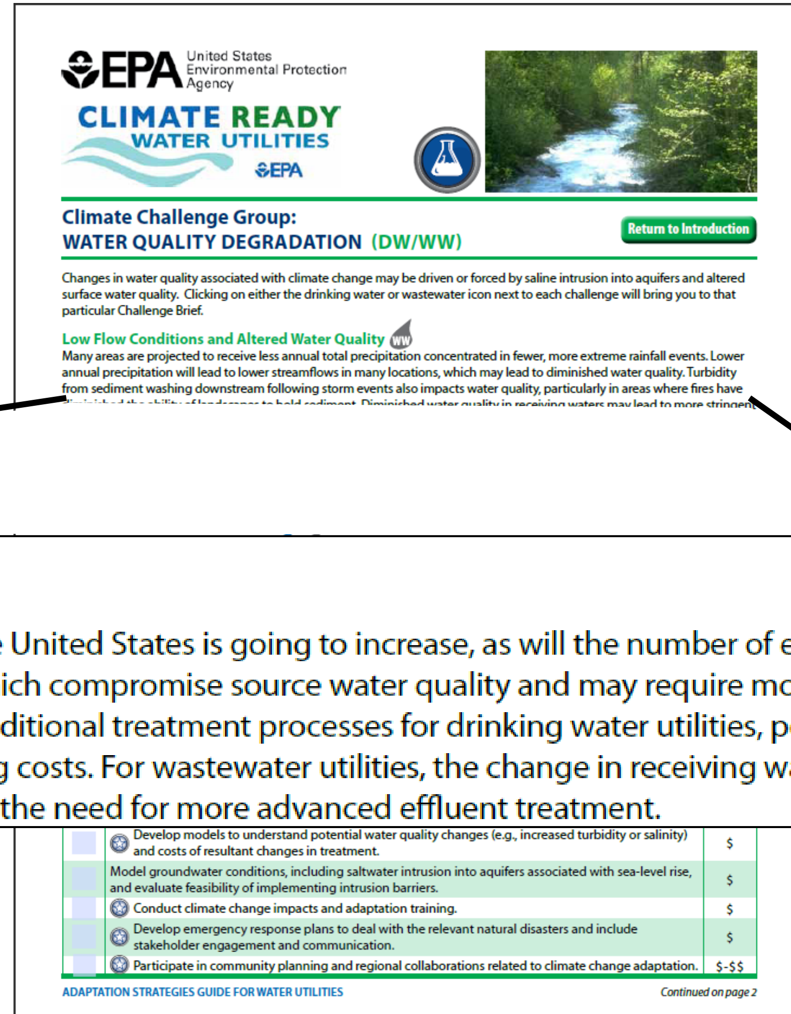
✓	PLANNING	COST
	Update fire models and fire management plans for any water supply sources in fire-prone watersheds to incorporate any changes in fire frequency, magnitude and extent due to projected future climatic conditions.	$-$$
	Conduct sea-level rise and storm surge modeling. Incorporate resulting inundation mapping and estimates of saltwater intrusion into groundwater or estuaries into land use, water supply, and facility planning.	$
	Develop models to understand potential water quality changes (e.g., increased turbidity or salinity) and costs of resultant changes in treatment.	$
	Model groundwater conditions, including saltwater intrusion into aquifers associated with sea-level rise, and evaluate feasibility of implementing intrusion barriers.	$
	Conduct climate change impacts and adaptation training.	$
	Develop emergency response plans to deal with the relevant natural disasters and include stakeholder engagement and communication.	$
	Participate in community planning and regional collaborations related to climate change adaptation.	$-$$

ADAPTATION STRATEGIES GUIDE FOR WATER UTILITIES

Continued on page 2

Challenge Group Brief

Dan is most interested in the Altered Surface Water Quality for the drinking water portion of his plant, so he clicks on the drinking water (DW) water droplet to see that brief first.



United States Environmental Protection Agency

CLIMATE READY WATER UTILITIES

Climate Challenge Group:
WATER QUALITY DEGRADATION (DW/WW)

Return to Introduction

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Altered Surface Water Quality DW WW

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Develop models to understand potential water quality changes (e.g., increased turbidity or salinity) and costs of resultant changes in treatment.	$
Model groundwater conditions, including saltwater intrusion into aquifers associated with sea-level rise, and evaluate feasibility of implementing intrusion barriers.	$
Conduct climate change impacts and adaptation training.	$
Develop emergency response plans to deal with the relevant natural disasters and include stakeholder engagement and communication.	$
Participate in community planning and regional collaborations related to climate change adaptation.	$-$$

ADAPTATION STRATEGIES GUIDE FOR WATER UTILITIES

Continued on page 2

CLIMATE READY WATER UTILITIES

EPA

Challenge Brief

Each Challenge Brief contains:

- Climate information
- List of adaptation options
- Utility case study

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ALTERED SURFACE WATER QUALITY (DW)

Return to Introduction

Climate models project that the average temperature in the United States is going to increase, as will the number of extreme hot days. Higher temperatures can lead to algal blooms, which compromise source water quality and may require more advanced treatment. Compounding the degradation of water quality, turbidity and pollution inputs may increase due to extreme storm and high flow events and altered or reduced vegetation cover in watersheds. These water quality impacts will drive the need for additional drinking water treatment processes, potentially leading to higher energy demand and capital and operating costs.

CLIMATE INFORMATION

- Precipitation intensity (e.g., precipitation per rainy day) is projected to increase by mid-century for most of the United States (Meehl et al. 2007). This can be expected to lead to more high flow events and flooding. Moreover, by 2070, the length of the fire season could increase by 2 – 3 weeks in the southwestern United States (Barnet et al. 2004). Altered or reduced vegetation cover in watersheds, coupled with extreme storm and high flow events, will lead to increased runoff, turbidity, and pollution inputs into watercourses.
- Some parts of the Southwest are projected to have decreases in spring and winter precipitation of greater than 20% and 40%, respectively. The Pacific Northwest may experience declines in summer precipitation of greater than 30% (USGCRP 2009). Lower volumes in surface water bodies, coupled with rising temperatures, may lead to higher pollutant concentrations, eutrophication, and algal blooms in surface water.

ADAPTATION OPTIONS

Click to left of name to check off options for consideration; $'s indicate relative costs
Click name of any option to review more information in the Glossary
No Regrets options - actions that would provide benefits to the utility under current climate conditions as well as any future changes in climate. For more information on No Regrets options, see Page 7 in the Introduction.

✓	PLANNING	COST
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	Conduct sea-level rise and storm surge modeling. Incorporate resulting inundation mapping and estimates of saltwater intrusion into groundwater or estuaries into land use, water supply, and facility planning.	$
	Develop models to understand potential water quality changes (e.g., increased turbidity or eutrophication) and costs of resultant changes in treatment.	$
	Conduct climate change impacts and adaptation training for personnel.	$
	Develop emergency response plans to deal with the relevant natural disasters and include stakeholder engagement and communication.	$
	Participate in community planning and regional collaborations related to climate change adaptation.	$-$$

ADAPTATION STRATEGIES GUIDE FOR WATER UTILITIES

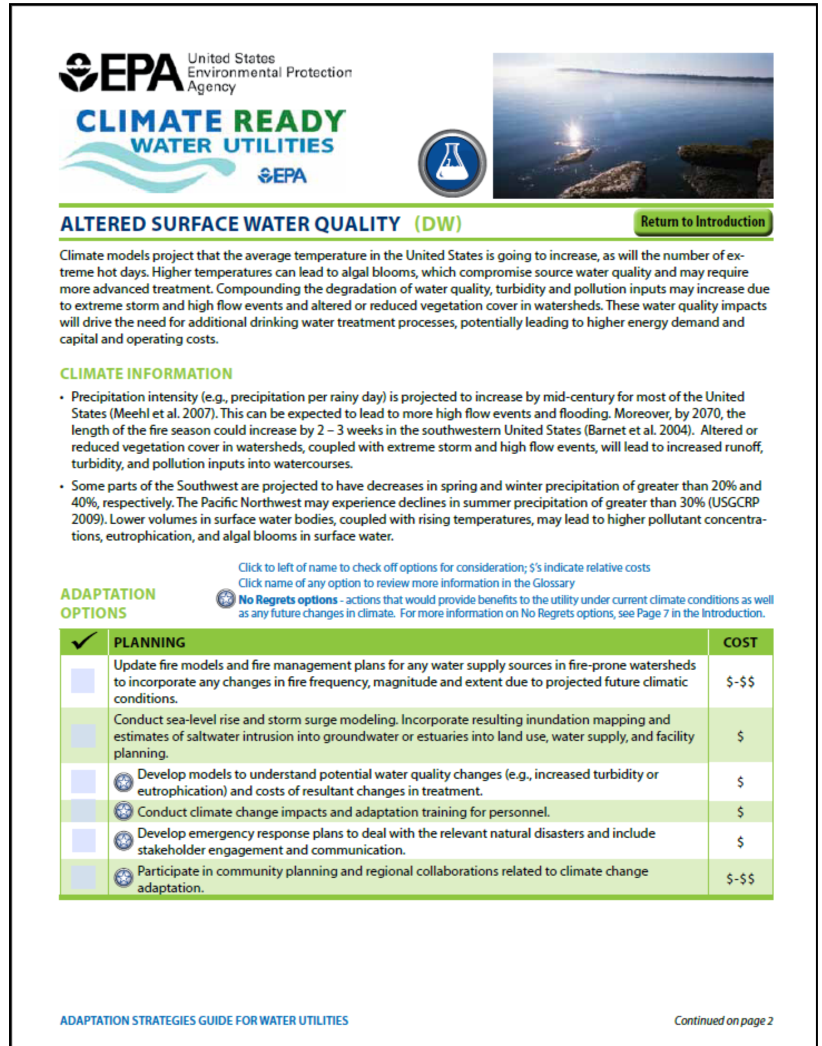
Continued on page 2

CLIMATE READY WATER UTILITIES EPA

Challenge Brief

Dan knows that the Big Creek Water Utility is vulnerable to flooding, and wants to review adaptation options that make sense for his utility.

He identifies some of the No Regrets strategies that would benefit his utility today and notes them in his Adaptation Planning Worksheet.



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ALTERED SURFACE WATER QUALITY (DW)

Return to Introduction

Climate models project that the average temperature in the United States is going to increase, as will the number of extreme hot days. Higher temperatures can lead to algal blooms, which compromise source water quality and may require more advanced treatment. Compounding the degradation of water quality, turbidity and pollution inputs may increase due to extreme storm and high flow events and altered or reduced vegetation cover in watersheds. These water quality impacts will drive the need for additional drinking water treatment processes, potentially leading to higher energy demand and capital and operating costs.

CLIMATE INFORMATION

- Precipitation intensity (e.g., precipitation per rainy day) is projected to increase by mid-century for most of the United States (Meehl et al. 2007). This can be expected to lead to more high flow events and flooding. Moreover, by 2070, the length of the fire season could increase by 2 – 3 weeks in the southwestern United States (Barnet et al. 2004). Altered or reduced vegetation cover in watersheds, coupled with extreme storm and high flow events, will lead to increased runoff, turbidity, and pollution inputs into watercourses.
- Some parts of the Southwest are projected to have decreases in spring and winter precipitation of greater than 20% and 40%, respectively. The Pacific Northwest may experience declines in summer precipitation of greater than 30% (USGCRP 2009). Lower volumes in surface water bodies, coupled with rising temperatures, may lead to higher pollutant concentrations, eutrophication, and algal blooms in surface water.

ADAPTATION OPTIONS

Click to left of name to check off options for consideration; $'s indicate relative costs
Click name of any option to review more information in the Glossary
No Regrets options - actions that would provide benefits to the utility under current climate conditions as well as any future changes in climate. For more information on No Regrets options, see Page 7 in the Introduction.

✓	PLANNING	COST
	Update fire models and fire management plans for any water supply sources in fire-prone watersheds to incorporate any changes in fire frequency, magnitude and extent due to projected future climatic conditions.	$-$$
	Conduct sea-level rise and storm surge modeling. Incorporate resulting inundation mapping and estimates of saltwater intrusion into groundwater or estuaries into land use, water supply, and facility planning.	$
	(No Regrets) Develop models to understand potential water quality changes (e.g., increased turbidity or eutrophication) and costs of resultant changes in treatment.	$
	(No Regrets) Conduct climate change impacts and adaptation training for personnel.	$
	(No Regrets) Develop emergency response plans to deal with the relevant natural disasters and include stakeholder engagement and communication.	$
	(No Regrets) Participate in community planning and regional collaborations related to climate change adaptation.	$-$$

ADAPTATION STRATEGIES GUIDE FOR WATER UTILITIES

Continued on page 2

Challenge Brief

He then reads the case study and sees that a utility in California uses lake aeration to control water quality in their sources to adapt to potential changes in water quality due to an increase in the number of severe storms.

Dan believes that his utility can also engage in this activity, so he marks that adaptation option within the brief.

EPA CLIMATE READY WATER UTILITIES

ALTERED SURFACE WATER QUALITY (DW)

page 2 of 2

✓	OPERATIONAL STRATEGIES	COST
	Practice fire management plans in the watershed, such as mechanical thinning, weed control, selective harvesting, controlled burns and creation of fire breaks.	$-$$
✓	Manage reservoir water quality by investing in practices such as lake aeration to minimize algal blooms due to higher temperatures.	$$
✓	Monitor flood events and drivers that may impact flood and water quality models (e.g., precipitation, catchment runoff).	$
✓	Monitor vegetation changes in watersheds.	$

✓	CAPITAL/ INFRASTRUCTURE STRATEGIES	COST
	Implement watershed management practices to limit pollutant runoff to reservoirs.	$$
	Implement or retrofit source control measures that address altered influent flow and quality at treatment plants.	$$-$$$
	Diversify options to complement current water supply, including recycled water, desalination, conjunctive use, and stormwater capture.	$$$
✓	Expand current resources by developing regional water connections to allow for water trading in times of service disruption or shortage.	$$-$$$
✓	Increase treatment capabilities to address water quality changes (e.g., increased turbidity or eutrophication).	$$$

EXAMPLE

The East Bay Municipal Utility District (EMBUD) in California has found from experience that severe storms can slow its ability to produce treated water while simultaneously increasing the costs of production. Its treatment plants were designed to treat water with low turbidity. Increased severe storms with climate change may result in higher turbidity in source waters. There is also a concern that increasing temperatures will affect water quality by promoting algal growth in surface water bodies, which may result in algal byproducts such as taste and odor compounds. The main water source for EBMUD is the Mokelumne River Watershed (577 mi²), which is located approximately 100 miles northeast in the Sierra Nevada Mountains. Approximately 90% of the water supply originates from this area. Two primary water supply reservoirs on the Mokelumne – Pardee and Comanche – provide water supply, flood protection, hydropower, resource management, and recreation. EBMUD uses a combination of watershed management and lake aeration to control water quality in these water sources.

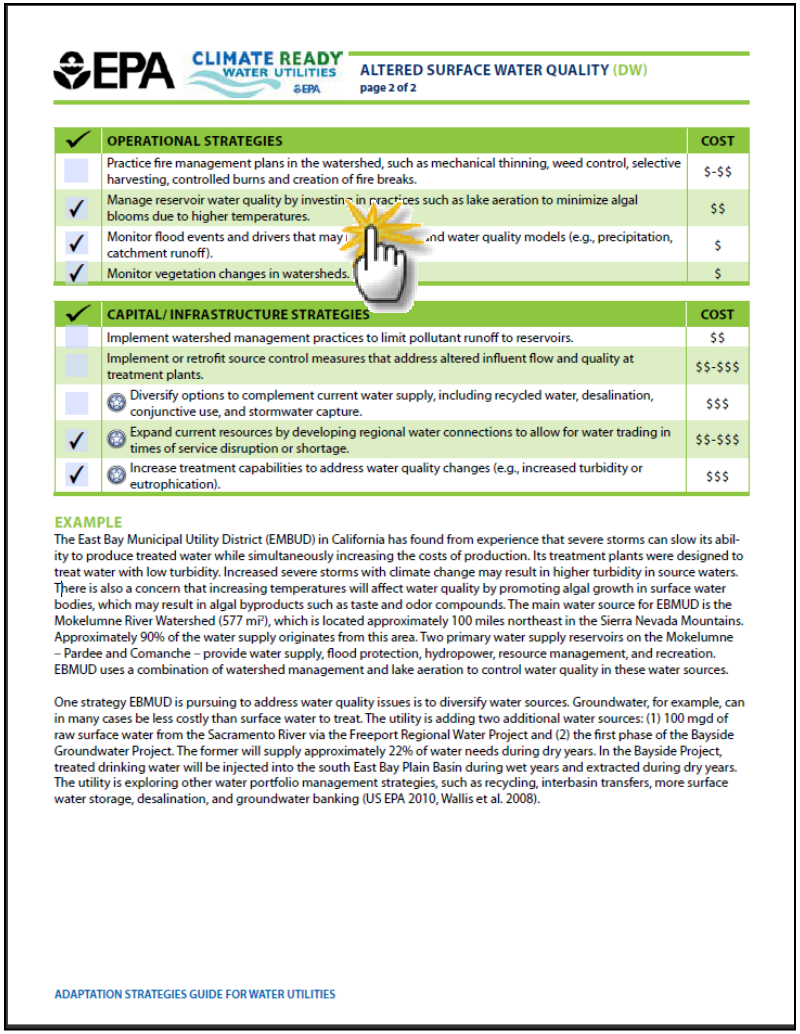
One strategy EBMUD is pursuing to address water quality issues is to diversify water sources. Groundwater, for example, can in many cases be less costly than surface water to treat. The utility is adding two additional water sources: (1) 100 mgd of raw surface water from the Sacramento River via the Freeport Regional Water Project and (2) the first phase of the Bayside Groundwater Project. The former will supply approximately 22% of water needs during dry years. In the Bayside Project, treated drinking water will be injected into the south East Bay Plain Basin during wet years and extracted during dry years. The utility is exploring other water portfolio management strategies, such as recycling, interbasin transfers, more surface water storage, desalination, and groundwater banking (US EPA 2010, Wallis et al. 2008).

ADAPTATION STRATEGIES GUIDE FOR WATER UTILITIES

Challenge Brief

While reading the adaptation strategies, Ben wants to learn more about the operational strategies, more specifically the "Manage reservoir water quality by investing in practices such as lake aeration to minimize algal blooms due to higher temperatures" option.

Dan clicks on that adaptation measure to read the glossary entry.



ALTERED SURFACE WATER QUALITY (DW)
page 2 of 2

✓	OPERATIONAL STRATEGIES	COST
	Practice fire management plans in the watershed, such as mechanical thinning, weed control, selective harvesting, controlled burns and creation of fire breaks.	\$-\$\$
✓	Manage reservoir water quality by investing in practices such as lake aeration to minimize algal blooms due to higher temperatures.	\$\$
✓	Monitor flood events and drivers that may [illegible] and water quality models (e.g., precipitation, catchment runoff).	\$
✓	Monitor vegetation changes in watersheds.	\$

✓	CAPITAL/ INFRASTRUCTURE STRATEGIES	COST
	Implement watershed management practices to limit pollutant runoff to reservoirs.	\$\$
	Implement or retrofit source control measures that address altered influent flow and quality at treatment plants.	\$\$-\$\$\$
	Diversify options to complement current water supply, including recycled water, desalination, conjunctive use, and stormwater capture.	\$\$\$
✓	Expand current resources by developing regional water connections to allow for water trading in times of service disruption or shortage.	\$\$-\$\$\$
✓	Increase treatment capabilities to address water quality changes (e.g., increased turbidity or eutrophication).	\$\$\$

EXAMPLE

The East Bay Municipal Utility District (EMBUD) in California has found from experience that severe storms can slow its ability to produce treated water while simultaneously increasing the costs of production. Its treatment plants were designed to treat water with low turbidity. Increased severe storms with climate change may result in higher turbidity in source waters. There is also a concern that increasing temperatures will affect water quality by promoting algal growth in surface water bodies, which may result in algal byproducts such as taste and odor compounds. The main water source for EBMUD is the Mokelumne River Watershed (577 mi^2), which is located approximately 100 miles northeast in the Sierra Nevada Mountains. Approximately 90% of the water supply originates from this area. Two primary water supply reservoirs on the Mokelumne – Pardee and Comanche – provide water supply, flood protection, hydropower, resource management, and recreation. EBMUD uses a combination of watershed management and lake aeration to control water quality in these water sources.

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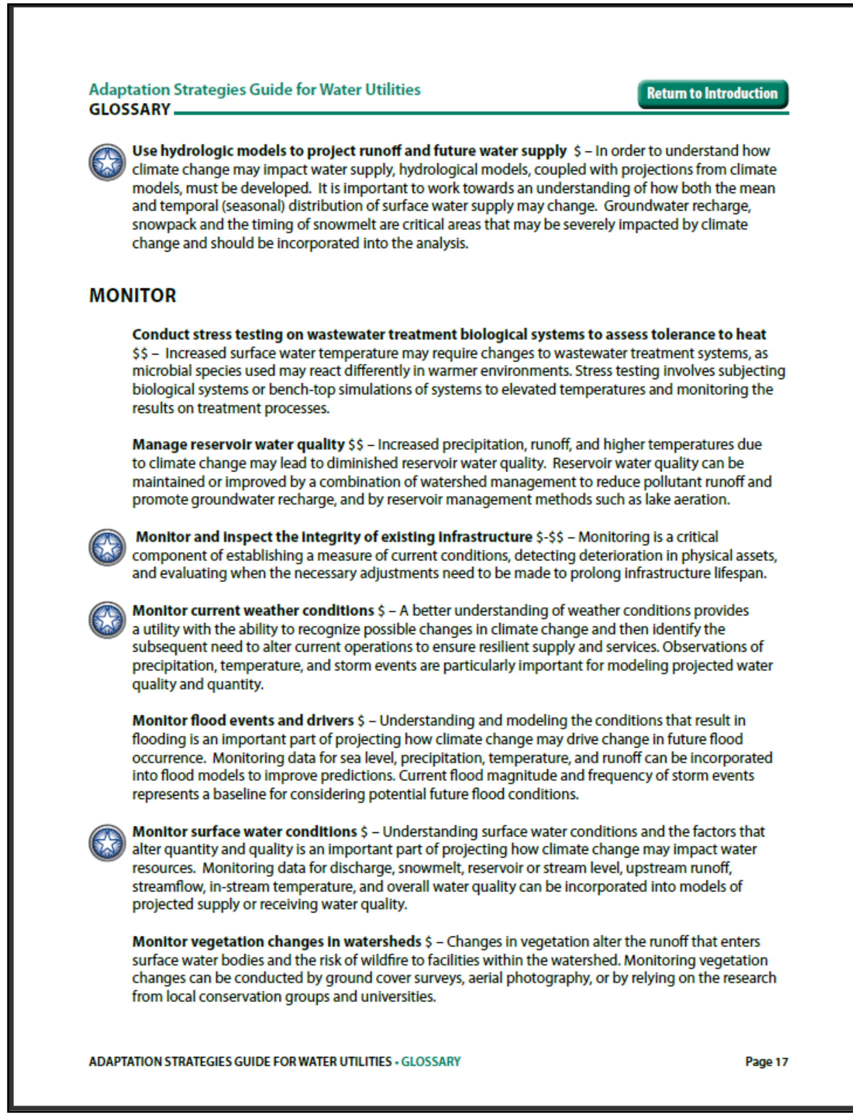
ADAPTATION STRATEGIES GUIDE FOR WATER UTILITIES

Glossary

The glossary provides more detailed explanations of all of the adaptation options found in the Guide.

Clicking on any adaptation option in a Challenge or Challenge Group Brief will bring you to its respective entry in the glossary.



Adaptation Strategies Guide for Water Utilities

Return to Introduction

GLOSSARY

Use hydrologic models to project runoff and future water supply $ – In order to understand how climate change may impact water supply, hydrological models, coupled with projections from climate models, must be developed. It is important to work towards an understanding of how both the mean and temporal (seasonal) distribution of surface water supply may change. Groundwater recharge, snowpack and the timing of snowmelt are critical areas that may be severely impacted by climate change and should be incorporated into the analysis.

MONITOR

Conduct stress testing on wastewater treatment biological systems to assess tolerance to heat $$ – Increased surface water temperature may require changes to wastewater treatment systems, as microbial species used may react differently in warmer environments. Stress testing involves subjecting biological systems or bench-top simulations of systems to elevated temperatures and monitoring the results on treatment processes.

Manage reservoir water quality $$ – Increased precipitation, runoff, and higher temperatures due to climate change may lead to diminished reservoir water quality. Reservoir water quality can be maintained or improved by a combination of watershed management to reduce pollutant runoff and promote groundwater recharge, and by reservoir management methods such as lake aeration.

Monitor and inspect the integrity of existing infrastructure $-$$ – Monitoring is a critical component of establishing a measure of current conditions, detecting deterioration in physical assets, and evaluating when the necessary adjustments need to be made to prolong infrastructure lifespan.

Monitor current weather conditions $ – A better understanding of weather conditions provides a utility with the ability to recognize possible changes in climate change and then identify the subsequent need to alter current operations to ensure resilient supply and services. Observations of precipitation, temperature, and storm events are particularly important for modeling projected water quality and quantity.

Monitor flood events and drivers $ – Understanding and modeling the conditions that result in flooding is an important part of projecting how climate change may drive change in future flood occurrence. Monitoring data for sea level, precipitation, temperature, and runoff can be incorporated into flood models to improve predictions. Current flood magnitude and frequency of storm events represents a baseline for considering potential future flood conditions.

Monitor surface water conditions $ – Understanding surface water conditions and the factors that alter quantity and quality is an important part of projecting how climate change may impact water resources. Monitoring data for discharge, snowmelt, reservoir or stream level, upstream runoff, streamflow, in-stream temperature, and overall water quality can be incorporated into models of projected supply or receiving water quality.

Monitor vegetation changes in watersheds $ – Changes in vegetation alter the runoff that enters surface water bodies and the risk of wildfire to facilities within the watershed. Monitoring vegetation changes can be conducted by ground cover surveys, aerial photography, or by relying on the research from local conservation groups and universities.

ADAPTATION STRATEGIES GUIDE FOR WATER UTILITIES - GLOSSARY Page 17

Adaptation Worksheet

Dan has identified his climate region, climate challenges of interest, and relevant adaptation options.

He will record that information in the Adaptation Planning Worksheet, as well as a timeline for adaptation implementation and potential parties for collaboration.

Dan will then save and print the worksheet for his records and follow the implementation plan and timeline he has created.

The next slide shows an example of a completed worksheet. The completed worksheet is also included in the ASG for your reference.

Adaptation Worksheet

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EPA United States Environmental Protection Agency

CLIMATE READY WATER UTILITIES EPA

Adaptation Strategies Guide for Water Utilities

WORKSHEET FOR ADAPTATION PLANNING

This adaptation planning worksheet is provided to help identify and organize adaptation options of interest. Either (1) print this worksheet and fill in the fields by hand while browsing through the Guide, or (2) type in the fields electronically, and make sure to print or save this worksheet before closing the Guide.

Contact and Utility Information

Name: Dan Frialini

Phone: 708-555-1212

Email: dfrialini@bcwu.org

Utility Name: Big Creek Water Utility

Utility Type: DW ■ WW ■ SW ■

Climate Region: Midwest (IL) Coasts ☐

Climate-Related Challenges

Review the brief for your climate region and select those challenges that are of concern to your utility

Challenge Group: Drought
- ☐ Reduced groundwater recharge
- ☐ Lower lake and reservoir levels
- ■ Changes in seasonal runoff & loss of snowpack

Challenge Group: Water Quality Degradation
- ☐ Low flow conditions & altered water quality
- ☐ Saltwater intrusion into aquifers
- ■ Altered surface water quality

Challenge Group: Floods
- ■ High flow events and flooding
- ☐ Flooding from coastal storm surges

Challenge Group: Ecosystem Changes
- ☐ Loss of coastal landforms / wetlands
- ■ Increased fire risk & altered vegetation

Challenge Group: Service Demand & Use
- ☐ Volume & temperature challenges
- ☐ Changes in agricultural water demand
- ☐ Changes in energy sector needs
- ☐ Changes in energy needs of utilities

Note specific utility assets and water resources where any damage or loss would impair meeting your utility's mission

Storage tanks to provide residual storage for maintaining inflow to treatment plant. Located in Big Creek Forest near creek shore. Past algal blooms in source water have contaminated tanks, resulting in loss of stored water for use as supply and an added expense of cleaning to re-use tanks.

Watershed for Big Creek, including Big Creek Forest, and paper mill. Watershed managers heard about the ongoing BCWU climate assessment and wanted to know if the utility was seeking input or collaboration opportunities. Collaboration could ensure that the implications of climate change impacts on the watershed was considered as part of adaptation planning at the utility.

WORKSHEET

List the critical threshold conditions (e.g., specific flood heights, drought durations, and peak influent volumes that exceed your current operating capacity) that may result in damage or loss to your assets and water resources. For example, if your previous experience indicates that a daily rainfall total of 3 inches would flood critical pump stations, then document this type of event as a threshold to consider during adaptation planning.

* 100-year flood would damage storage tanks
* Creek level drops below current intake would restrict supply
* 50% extent of forest loss would lead to increased erosion from forest into Big Creek

Review the briefs for selected challenges and note the adaptation options that you would consider implementing to reduce the consequences of climate change at your utility

BCWU has started climate change training for personnel and management.
For floods: BCWU currently employs flood models and a temporary flood barrier, and wants to evaluate a new levee, wetlands for flood protection, green infrastructure in the community, and recent investments in a collaborative land-use planning project as potential future flood protection measures.

For wildfire: BCWU currently employs land-use planning and monitoring weather, and wants to evaluate a wildfire surveillance and integrated land-use planning as potential future wildfire protection measures.

For drought: BCWU currently employs demand reduction and modeling efforts, and wants to evaluate improved supply-demand models, increased storage, and watershed management strategies.

Communication with other utilities—what climate change-related actions have other drinking water and wastewater utilities in your area taken?

Other Midwestern utilities have been successful in using wildfire surveillance in cooperation with U.S. Forest Service to limit losses.

Representatives planning to attend upcoming utility management conference and joining city-wide flood preparedness task force.

Adaptation Implementation Planning

Year for completion: 2020

Limitations

Budget available for next decade / limited space for expansion of facilities / potential for relocation of facilities unknown

Priorities (select)
- ☐ Adaptation option type
- ■ Cost of adaptation
- ■ Timing of action
- ☐ Vulnerability assessment
- ■ Assets impacted
- ☐ Other:

Potential collaborators

Big Creek Watershed managers, regional assessment team, City of Cicero, City of Chicago, Big Creek Defenders (local advocacy group)

Use the information documented in this worksheet as a preliminary step in the adaptation planning process. As you continue to monitor conditions and begin implementing adaptation options, revisit the Guide and revise this worksheet accordingly to inform future planning efforts.

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Conclusion

Using the Big Creek Water Utility as an example, we have:

- Learned more about climate adaptation planning,
- Illustrated how the three briefs in the ASG (Climate Region, Challenge Group, and Challenge) interact, and
- Gained a greater understanding of how to access regional climate information, learn about specific climate impacts, and identify what adaptation options are beneficial at your utility.

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Download Guide & Contact Information

To download the Adaptation Strategies Guide or for more information on the Climate Ready Water Utilities initiative, please visit water.epa.gov/infrastructure/watersecurity/climate.

If you have any questions or would like to provide feedback or suggest additional content (i.e., examples) for the Adaptation Strategies Guide, please email CRWUhelp@epa.gov .