Planning and Financial Viability

Water System Plan Climate Resilience Element Workbook

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Washington State Department of HEALTH

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About This Document

This workbook is an optional companion to the *Water System Planning Guidebook* 331-068 (PDF) Chapter 2.8, Climate Resilience Element. Given the broad range of potential climate impacts water systems face, this document focuses on general approaches, information, and resources water systems may find helpful as they complete their Water System Plan (WSP) Climate Resilience Element (CRE). The structure of this publication parallels the CRE requirements in the WSP Guidebook. We aligned the objectives in each section of this workbook with requirements A-C of RCW 43.20.310.

Section A, Understand Exposure and Assess Vulnerability and Risk, of this workbook shares resources to help water systems understand how their exposure to hazards may change or vary in a changing climate (A.1). It identifies priority impacts on system operations that should be incorporated into other sections of their WSP (A.2).

Sections B, Investigate Options, and C, Prioritize and Plan, focus on integrating findings from Section A into existing water system planning activities; in other words, identifying critical assets, capital improvement program.

Water systems seeking general information on climate change in Washington are encouraged to refer to the resources linked on the companion Climate Resilience Planning Resources for Water Systems webpage hosted by the University of Washington Climate Impacts Group (CIG).

Introduction

Background

Climate change is expected to alter the quantity, quality, and availability of water supplies across Washington. These challenges led to the passage of HB 1181, which updates state planning requirements—adding a CRE to WSPs initiated after June 30, 2025. Chapter 2.8 in the *Water System Planning Guidebook* 331-068 details what systems need to include in their WSP to meet this new requirement. This workbook serves as a companion document to Chapter 2.8 CRE of the WSP Guidebook and shares additional resources and background information on climate resilience planning. The specific RCW requirements for a WSP CRE are described in the box below.

For Water System Plans initiated after June 30, 2025, systems serving 1,000 or more connections must include a CRE in their WSPs. The requirements are outlined in RCW 43.20.310 and include that water systems must:

A. Determine which extreme weather events **pose significant challenges** to their system and build scenarios to identify potential impacts;
B. **Assess critical assets** and the actions necessary to protect the system from the consequences of extreme weather events on system operations; and
C. Generate reports describing the **costs and benefits** of the system's risk reduction strategies and capital project needs.

The Washington State Climate Strategy defines climate resilience as "*the ongoing process of anticipating, preparing for, and adapting to changes in climate and minimizing negative impacts to our natural systems, infrastructure, and communities.*" What this means practically for water systems is that they understand, prevent, adapt, and recover from climate impacts. Communities plan and incorporate climate resilience in many different ways, depending on their capacity, risk tolerance, experience with climate impacts, and other factors. Ideally, the CRE and related activities incorporated into the system's capital improvement and financial programs can serve as a roadmap for a system's climate resilience planning and preparation efforts.

The impacts of climate change vary across the state. Impacts experienced by water systems are determined by multiple factors, including supply source (surface or groundwater), location, water rights, access to alternative supplies, and financial resources. Likewise, water systems across the state are at different stages in their climate resilience planning efforts. Some systems already have detailed climate resilience plans while, for others, the CRE will be their first time engaging in climate resilience planning. Given these differences, this document does not specify a singular approach for climate resilience planning but instead provides a framework and shares resources on a range of best practices. **As long as the RCW requirements are addressed, which specific approach(es) are most helpful and appropriate for meeting the requirements of the CRE is ultimately the decision of the water system.**

Resources shared on the University of Washington Climate Impacts Group's (CIG) Climate Resilience Planning Resources for Water Systems webpage highlight the diverse ways systems are planning and preparing for various climate impacts. While some systems have found modeling helpful for climate resilience planning, it is not required to complete the CRE. Where there is overlap between existing planning efforts and the CRE (e.g., identification of locally significant extreme events), systems are encouraged to include relevant findings and priorities into their CRE.

Key Concepts in Climate Resilience Planning for Water Systems

Hazard + Vulnerability = Risk

There are multiple frameworks for characterizing the risks posed by extreme events and climate change. At a basic level, the Intergovernmental Panel on Climate Change (IPCC) defines risk as the potential for adverse consequences. The Washington Department of Commerce's Climate Resilience Planning Guidance defines risk as the intersection of a hazard and vulnerability (Figure 1).

Figure 1. Hazard, Vulnerability, and Risk
Source: Adapted from Climate Element Planning Guidance (WA Department of Commerce, 2023.)

Hazards are factors that cause harm such as flooding and wildfires. A hazard's contribution to risk is the product of both the **probability** of that hazard occurring and the **magnitude** of the event.

Vulnerability is the combination of factors that make the impacts of a hazard more or less damaging. **Exposure** happens when assets, such as infrastructure and staff, are at risk from a hazard (e.g., distribution lines in a floodplain). Various social, economic, environmental, and biophysical factors such as revenue sufficiency and level of urban growth in the service area contribute to a system's **sensitivity** when exposed to a hazard. **Adaptive capacity** is a system's ability to respond to an extreme event or other stressors and can include things such as access to an alternative supply, financial resources, and mutual aid agreements with other water systems.

The focus of the WSP CRE is on understanding exposure, assessing vulnerability, and long-term planning to build resilience to climate-related impacts of greatest relevance to the system.

Acute and Chronic Climate Hazards

Water systems may face both acute and chronic hazards from climate change. Acute hazards are typically event-driven and include extreme weather events such as floods, droughts, and heatwaves. Longer-term trends such as rising temperatures, sea level rise, and changes in precipitation patterns are examples of chronic hazards. Hazards often compound as well. For example, drought may contribute to both decreased water availability and increased wildfire risk.

Uncertainty in Climate Resilience Planning

All assessments of exposure and sensitivity have inherent uncertainties. Because the future is uncertain, climate models and risk assessments use different scenarios to help explore what might happen under various conditions. Climate models typically look at a range of emissions scenarios (e.g., Representative Concentration Pathway 4.5 and 8.5) and average results over periods of 30 years or longer to help account for natural variation in the timing and magnitude of events. Likewise, it is difficult to predict the exact point in time when a hazard will lead to harmful consequences. Plausible scenarios based in local knowledge of a system's strengths and vulnerabilities can help assess the relative impacts of climate-related changes and support productive engagement in climate resilience planning.

Non-Stationarity

Non-stationarity, as it relates to climate change, is the concept that the past is no longer an accurate predictor of future conditions. While there are important lessons to be learned from responses to and impacts from past events, comprehensive climate resilience planning should incorporate predictions of future conditions.

Terminology in This Document

In this document we use:

Climate-Related Hazards to describe acute and chronic climate-related hazards such as extreme weather events, natural disasters, and longer-term changes in precipitation, temperature, and snowpack.

Climate-Related Challenges to refer to a system's vulnerability to climate-related challenges. In other words, the product of both their exposure to climate-related hazards and its unique sensitivities to these hazards.

Climate-Related Impacts to refer to the risks and impacts a system faces when a hazard occurs and/or the response triggered by the impact (e.g., needing to develop an alternative supply, or upgrade treatment processes).

Steps to Resilience Framework

We modeled the approach outlined in Chapter 2.8 of the WSP Guidebook and this workbook after the Steps to Resilience framework in the U.S. Climate Resilience Toolkit (Figure 2) and we structured it to align with requirements A-C in RCW 43.20.310. The Steps to Resilience Framework provides a general stepwise, iterative approach for evaluating and responding to risks from climate-related hazards (Figure 2). A comparison of the Steps to Resilience Framework to other risk frameworks is included on the [U.S. Climate Toolkit website]().

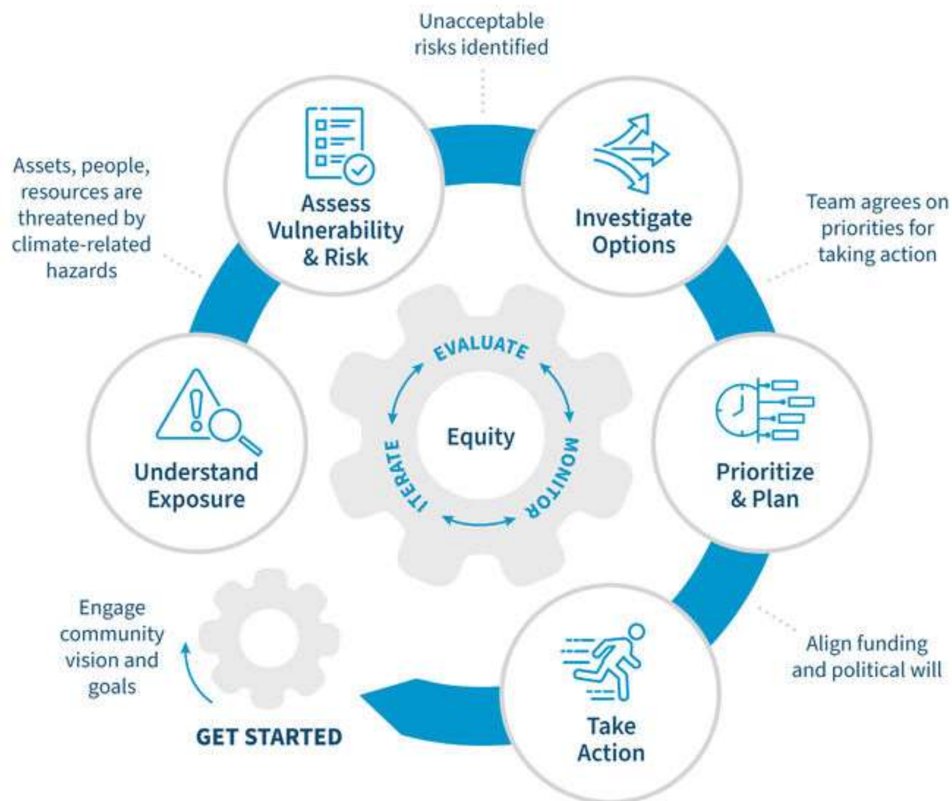

Figure 2. *Steps to Resilience Framework*
Source: *U.S. Climate Resilience Toolkit.*

WSP Climate Resilience Element Development Resources

This section provides an overview of resources that systems may find useful as they develop their CRE. This includes a series of examples, template tables, and pointers to other planning documents that may address climate resilience planning. Additional resources are included in Appendix B and on CIG's Climate Resilience Planning Resources for Water Systems webpage.

A.1. Understand Exposure

Objective: Determine which extreme weather events pose significant challenges to your system.

Background

Water systems' exposure to climate-related hazards and their impacts varies across Washington. There are many tools and resources available to help systems better understand the magnitude and geography of climate-related changes in Washington. The best approaches, tools, and resources for a system depend on factors like climate risks, location, system features, and risk tolerance. To begin, water systems can review existing planning documents to assess how they already address climate resilience and identify potential gaps.

Climate Impacts in Existing Planning Documents

Climate-related hazards and their impacts are often considered both directly and indirectly in existing planning efforts such as an Emergency Response Plan or a city's comprehensive plan. Likewise, several existing sections in the WSP Guidebook require consideration of weather, climate, and/or extreme events. Reviewing existing planning documents to identify what climate-related hazards and impacts were identified and the management strategies being planned or implemented is an important first step in preparing the CRE. Water systems can and should use relevant findings from existing planning documents when developing the CRE in their WSP.

However, it is important to note that the goals of existing planning efforts may be different than the purpose of the CRE (e.g., emergency response to an acute water shortage versus managing for increasing costs of procuring water due to multi-year declines in supply availability). It is important to review the hazards and impacts identified in other planning documents and also consider long-term climate-related challenges for a water system's infrastructure, operations, finances, supply, water quality, etc.

Climate-Related Hazards in Existing Planning Documents

While plan content will vary across communities, the list below includes commonly prepared planning documents that may contain information on how communities are planning for climate change. Water systems can and should use relevant findings from these and other existing documents when developing the CRE in their WSP.

Examples of Common Planning Documents Relevant to Climate Resilience Planning:

- City and county comprehensive plans.
- FEMA Hazard Mitigation Plan (HMP).
- WSP Emergency Response Plan (ERP).
- Risk and Resilience Assessments (America's Water Infrastructure Act).
- Coordinated Water System Plans (CWSP).
- Abbreviated Coordinated Water System Plans (ACWSP). See RCW 70.116.050.
- County water and sewer general plans. See RCW 36.94.030.
- Groundwater management plans.
- Watershed plans for Water Resource Inventory Areas (WRIA).
- Regional water supply plans.

Box: HB 1181: Improving the state's response to climate change by updating the state's planning framework

Washington's HB 1181, signed into law in 2023, updates state-level planning requirements to require inclusion of a 'climate resilience element' in certain Comprehensive, Coastal Resilience, and Water System Plans. While the specifics and timelines for incorporating a climate resilience element vary across these three types of plans, there are likely to be many similarities in the types of activities undertaken (e.g., understand exposure). Water systems are encouraged to coordinate with other planning efforts and incorporate relevant information into their WSP.

Risk and Resilience Assessments, Emergency Response Plans, and WSP Climate Resilience Element: How are they similar, How are they different?

Under state and/or federal law, many water systems in Washington are required to complete three related planning efforts: a Risk and Resilience Assessment (RRA), an Emergency Response Plan (ERP), and Washington's new WSP CRE. Table 1 and text below summarize similarities and differences between these three documents. Systems are encouraged to use relevant findings from their RRA and ERP in their CRE while also considering longer-term, slower moving impacts such as multiple years of declining groundwater levels or changes in late-season streamflow patterns in their CRE.

Table 1. Comparison of RRA, ERP, and CRE Scope, Content, and Reporting Requirements

	Risk and Resilience Assessment (RRA)	Emergency Response Plan (ERP)	WSP Climate Resilience Element
Focus of Assessment	Evaluate the vulnerabilities, threats, and consequences from potential hazards	Tactical level plan for immediate response to incidents of all types.	Understand exposure to climate-related hazards, prioritize strategies for mitigating key impacts, and incorporate strategies into long-term planning (capital improvement and financial programs)
Time Scale	Assessing acute hazards	Emergency response	Long-term planning for acute and chronic impacts
Classes of Hazards	Malevolent Acts and Natural Hazards	Natural Disasters and Human-Caused Events	Climate-Related Hazards Including Extreme Weather Events
Natural Hazards Included	Hurricane, Flood, Earthquake, Tornado, Ice Storm, Fire, Other	Earthquakes, Floods, High Winds, Ice Storms, Wildfires, Waterborne Diseases, Other	Weather-related events impacting climate resilience (system-identified)
Systems Included	System serves >3300 people (separate requirements for smaller systems);	In WA: Group A systems with >1000 connections (required for completion of WSP); EPA: Required in combination with RRA	Group A systems with >1000 connections

Table 1. Comparison of RRA, ERP, and CRE Scope, Content, and Reporting Requirements

	Risk and Resilience Assessment (RRA)	Emergency Response Plan (ERP)	WSP Climate Resilience Element
Available Tools/ Resources	Small system checklist (<50,000 persons); Vulnerability Self-Assessment Tool (VSAT) (>50,000 persons);	Emergency Response Planning Guide (DOH); EPA Incident Action Checklists for Water Utilities; Other federal tools	CRE Workbook; UW CIG; EPA CRWU resources; WUCA resources; Other state/federal tools and resources
Reporting	Certification statement to EPA every 5 years	EPA: Within 6 mo of submission of RRA certification statement; WA: Overview in WSP	Every 10 years or other qualifying event (requiring WSP update)
Statute	America's Water Infrastructure Act (AWIA) (federal, 2018)	AWIA; WAC 246-290-415(2)(d)	RCW 43.20.310

While there are similarities across the RRA, ERP, and CRE (e.g., all include consideration of exposure to natural hazards such as floods and wildfires), there are substantial differences. In particular, the RRA and ERP both focus on evaluating and responding to acute challenges, while the CRE focuses more heavily on the long-term planning aspects of resilience. The CRE goes one step beyond the RRA and ERP, asking water systems to incorporate findings from their exposure and vulnerability assessments into their capital improvement and financial programs. **This added step helps systems develop a roadmap that incorporates their specific climate resilience priorities into long-term planning efforts while also increasing the visibility of systems' funding needs in this area.**

RRAs, a federal requirement under AWIA, focus on the identification of a broad range of risks and the system components most likely to be impacted. Consideration of countermeasures to the identified risks is optional. Water systems are required to submit a certification statement to EPA every five years stating that they completed/updated their RRA. A water systems' RRA findings may be used directly in the first components of a water system's CRE—understand exposure and assess vulnerability and risk.

ERPs are required by both AWIA and state water system planning requirements. Section 4 of the ERP Guide asks water systems to identify types of events that cause emergencies and the probability or risk of that emergency. Section 9 of the ERP Guide asks water systems to describe the characteristics and condition of system components, key vulnerabilities, improvements or mitigating actions (including security improvements). Findings in these sections linked to climate-related hazards and critical assets may be directly transferable to a system's CRE.

While many of the findings in RRA and ERP are directly relevant to the CRE, water systems may also find it helpful to consider non-emergent challenges associated with chronic hazards in their CRE. For example, considering impacts such as the effect of declining groundwater levels on pumping costs/well yields or extreme heat on maintenance activities may help systems identify non-emergent, but significant impacts.

Consideration of Climate-Related Hazards in Existing Water System Planning Documents

Existing sections of the WSP Guidebook ask water systems to document changes in water supply availability and quality plus impacts from various climate-related hazards. Sections of the existing WSP Guidebook referencing climate-related hazards and changes are listed in Table 2. It is important to note that, for many of these items, systems are asked to look backwards at past events and historical data. This provides important insights, but, increasingly, the past is not representative of the future we expect under climate change.

Table 2. Existing Guidebook Sections Referencing Extreme Weather Events and Hazards

	General Classes		Acute Hazards/Extreme Weather Events					Long-Term Changes and Hazards						Secondary Water System Impacts		
Water System Planning Guidebook Section*	Natural Hazards/ Disasters	Changes Over Time (General)	Riverine Flooding	Coastal Flooding	Drought	Wildfire	Extreme Heat Events	Air Temperature	Precipitation	Surface Runoff/ Streamflow	Snowpack	Sea Level Rise	Changes in Groundwater	Changes in groundwater availability	Changes in surface water availability	Changes in source water quality
Chapter 1 Description of the Water System																
1.2 System History and Background	X		X	X					X							
Chapter 2 Basic Planning Data																
2.4 Water Supply Characteristics													X	X	X	X
2.5 Water Supply Reliability Evaluation	X				X								X	X	X	X
Chapter 3 System Analysis and Asset Management																
Link to Water System Design Manual	X															
3.1 Asset Management—Asset Inventory and Analysis	X		X	X		X								X	X	X
3.2 Water Quality		X														X
3.4 Capacity Analysis																
Chapter 4 Water Use Efficiency Program																
4.1 Source and Service Metering																
Water Use Efficiency Manual			X	X	X	X								X	X	X

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Water System Planning Guidebook Section*	Natural Hazards/ Disasters	Changes Over Time (General)	Riverine Flooding	Coastal Flooding	Drought	Wildfire	Extreme Heat Events	Air Temperature	Precipitation	Surface Runoff/ Streamflow	Snowpack	Sea Level Rise	Changes in Groundwater	Changes in groundwater availability	Changes in surface water availability	Changes in source water quality
Chapter 5 Source Water Protection																
5.2 Wellhead Protection Program																X
5.3 Watershed Control Program		X	X	X		X				X						X
Chapter 6 Operation and Maintenance Program																
6.4 Emergency Preparedness and Response			X	X	X	X			X	X				X	X	X
Publications Reference List						X										
Chapter 7 Distribution Facilities Design and Construction Standards																
Chapter 8 Capital Improvement Program																
8.1 Prioritization														X	X	X
8.2 Capital Improvement Program Summary and Schedule					X											
Chapter 9 Financial Program																
Chapter 10 Miscellaneous Documents																

**Chapters with no subsections listed do not explicitly call out any of the highlighted hazards/topics in the existing WSP Guidebook.*

Approaches and Tools for Identifying Significant Climate-Related Hazards

There is no singular "right way" to consider the impacts of climate change. Decisions on which approach(es) to use to identify priority climate impacts should incorporate the requirements of RCW.43.20.310, existing planning efforts, a system's risk tolerance, historical impacts, business and operational priorities, and other context-specific factors. This section includes examples of some common approaches for understanding exposure to climate-related hazards, including hypothetical use cases. Links to additional resources and tools can be found on CIG's WSP Resources webpage.

Example Approach: Considering the Impacts of Past Extreme Events

Reviewing how natural hazards and environmental changes have impacted your system in the past can help systems identify future challenges. Past events can also serve as analogs for future conditions. For example, the magnitude of today's 25-year storm may look more like 2050's ten-year storm event. Examples of the types of questions that may be helpful when reflecting on impacts from past events include:

- What types of hazards have caused significant challenges for your water system?
- In the past, how frequently have extreme events and/or changes in weather caused significant challenges to your water system (e.g., monthly, seasonally, yearly, decade)?
- What challenges have these events caused for your system?
- What would help mitigate the impacts of these challenges moving forward?
- Do you anticipate the frequency, severity, and/or impacts of these types of events changing with climate change?

Example Use Case

A medium-sized, groundwater dependent Group A system in eastern Washington has four wells, two pumping water from a deeper basalt aquifer and two pulling from a shallower alluvial aquifer. The alluvial aquifer is known to be groundwater under the influence of surface water. During recent periods of drought, water levels in the alluvial aquifer have dropped below current well screen levels, making those two wells unusable during the late-summer months. The system implements emergency conservation measures during these periods. Extended periods of drought are becoming increasingly common in this region. Because of the significant challenges created by past events, the water system has chosen to use their CRE to begin planning for long-term drought mitigation strategies.

Example Approach: Climate Mapping for a Resilient Washington Tool

The Climate Mapping for a Resilient Washington (CMRW) Tool is a Washington-specific tool developed by the University of Washington Climate Impacts Group to support communities in identifying climate-related changes relevant to their community and the predicted range of change under different climate scenarios. This tool was developed, in part, to support the

Washington Department of Commerce's incorporation of a climate element into the Growth Management Act comprehensive planning requirements.

The CMRW User Guide provides an overview of the CMRW tool. The report 'Biophysical Climate Risks and Economic Impacts for Washington State' is related to the CMRW tool and summarizes key findings at the state and regional level.

Example Use Case

A smaller Class A water system on the western slope of the Cascades relies primarily on surface water for their water supply. They recently faced two significant flood events that impacted source water quality and their distribution infrastructure. They are interested in understanding – were the recent flood events an anomaly or will events like these become more common under climate change? They navigate to the CMRW tool and have three initial choices to make.

What climate indicators are relevant to their question?

Filtering by hazard (flooding)* helps narrow down the list of indicators to peak streamflow; and return interval of 25-year peak streamflow. Given their questions, both indicators seem like good options.

**In this case, filtering by sector (water resources) constrained the indicators too much so they chose to just focus on indicators associated with flood hazards.*

Which greenhouse gas (GHG) scenario(s) should they consider?

They are not sure what emissions scenario to choose but know there is uncertainty in climate projections, so they decide to look at both the higher and lower GHG scenarios (RCP 4.5 and RCP 8.5).

What time period(s) do they want to look at?

They are interested in both near and longer-term changes (20 and 60 years) so they choose to look at results for both 2020-49 and 2070-99.

Findings: The water system finds it easiest to record their findings in simple tables (below).

Percent Change Annual Maximum Streamflow	RCP 4.5	RCP 8.5
2020-49	17%	18%
2070-99	37%	76%

Return Interval of 25-yr Peak Streamflow	RCP 4.5	RCP 8.5
2020-49	9.0 yrs	8.1 yrs
2070-99	4.3 yrs	2.6 yrs

While there is uncertainty in the specific values, both indicators point toward substantial increases in peak streamflow, especially looking toward 2070-2099. Given these observations, the location of critical assets, impacts from past floods, and other local risk factors, they decide that these changes would have a substantial impact and warrant deeper consideration. The water system decides to begin budgeting for a planning study with locally specific modeling and evaluation of flood mitigation measures into their Capital Improvement and Financial Programs.

Example Approach: Modeling

The CRE does not require water systems to model the impacts of climate change on their water system. However, at times, systems may decide that more detailed or geographically specific information is warranted to better understand the local impacts of climate change. In these cases, a variety of modeling approaches can be used to directly assess the impacts of climate change. The Water Utility Climate Alliance's (WUCA) website serves as a clearinghouse for information on climate adaptation, resilience, and mitigation in water utilities, including information on modeling approaches, data, and case studies.

WUCA Resources

Leading Practices in Climate Adaptation

Engineering Case Studies

Plans and Publications

Training and Presentations

Water System Plan Template Table: Climate-Related Hazards

Template Table Description

Water systems' exposure to climate-related hazards is expected to vary across Washington. Systems should use local knowledge, existing planning efforts, resources highlighted above, and/or other locally relevant approaches to assess which types of exposure to prioritize in their CRE. Table 3 can be used to document the relative significance of your system's exposure to different climate-related hazards, though its use is not required in WSPs.

Table 3 is divided into two sections – acute, event-based natural hazards and longer-term physical changes such as sea level rise. In this table, please note:

- Which classes of hazards are relevant to your water system,
- Briefly describe the change you expect and related challenges,
- The relative significance of those challenges, and,
- How you assessed the significance of each hazard.

Systems only need to report on the classes of exposure that are relevant to their systems but should approach their assessment with a vision toward the future (i.e., not based entirely on past events). Blank copies of template tables are in Appendix A. We include below an example using a hypothetical system.

Example Significance of Climate-Related Hazards Table

Example System

This example is for the water system in the first example above (medium sized, groundwater dependent Group A system in eastern Washington with four wells, two pumping water from a deeper basalt aquifer and two pulling from a shallower alluvial aquifer). The system faced significant challenges during past droughts and has chosen to use their CRE to better understand the projected severity and impacts of future droughts. The water system chose to summarize their findings using the provided template table.

Example Approach

The example system used multiple methods to assess their system's exposure to climate hazards.

Past Experience: Drought was identified as a priority based on impacts during past droughts.

CMRW Tool: Based on the severity of past drought impacts, the system has decided to also use the CMRW tool to better understand expected changes in their exposure to some common drought indicators such as warm season streamflow, snowpack, and total precipitation. The system chose these indicators because the alluvial aquifer is groundwater under the influence of surface water. When using the CMRW Tool, the water system chose to focus on the high emissions, RCP 8.5 greenhouse gas scenario looking at two time periods (2020-49 and 2070-99).

Existing Planning Documents: Wildfire and extreme heat—acute hazards often associated with drought—were identified in other planning documents. Findings from these planning documents were included in their CRE hazard identification summary table.

The example system chose to look into the following drought related climate indicators.

Warm Season Streamflow: Using the CMRW tool, they see that warm season streamflow is expected to decrease by approximately 20-25 percent by 2070-99 (under the RCP 8.5 emissions scenario) in the watershed connected to their local alluvial aquifer. They record this finding in the "Surface Runoff/Streamflow" row in their table.

Snowpack: Under these same scenarios (2070-99, RCP 8.5) they see that snowpack is expected to decrease by 40-100 percent across the watershed connected to their alluvial source aquifer, with no snowpack in lower elevation foothill streams by April 1. They record these findings in the "Snowpack" row of their table.

Total Precipitation: In their region, total annual precipitation is expected to increase by 10-15 percent by 2070-2099 (RCP 8.5 scenario). They record these findings in their table and make a note to consider opportunities for managed aquifer-recharge in the alluvial aquifer.

Wildfire and Extreme Heat: The water system is also located in an area at elevated risk for wildfires and extreme heat, acute hazards linked directly with changes in precipitation and temperature. Community responses to these hazards are discussed extensively in the local comprehensive plan and their water system Emergency Response Plan. The water agency summarizes key findings from existing planning efforts in their summary table.

Other Climate Indicators Evaluated

One aim of the CRE is to help systems identify emerging challenges through more holistic consideration of climate hazards. In this example, the water system was surprised to see projected increases in total precipitation in their evaluation of drought indicators. Based on this observation, they decided to look at CMRW indicators related to flooding rivers ("peak streamflow" and "return interval of 25-year peak streamflow"). Peak annual streamflow is expected to increase 30-50 percent in local tributaries, but less so in mainstem rivers. The 25-year return interval in local tributaries decreases substantially to ~5-10 years, indicating more frequent high-flow events in future years. The water system has not historically faced problems with flooding during extreme events and makes a note to identify critical assets in areas that may face increased flood risks.

Next Steps: The water system documented their process and identified which types of exposure to prioritize for inclusion in their WSP asset inventory using the provided template table. Of the hazards identified, they felt time impacts of drought will be most significant for their water system and chose to focus on drought-related impacts to their system in subsequent portions of their CRE.

Example Table

Table 3. Example Table—Summarizing Significance of Climate-Related Hazards

Hazards	**Is this hazard likely to pose a significant challenge for your system?** *(Yes/No/ Maybe/NA)*	**Brief Description of Anticipated Change in Hazard and Challenges Associated with Hazard** (for all Yes/Maybe responses in previous column)	**Relative Significance of Challenge Posed by Exposure to Hazard** *(High/Med/Low/Not Sure)*	**How was your system's exposure to this hazard evaluated?** (e.g., existing planning effort (specify), local knowledge, CMRW Tool, Modeling/Analysis, Other (specify))
Acute Hazards/Extreme Weather Events				
River Flooding	Maybe	Peak streamflow expected to increase in local tributaries, but not mainstem river; Minimal assets located in floodplain	Low	Local experience/CMRW – 'Peak Streamflow' and '25-year return interval' indicators
Coastal Flooding	N/A			
Drought	Yes	Droughts are expected to become more common and severe in our region. We have had to temporarily take two wells offline and implement mandatory conservation measures during past droughts.	High	Local knowledge/experience during past droughts.
Wildfire	Yes	Local comprehensive plan noted 77% chance of wildfire within the county in the next 30 years (2020-49) (RCP 8.5) (used CMRW).	High	Existing Planning Effort – Comprehensive Plan; Water System Emergency Response Plan
Extreme Heat Events	Yes	Local comprehensive plan noted 52 additional days above 90 degrees by 2070-99 (RCP 8.5) (used CMRW).	High	Existing Planning Effort – Comprehensive Plan

Table 3. Example Table—Summarizing Significance of Climate-Related Hazards

Hazards	**Is this hazard likely to pose a significant challenge for your system?** *(Yes/No/ Maybe/NA)*	**Brief Description of Anticipated Change in Hazard and Challenges Associated with Hazard** (for all Yes/Maybe responses in previous column)	**Relative Significance of Challenge Posed by Exposure to Hazard** *(High/Med/Low/Not Sure)*	**How was your system's exposure to this hazard evaluated?** (e.g., existing planning effort (specify), local knowledge, CMRW Tool, Modeling/Analysis, Other (specify))
Other	N/A			
Long-Term Changes and Hazards				
Air Temperature	Yes	See 'Extreme Heat'	High	Existing Planning Effort – Comprehensive Plan
Precipitation	Yes	CMRW Tool predicts a 10-15% increase in total precipitation (2070-99, RCP 8.5 scenario). (Could create an opportunity for managed aquifer recharge? Is flooding expected to increase?)	Not sure – Consider further in future planning goals	CMRW Tool – 'Total Annual Precipitation' climate indicator
Surface Runoff/ Streamflow	Yes	CMRW Tool predicts a 20-25% decrease in warm season streamflow (2070-99, RCP 8.5 scenario) in the watershed supplying the alluvial aquifer we use as a primary source.	High/Medium	CMRW Tool – 'Warm Season Streamflow' climate indicator
Snowpack	Maybe	CMRW Tool predicts a 40-100% change in April 1 snowpack (2070-99, RCP 8.5). (Greater % reductions at lower elevations, less at higher elevations).	Not Sure – Know snowpack serves as a reservoir, contributes to spring/summer recharge, but uncertain of magnitude	CMRW Tool – 'Snowpack' climate indicator

Table 3. Example Table—Summarizing Significance of Climate-Related Hazards

Hazards	**Is this hazard likely to pose a significant challenge for your system?** *(Yes/No/ Maybe/NA)*	**Brief Description of Anticipated Change in Hazard and Challenges Associated with Hazard** (for all Yes/Maybe responses in previous column)	**Relative Significance of Challenge Posed by Exposure to Hazard** *(High/Med/Low/Not Sure)*	**How was your system's exposure to this hazard evaluated?** (e.g., existing planning effort (specify), local knowledge, CMRW Tool, Modeling/Analysis, Other (specify))
Sea Level Rise	N/A			
Changes in Groundwater Recharge/Levels	Yes	See 'Drought', 'Snowpack', and 'Surface Runoff'	High	Local knowledge/experience – Observed declining groundwater levels during past periods of drought/high demand/decreased recharge (low streamflow) in alluvial aquifer
Other				

A.2. Assess Vulnerability and Risk

Objective: Build scenarios to identify potential impacts.

Background

The impacts of hazards on water systems can be varied and wide reaching – impacting water supply, water quality, staffing, finances, and other utility functions (Figure 3). **This section identifies assets and operations most likely to be impacted by the climate-related hazards identified in Section A.1.** Systems approach assessments of vulnerability and risk in many ways. The EPA Creating Resilient Water Utilities (CRWU) tools include modules for assessing vulnerabilities and identifying strategies. Likewise, scenario planning can serve as a useful process for identifying and prioritizing impacts from the hazards identified in Section A.1. More detailed information on the specific impacts of climate-related hazards on water systems can be found on CIG's WSP Resources webpage.

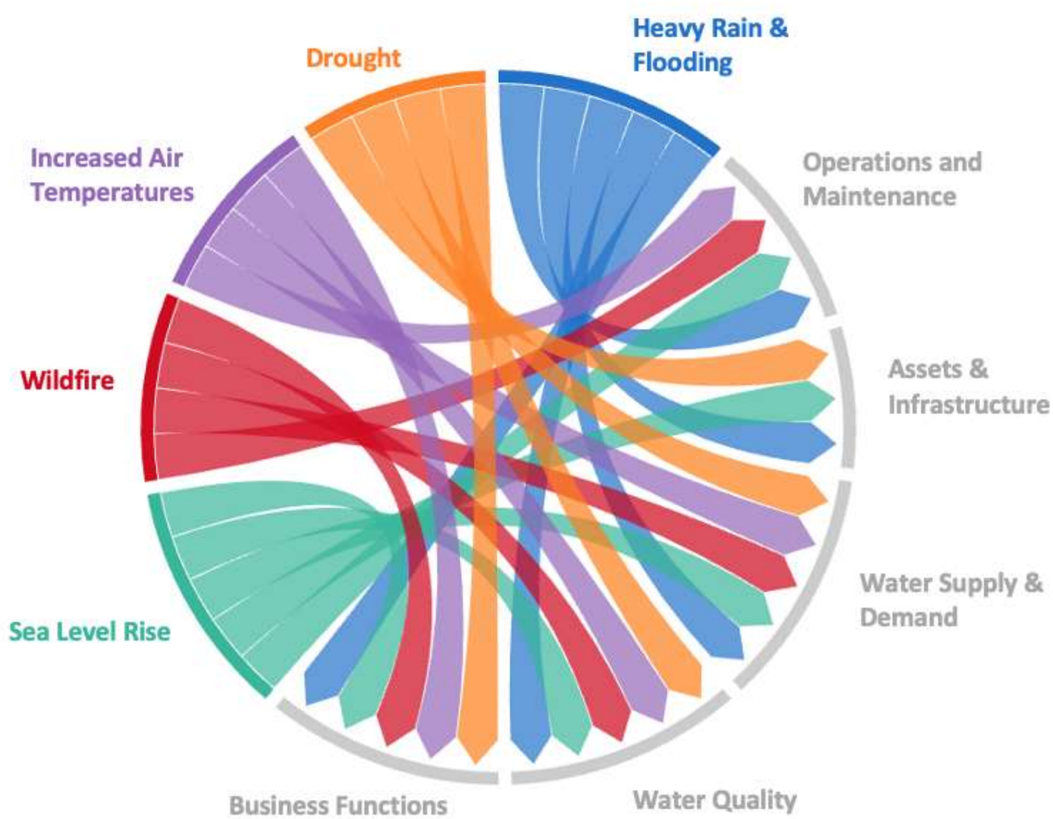

Figure 3. Multi-Dimensional Impacts of Climate Hazards on Water Systems.
Source: *CIG Climate Resilience for Small and Medium Water Systems Project*

Reflection Questions by WSP Guidebook Chapter

Appendix C includes a series of reflection questions connecting climate-related hazards, challenges, and impacts to existing WSP activities. Sensitivity and adaptive capacity are two key determinants of the realized impacts of climate-related hazards on water systems (see Key Concepts) but are often difficult to evaluate. The included reflection questions are helpful for exploring your water system's unique sensitivities, strengths, and opportunities for building resilience.

These questions support internal consideration of climate-related impacts across WSP activities. Not all questions are relevant to all systems; and systems are not expected to respond to each question in their CRE.

Scenario Planning

Scenario planning enables water systems to assess vulnerabilities and risks associated with a wide variety of risks and hazards, including climate change. It can include many different approaches ranging from tabletop exercises through complex models but should be driven by local priorities and risks. Climate-related hazards can manifest as impacts across multiple core components of water systems (Figure 3). By exploring a range of plausible future scenarios—such as differing frequencies or magnitudes of droughts, floods, or heatwaves—water systems can identify potential impacts on infrastructure and operations and develop adaptation strategies to mitigate risks.

In the case of the CRE, scenarios may look quite different across water systems. The CRE is not prescriptive about the types of scenarios water systems need to consider. Some examples of the types of scenarios and/or activities water systems might choose to pursue include:

- Differences in exposure associated with RCP 4.5 vs. RCP 8.5 and relative impacts.
- Contingency planning for 5, 10, 20 percent declines in groundwater levels.
- Evaluation of potential climate-related changes in demand and impacts on revenue.
- Tabletop exercise focused on different adaptation activities.
- Standalone climate vulnerability assessment.

Note: *Some scenario analysis/planning activities may not be feasible in the context of the CRE. When these activities are identified as priority climate resilience actions, they should be incorporated into CIP and Financial Programs.*

Scenario Planning Example

Scenario Planning Process

Scenario planning processes involve several common steps, though they can vary from system to system with the questions being explored. Below is an example of a set of broad steps that a water system may engage in when doing scenario planning.

- Defining the planning context, including focus, planning horizon, and current conditions.

- Identifying and ranking external driving forces, for example climate change or population growth, based on their importance and uncertainty.
- Developing a matrix of scenarios and crafting narratives for each. One common scenario differentiator is using low and high emissions scenarios to show a range of possible climate and extreme weather impacts.
- Understanding the implications of each future scenario.
- Creating action plans tailored to each scenario.
- Comparing actions across scenarios to identify common strategies.
- Defining trigger points to apply adaptive plans as conditions evolve.
- Conducting periodic review of plans and strategies and implementing changes through adaptative management-type approaches.

Comprehensive planning helps water systems prepare for a range of climate scenarios. This includes efforts like integrated water management, emergency and contingency planning, risk assessments, and energy management. These tools support both preparation and response to changing and unpredictable climate conditions. Scenario planning may consider the effects of extreme weather and climate impacts on water demand, supply, and/or quality.

Example Use Case(s)

Using the example of a medium sized, groundwater-dependent Group A system in eastern Washington that experienced periodic water supply shortages due to groundwater drought conditions. This system conducts a scenario planning process that considers various scenarios based on the significant risks they identified in Table 3 and Table 4. Two example scenarios are provided below.

Scenario 1: Drought and Increased Water Demand Due to Higher Average Annual Temperatures

- **Physical changes.** This scenario anticipates a prolonged period (five–ten years) of below-average rainfall and snowpack, combined with rising average annual temperatures (2–3°C above historical norms). Using the CMRW tool for Table 3 exercises, warm season streamflow is expected to decrease by approximately 20-25 percent by 2070-2099 (under the RCP 8.5 emissions scenario) in the watershed connected to their local alluvial aquifer.
- **Changes to Water Demand.** As a result of rising annual temperatures, domestic water users have increased their water use. Longer and warmer growing seasons are also driving an increase in agricultural water use, further limiting supply within the watershed.
- **Preparedness and mitigation strategies.** Given the possible conditions identified in this scenario, the water system chooses to model impacts on groundwater from extended droughts. The water system also identifies water supply and demand “trigger” points that allows the water system to implement demand management strategies and provide alternative, contingency supply sources if alluvial well water sources become unavailable either temporarily or over longer stretches of time.

Scenario 2: Wildfires Impacts to Infrastructure.

- **Physical changes.** This scenario assumes increasingly frequent and intense wildfires that either directly impact the water system's supply and distribution infrastructure or indirectly affects the water quality in the watershed through increases in contaminants via surface water runoff following a wildfire event. Insights from the local comprehensive plan noted 77 percent chance of wildfire within the county in the next 30 years (2020-2049) (RCP 8.5) (using CMRW; identified in the Table 3 exercise). Therefore, this water system anticipates with a high degree of certainty that a significant wildfire event is likely to happen somewhere in the watershed during that timeframe.
- **Wildfire impacts to infrastructure and source water quality.** This water system chooses to build a scenario off a worst case wildfire event. They base the scenario off of a high-severity wildfire that directly impacts key water system infrastructure in the immediate term and longer-term. This includes considerations of post-wildfire impacts to water quality up to ten years later. Wildfires can change soil and vegetation composition, which significantly impacts the hydrological cycle. It can also alter future runoff and infiltration patterns, in turn degrading source water quality for surface and groundwater sources.
- **Preparedness and mitigation strategies.** To address possible immediate impacts from a wildfire event that destroys infrastructure assets, the water system explores options for emergency water delivery services. The existing Emergency Response Plan includes some of these options already, though the projected increase in the chance of wildfire prompts water system managers to update the emergency operations plan and expand partnership agreements with nearby utilities for mutual aid and resource sharing in the event of a wildfire.

Water System Plan Template Table: Climate-Related Challenges and Impacts

Template Table Description

Assessments of climate-related risks should account for both direct impacts (e.g., damage to physical infrastructure caused by a wildfire) and indirect impacts (e.g., degradation of source water quality due to increased pollutant loads following a wildfire in the watershed—potentially far from the infrastructure itself). These impacts can be acute, one-time events or chronic, recurring events that intensify and become more frequent over time. Drawing on the hazards identified in Table 3, water systems can use Table 4 to identify which system components (e.g., water supply, source water quality and monitoring, physical infrastructure, etc.) may be affected by significant events. Water systems can also include additional categories to reflect impacts on broader operational and business functions.

Example 'Climate-Related Challenges and Impacts' Table

The table below is completed as an example template, and follows the significant hazards identified in the example provided for Table 3.

Table 4. Example Table—Summarizing Climate Related Challenges and Impacts

Hazards	Hazard Identified as Significant Challenge in Section A.1	For items marked 'yes' or 'maybe' in the first column, what system components would you anticipate being impacted by the identified hazards? What is the level of potential impact you anticipate associated with each of these hazards (High/Med/Low/NA)?									Please briefly describe the types of impacts you anticipate for impacted system components.
		Water Supply	Water Demand	Source Water Quality and Monitoring	Water Treatment and Monitoring	Physical Infrastructure	Supply Chains/ Procurement	Workforce	Finance	Other	
Acute Hazards/Extreme Weather Events											
Riverine Flooding	No										
Coastal Flooding	N/A										
Drought	Yes	High	High								Decreasing supply with increasing demand (outdoor use + regional agriculture) during drought.

Hazards	Hazard Identified as Significant Challenge in Section A.1	For items marked 'yes' or 'maybe' in the first column, what system components would you anticipate being impacted by the identified hazards? What is the level of potential impact you anticipate associated with each of these hazards (High/Med/Low/NA)?										Please briefly describe the types of impacts you anticipate for impacted system components.
		Water Supply	Water Demand	Source Water Quality and Monitoring	Water Treatment and Monitoring	Physical Infrastructure	Supply Chains/ Procurement	Workforce	Finance	Other		
Wildfire	Yes	Med		Med	High	High			High			Damage to physical infrastructure would be costly. Additional monitoring for distribution system related contamination.
Extreme Heat	Yes	Low	Med	Low	Med			High				Impacts for maintenance staff and ongoing construction projects; Potential impacts on treatment chemistry

Hazards	Hazard Identified as Significant Challenge in Section A.1	For items marked ‘yes’ or ‘maybe’ in the first column, what system components would you anticipate being impacted by the identified hazards? What is the level of potential impact you anticipate associated with each of these hazards (High/Med/Low/NA)?									Please briefly describe the types of impacts you anticipate for impacted system components.
		Water Supply	Water Demand	Source Water Quality and Monitoring	Water Treatment and Monitoring	Physical Infrastructure	Supply Chains/ Procurement	Workforce	Finance	Other	
Other											
Long-Term Changes and Hazards											
Air Temperature	Yes		Med		Med			High			See drought and wildfire
Precipitation	Yes	Med				Low					Potential for increased recharge with increased total precipitation, but decrease during critical dry months

Hazards	Hazard Identified as Significant Challenge in Section A.1	For items marked 'yes' or 'maybe' in the first column, what system components would you anticipate being impacted by the identified hazards? What is the level of potential impact you anticipate associated with each of these hazards (High/Med/Low/NA)?									Please briefly describe the types of impacts you anticipate for impacted system components.
		Water Supply	Water Demand	Source Water Quality and Monitoring	Water Treatment and Monitoring	Physical Infrastructure	Supply Chains/ Procurement	Workforce	Finance	Other	
Surface Runoff/Streamflow	Yes	High									Decrease in recharge of alluvial aquifer during summer months
Snowpack	Maybe	Med									
Sea Level Rise	N/A										
Changes in Groundwater Recharge/Levels	Yes	High				High					Declining groundwater levels during drought/periods of high demand; Shallow wells offline during severe droughts

Hazards	Hazard Identified as Significant Challenge in Section A.1	For items marked 'yes' or 'maybe' in the first column, what system components would you anticipate being impacted by the identified hazards? What is the level of potential impact you anticipate associated with each of these hazards (High/Med/Low/NA)?									Please briefly describe the types of impacts you anticipate for impacted system components.
		Water Supply	Water Demand	Source Water Quality and Monitoring	Water Treatment and Monitoring	Physical Infrastructure	Supply Chains/ Procurement	Workforce	Finance	Other	
Other______________											

B. Investigate Options

Objective: Assess critical assets and the actions necessary to protect the system from the consequences of extreme weather events on system operations.

The aims of this section of the CRE are: 1) Incorporate findings on significant climate-related challenges and impacts (Section A.2) into the system's existing assessment of critical assets; and 2) Begin identifying actions that could help mitigate significant, high priority climate impacts. Systems should include a brief description of how climate-related impacts were considered in their assessment of critical assets in their CRE then incorporate the substance of their work integrating these findings into relevant activities/sections of their WSP (e.g., asset criticality, capacity analysis). Systems should also use this section to identify any existing and proposed mitigating actions needed to reduce risks and/or protect critical assets from climate-related impacts.

A template table (Table 5) is provided to help systems summarize impacts on critical assets. Case studies, tools and resources supporting identification and evaluation of climate adaptation and resilience strategies are included in the [WSP Resources] section of CIG's website.

Table 5. Example template table summarizing high exposure hazards (identified in Table 3; Section A.1; corresponding sensitivity to a hazard (High/Medium/Low); and identification of existing and proposed actions that may mitigate impacts from the hazard.

Hazard	Hazard Rating (From Table 3)	Sensitivity of Critical Assets to Impact from Hazard	Impacted Critical Assets	Near (1-5 yrs) - or long-term (5+ yrs) risk?	Mitigating actions
Drought	High	Low	Storage tanks; Distribution infrastructure	Near-term	**Existing:** Upgrade storage capacity with larger volume storage tanks **Proposed:** Expand leak detection and repair program for all distribution infrastructure
Wildfire	High	High	Infrastructure (within wildfire prone areas)	Near-term	**Existing**: Wildfire mitigation and hardening of existing infrastructure within wildfire prone areas. **Proposed**: Develop additional wells that are not within the Wildland Urban Interface
Changes in Groundwater Recharge/ Levels	High	High	Pumping infrastructure; Supply wells	Long-term	**Existing:** Upgrades to pumping systems to improve efficiency and system reliability

Hazard	Hazard Rating (From Table 3)	Sensitivity of Critical Assets to Impact from Hazard	Impacted Critical Assets	Near (1-5 yrs) - or long-term (5+ yrs) risk?	Mitigating actions
					Proposed: Add additional backup wells for contingency sources during times of low well levels

C. Prioritize and Plan

Objective: Generate reports describing the costs and benefits of the system's risk reduction strategies and capital project needs.

Capital improvement planning activities should incorporate the risk reduction strategies identified in Section B. Systems should include a brief description of how they addressed this requirement in their CRE and incorporate the substance of their work integrating these findings into applicable activities/sections of their WSP (e.g., capital improvement program, financial program). Table 6 modifies Table 8-1 from WSP Guidebook Chapter 8 (Capital Improvement Program) to add a 'Climate Resilience Action' column that allows systems to indicate whether a project contributes to resilience (either as a primary driver or co-benefit) against identified climate-related hazards. Using this table—or otherwise incorporating climate resilience considerations into Chapter 8—is one effective way for systems to fulfill the "Prioritize and Plan" component of the CRE.

Table 6. Example template table of a Capital Improvement Program schedule that also notes whether the project provides a climate resilience-building action or mitigates a climate-related hazard. This table mirrors Table 8-1 from WSP Guidebook Chapter 8 (Capital Improvement Program).

Project	Project Type	Year	Total Project Cost	Anticipated Source of Funding	Classification of Deficiency	Climate Resilience Action (Y/N)?

Appendix A
Blank Copies of Climate Resilience Element Workbook Tables

You can download blank copies of the template tables shared in this workbook are available as an Excel spreadsheet 331-778-WS (Excel).

Appendix B
Collections of Climate Resilience Planning Resources for Water Systems

This appendix includes links to several significant collections of resources on climate resilience planning for water systems.

Climate Resilience Planning Resources for Water Systems

This webpage, hosted by CIG, offers a curated collection of data sources, tools, and informational resources designed to support drinking water systems in addressing potential impacts from climate change, extreme weather events, and other natural hazards. It serves as a central hub for water utilities, planners, and operators seeking guidance on building climate resilience and adapting infrastructure and operations. The resources on this page are designed to support all stages of the adaptation and resilience cycle. Whether you are just beginning risk assessment and adaptation planning or enhancing existing efforts, this page connects you to practical, science-based support.

Washington State Climate Resilience Strategy

The Washington State Climate Strategy, a collaborative product of ten state agencies, outlines priorities and actions supporting the state's response to climate change. Ecology's Washington State Climate Resilience Strategy Appendix A includes regional summaries of current climate projections.

Water Utility Climate Alliance (WUCA)

WUCA has developed an extensive collection of resources on climate resilience planning and adaptation. WUCA is comprised of twelve of the nation's largest water providers (including Seattle Public Utilities and Portland Water Bureau), but many of the resources are relevant to a broader range of agencies.

U.S. EPA Creating Resilient Water Utilities (CRWU)

The CRWU website hosts a broad range of tools, resources, and case studies supporting water agencies at all stages in their climate resilience planning efforts, including links to EPA's Resilient Strategies Guide and Climate Resilience Evaluation and Awareness Tool (CREAT). Both tools walk users through steps paralleling those in the Steps to Resilience Framework.

American Water Works Association (AWWA)—Climate Change for Water Utilities Resources

AWWA maintains a collection of resources to aid drinking water systems in building climate resilience. The collection includes technical manuals, reports, and case studies. One notable resource is a guidebook titled *Incorporating Climate Change Impacts Into Demand Forecasting—A Guidebook for Practitioners*, which provides an in-depth overview of challenges water systems may face to meet customer water needs as a result of climate change impacts

Appendix C
Reflection Questions by WSP Guidebook Chapter

About This Section

The reflection questions in Appendix C are intended to:

- Help systems identify which water system components, operations, and other elements may be impacted by the hazards identified in Section A.1; and
- Provide ideas on the types of climate resilience actions that may be most helpful.

These questions are intended as a starting point. Not all questions will be relevant to all systems and, likewise, there may be topics that warrant deeper investigation depending on a system's level of exposure, risk tolerance, and other factors. These questions are meant as a general resource for a system's internal use. **Water systems are not expected to explicitly respond to these questions in their WSP CRE.**

Chapter 1: Description of the Water System

1.2 System History and Background

Given your understanding of the climate-related challenges your system is facing, is your system's history representative of what you would anticipate in the future? What changes are you anticipating? What challenges do you expect to remain similar?

1.3 Related Plans

What existing, adopted plans consider impacts from climate-related hazards?

- City and county comprehensive plan.
- Local land use and zoning.
- Coordinated Water System Plans (CWSP).
- Abbreviated Coordinated Water System Plans (ACWSP). See RCW 70.116.050.
- County water and sewer general plans. See RCW 36.94.030.
- Groundwater management plans.
- Watershed plans for Water Resource Inventory Areas (WRIA).
- Regional water supply plans.
- Water system plans for:
    - Water systems located within and adjacent to the service area
- Other?

1.4 Service Area, Maps, and Land Use

- Which regions of the service area might be affected by climate-related impacts?
- Are there other map data (e.g., floodplain maps) that can be overlaid to help examine high-risk areas?

1.5 Local Government Consistency

Are there any other government planning documents (such as local comprehensive plans, development regulations, and other local codes) that include similar climate-related risk and/or resilience considerations that can inform CRE for drinking water system plans?

Chapter 2: Basic Planning Data

2.2 Water Production and Usage

- How might the climate-related impacts identified in your CRE impact monthly and annual production from each source, including interties?
  (e.g., change in surface water availability in summer months, decrease in yield from groundwater wells)
- How might the climate-related challenges identified in your CRE impact annual usage totals by each customer class?
  (e.g., change in summer outdoor residential water demand)
- Are there seasonal differences in usage by different customer classes that could result in greater impacts from the climate-related challenges identified in your CRE (e.g., higher residential demand during dry summer months)?
- How might the climate-related challenges identified in your CRE impact the quantity of water you can supply to other public water systems (e.g., interties)?

2.4/2.5 Water Supply Characteristics and Water Supply Reliability

How might the climate-related challenges identified in your CRE impact supply availability and reliability for each of the sources used by your water system?

Surface Water

- Will projected changes in streamflow (in general, during the summer months, and during periods of drought) impact the timing or quantity of water available to your water system in a significant way? How so?
- How might projected changes in streamflow impact other water rights holders within your source watershed? Will these impacts change the amount of water available to your system (e.g., interruptible rights)?
- Will projected changes in snowpack impact the amount and/or timing of water available to your water system? How so?

Groundwater

- Is your water system dependent on groundwater under the influence of surface water? If so, how might anticipated changes in surface water flows impact your system?
- What does recharge look like in your source aquifer? (e.g., confined aquifer with minimal recharge, alluvial aquifer with extensive recharge)
- How might climate-related changes impact recharge within your source aquifer?

- What changes in groundwater supply, if any, have you observed occurring within your system's source aquifer in response to past extreme events (e.g., drought) and/or climate related changes (e.g., sea level rise)?
- What trends in groundwater levels within your source aquifer have been observed by your system over the past 10-30 years?
- Would you anticipate changes in groundwater level trends in response to future extreme events and/or climate-related changes?
- How might projected changes in aquifer conditions impact other water rights holders within your source aquifer and surrounding watershed? Will these impacts change the amount of water available to your system (e.g., curtailments, greater dependence on groundwater in agricultural sector)?

Interties/Purchased Water

- Are the water systems you have intertie(s) with anticipating any significant impacts from climate change or extreme events that could impact your system (e.g., in their WSP CRE)?
- Are the climate-related exposures of the system you have an intertie with similar to or different that those of your system?

2.6 Future Population Projections and Land Use

- Do local comprehensive plans consider climate-related changes in population within your supply and/or service areas? Could these changes impact water system operations? How so? (e.g., projected development along wildland-urban interface, retreat from specific coastal areas)
- Do local comprehensive plans consider climate-related changes in land use within your supply and/or service areas? Could these changes impact water system operations? How so? (e.g., projected development along wildland-urban interface, retreat from specific coastal areas)

2.7 Future Water Demand

Water Rights Self-Assessment

- Are there characteristics of your system's water rights (e.g., interruptible rights, seniority) that could make your system more likely to experience reduced water availability associated with the climate-related challenges you identified in your WSP CRE? How so?

Water Demand Forecasts

- Do you anticipate any changes in demand associated with the climate-related hazards you identified in your WSP CRE ? (e.g., increased outdoor demand due to increasing temperatures/decreasing precipitation) If yes, how so?

Chapter 3 System Analysis and Asset Management

3.1 Asset Management – Asset Inventory and Analysis

- Are there elements of your system's source(s) condition that makes it/them more vulnerable to the climate-related hazards you identified in your CRE? (e.g., source watershed with high wildfire risk, erosion prone slopes in source watershed + increase in extreme precipitation events)
- Are there elements of your water treatment facilities condition that make them more vulnerable to the climate-related hazards you identified in your CRE? (e.g., currently operating with filtration waiver, limited capacity to address HAB.)
- Are there elements of your storage facilities condition that make them more vulnerable to the climate-related hazards identified in your CRE?
- Are there elements of your distribution system's condition that make it more vulnerable to the climate-related hazards identified in your CRE?
- Are there identified 'critical assets' that are vulnerable to impacts from the climate-related hazards identified in your CRE? (e.g., primary distribution line in area vulnerable to coastal flooding)
- Have 'critical assets' been impacted by past extreme events and/or natural hazards?

3.2 Water Quality

- What changes in source water quality, if any, have you observed following past extreme events and/or exposure to natural hazards? (e.g., following 100-year storm, sea level rise)
- What changes in source water quality do you anticipate could be associated with changing exposure to the climate-related hazards you identified in your CRE?
- What changes in distributed water quality, if any, have you observed following past extreme events and/or exposure to natural hazards? (e.g., following 100-year storm, sea level rise)
- What changes in distributed water quality do you anticipate could be associated with changing exposure to the climate-related hazards you identified in your CRE?

3.3 Design Standards

- Do existing design standards consider and adequately account for the potential changes associated with the climate-related hazards identified in your CRE? How so?

3.4 Capacity Analysis

3.4.1 Water Rights

- Are the climate-related challenges identified in your CRE likely to change your system's assessment of the sufficiency of existing water rights?

3.4.2 Physical Capacity Analysis

- Are the climate-related challenges identified in your CRE likely to change your assessment of the sufficiency of your system's physical capacity?

3.4.3 New Source of Supply Analysis

- How might the new sources of supply identified by your water system be impacted by the climate-related challenges identified in your CRE?

3.5 Summary of System Deficiencies

- Are there any system deficiencies that may be exacerbated by the climate-related challenges identified in your CRE?
- Are there any water system projects planned to address a deficiency that could be expanded or modified to also address a current or future risk from the climate-related challenges identified in your CRE?

Chapter 4 Water Use Efficiency Program

4.3 Water Use Efficiency Program

- Do WUE plans consider impacts from identified climate-related challenges to source water supply?
- Do WUE demand projections include considerations of changes in demand associated with impacts from climate-related challenges? (e.g., warmer summer temperatures driving greater customer water usage)?
- Do WUE demand projections include considerations of changes in water supply due to from impacts from climate-related challenges? (e.g., reduced surface water resources from declining snowpack, or diminished groundwater resources because of declining recharge rates) Has your system needed to implement emergency conservation measures in response to climate-related challenges? (e.g., declining groundwater levels, drought)

4.4. Water Use Efficiency Savings

- What level of future WUE gains are likely to be possible? (i.e., are adoption rates of efficient devices and/or low water use landscapes high or is there room for improvement)
- How do water savings from WUE compare to expected changes in supply/demand (generally)?
- How can investments in WUE contribute to climate resilience?

Chapter 5 Source Water Protection

5.1 Sanitary Control Area

- Could any of the climate-related hazards identified in your CRE compromise maintenance of your water system's sanitary control area?

5.2 Wellhead Protection Program

- Would any of the climate-related hazards identified in your CRE increase your water system's risk of contamination? (e.g., chemical storage within wellhead protection area and increased flood or wildfire risk; changes in pollutant transport from known sources of in situ contamination associated with changes in groundwater recharge)
- Has your water system observed any changes in groundwater quality associated with past extreme weather events and/or natural hazards? How were these changes managed and/or what challenges did you face when managing these changes?

5.3 Watershed Control Program

Watershed Description

- Would any of the climate-related hazards identified in your CRE result in changes in:
    - Annual precipitation patterns.
    - Streamflow characteristics (including maximum, average, and minimum flows).
    - Sediment loading as related to rainfall intensity.
    - Terrain/geologic features.
    - Vegetation and soil type and any other characteristics detrimental to water quality such as areas subject to erosion or landslides?
- Has your water system observed any changes in surface water quality associated with past extreme weather events and/or natural hazards? How were these changes managed and/or what challenges did you face when managing these changes?

Identification of Activities and Land Uses Detrimental to Water Quality

- Do you anticipate any changes in land use associated with future climate-related hazards that could increase the vulnerability of surface water source(s)? (e.g., forest die off due to extreme heat/wildfires, changes in agricultural practices, changes in urban development patterns)?

Watershed Management and Control Measures

- Do current watershed control measures address anticipated climate-related challenges?
- Will existing deficiencies in current watershed control measures be exacerbated by anticipated changes in climate-related hazards?
- What watershed control measures is your system considering, planning for, or implementing in response (either entirely or in part) to anticipated changes in climate-related hazards?
- Are current wildfire control measures aligned with anticipated changes in wildfire risk?

Chapter 6 Operation and Maintenance Program

6.1 Water System Management and Personnel

- Are any of the climate-related hazards identified in your CRE likely to impact staff and/or contractor's ability to do their jobs? (e.g., extreme heat impacts on outdoor work and construction projects, flooding limits access to work sites)
- Are there any actions that can be taken to reduce exposure to climate-related workforce impacts? (e.g., cross-function training, changes to work conditions)

6.2 Operations and Preventative Maintenance

- Are any of the identified climate-related challenges likely to impact routine maintenance schedules? (e.g., more frequent filter backwashing in response to increased turbidity, reservoir maintenance activities)
- Would any of the identified climate-related challenges impact access to supplies and/or resources needed for operations and preventative maintenance? (e.g., power outages, routine deliveries of chemicals/supplies)

6.3 Comprehensive Water Quality Monitoring

- Are changes in water quality monitoring programs needed to detect and respond to changes in source water quality associated with climate-related hazards? (e.g., more frequent sampling after storm events, additional sampling locations, additional monitoring parameters)

6.4 Emergency Preparedness and Response

- Do current emergency preparedness and response plans (including risk and resiliency assessments, emergency operations protocols, water shortage plans, etc.) anticipate risks from climate-related hazards and challenges (such as heavy rainfall events, extreme heat events, and prolonged drought) that have not been historically considered?
- Are assessments of risk significance based primarily on past experience, or do they also include consideration of future changes?
- What existing risks within emergency preparedness and response plans might overlap with climate-related hazards and challenges identified for the CRE?
- Do current emergency preparedness and response planning efforts include the possibility of more frequent extreme weather events occurring in the future?
- Do water shortage response plans consider the possibility of longer, more intense droughts, or other climate-related challenges that could disrupt supply or affect demand over longer time horizons?
- Can emergency plans and operational capacity (including protocols, staffing, and budgets) accommodate more frequent and/or co-occurring emergencies caused by climate-related hazards?

6.8 Surface Water Treatment

- Could the climate-related hazards identified in the CRE impact current surface water treatment practices and/or water quality reliability? If yes, how so?

6.9 Summary of O&M Deficiencies

- Are any of the identified O&M deficiencies likely to be exacerbated by the climate-related challenges identified in your CRE?
- Are there any additional O&M deficiencies that could be created as a result of the climate-related challenges identified in your CRE?

Chapter 7 Distribution Facilities Design and Construction Standards

7.3 Construction and Design Standards

- Do construction and design standards consider changes from historical norms resulting from climate-related hazards? (e.g., design of distribution lines in coastal zones subject to increased flooding; distribution system piping materials and depth in high wildfire risk areas; fire resistant building materials)
- How can small changes in construction and design approaches provide resilience co-benefits? (e.g., pipe materials in wildfire risk zones, treatment processes suitable for future water quality challenges)

Chapter 8 Capital Improvement Program

This chapter joins the project solutions list from "System Inventory and Analysis" and the needed action list from "Operations and Maintenance" into a comprehensive, prioritized summary

8.1 Prioritization

Project Assessment—Consider Prompt for Climate Resilience Motivated Projects

- Do any significant climate-related challenges identified for the CRE require technical, managerial, and financial resources to plan, design, implement, operate, and maintain physical infrastructure assets and workforce?

Value Planning – link to resources on co-benefits?

- Are there capital improvement projects that could be modified to provide co-benefits to address both existing needs and can also work to mitigate impacts from climate-related challenges identified for the CRE?

8.2 Capital Improvement Program Summary and Schedule

- What projects listed in the Capital Improvement Program Summary and Schedule provide climate resilience benefits either as the primary project driver or as a co-benefit?

Chapter 9 Financial Program

- What are the financial costs of CIP projects flagged as providing climate-resilience benefits or co-benefits?

Chapter 10 Miscellaneous Documents

- Do any of the cited documents contain information or resources relevant to development of your CRE?