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Summary of Achieving Equitable, Climate-Resilient Water and Sanitation for Frontline Communities

WATER, SANITATION, AND CLIMATE CHANGE IN THE UNITED STATES SERIES, PART 3

MARCH 2025

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ABOUT THE PACIFIC INSTITUTE

The Pacific Institute envisions a world in which society, the economy, and the environment have the water they need to thrive now and in the future. In pursuit of this vision, the Institute creates and advances solutions to the world's most pressing water challenges, such as unsustainable water management and use; climate change; environmental degradation; food, fiber, and energy production for a growing population; and basic lack of access to fresh water and sanitation. Since 1987, the Pacific Institute has cut across traditional areas of study and actively collaborated with a diverse set of stakeholders, including leading policymakers, scientists, corporate leaders, international organizations such as the United Nations, advocacy groups, and local communities. This interdisciplinary and independent approach helps bring diverse groups together to forge effective real-world solutions. More information about the Institute and our staff, directors, funders, and programs can be found at www.pacinst.org.

ABOUT DIGDEEP

DigDeep is a human rights nonprofit working to ensure every person in the United States has access to clean running water and sanitation at home. We have served thousands of families across the country through our award-winning and community-led field projects: the Navajo Water Project (Arizona, New Mexico, and Utah), the Appalachia Water Project (West Virginia), and the Colonias Water Project (Texas). DigDeep is a leading force in US water access research, workforce development, and policy advocacy, underscoring our commitment to addressing the sector's lack of comprehensive data. Notable national reports, including "Closing the Water Access Gap in the United States: A National Action Plan" and "Draining: The Economic Impact of America's Hidden Water Crisis," unveiled the harsh reality that over 2 million people in the US live without a toilet or tap at home, which costs the American economy a staggering $8.6 billion annually. For more information, please visit digdeep.org.

ABOUT CENTER FOR WATER SECURITY AND COOPERATION

The Center for Water Security and Cooperation (CWSC) is a 501(c)(3) nonprofit organization based in Washington, D.C. Founded in 2015, the mission of the CWSC is to advance water security and cultivate cooperation by building a unified body of laws, policies, practices, and standards that ensure the availability of water for current and future generations, and a peaceful, stable, and vibrant global society. Ultimately, the CWSC works to ensure that law and practice guarantee water security and universal access to water and sanitation because without good law those people who have access will lose it, and those who don't, won't ever get it. More information about the CWSC can be found at www.thecwsc.org.

ABOUT THE AUTHORS

Shannon McNeeley

Shannon McNeeley is a Senior Researcher at the Pacific Institute and the Water and Climate Equity Lead. Her work focuses on water and climate equity and justice for frontline communities. This engages an interdisciplinary and cross-cultural co-production approach, incorporating the social and natural sciences along with different ways of knowing to understand human-environment relationships and how people are impacted by and respond to environmental change. Her research has focused on climate change science and policy, water resources and drought preparedness, and climate planning and action, all with a strong focus on supporting those who are overburdened and underresourced through just and equitable solutions. Dr. McNeeley has worked closely for decades with a multitude of different partners, organizations, decision makers, Tribes and Indigenous peoples, and frontline communities bridging technical research with applied decision support information and tools. Prior to joining the Pacific Institute, she was at the North Central Climate Adaptation Science Center at Colorado State University and before that at the National Center for Atmospheric Research. Dr. McNeeley holds a master's degree in international environmental policy from the Middlebury Institute of International Studies at Monterey and a doctoral degree in environmental change and sustainability science, which integrated anthropology, ecology, and climatology, from the University of Alaska Fairbanks.

Morgan Shimabuku

Morgan Shimabuku is a Senior Researcher at the Pacific Institute where she researches a wide range of water management issues, including water equity and access challenges, benefits and tradeoffs of water management strategies, water resilience, and more. Prior to joining the Pacific Institute, Morgan was a senior program manager at an environmental nonprofit in Colorado where she ran residential and commercial water conservation program operations in partnership with municipal water providers. Morgan received a bachelor's degree in environmental studies and geology from Whitman College and a master's degree in geography at the University of Colorado Boulder, where she studied climate change, hydrochemical cycling, and snow hydrology at the Institute of Arctic and Alpine Research.

Rebecca Anderson

Rebecca "Becky" Anderson is a Researcher in Water and Climate Equity at the Pacific Institute, where she focuses on interdisciplinary and collaborative research to advance climate-resilient water and sanitation for frontline communities. Before joining the Pacific Institute, Becky worked as a program manager at a national environmental nonprofit where she supported underresourced communities in developing locally driven, climate-resilient water projects. Her earlier work includes research on agricultural perspectives on water and climate change in the Colorado River Basin, as well as contributions to the review of Groundwater Sustainability Plans in California. Becky holds a bachelor's degree in earth sciences from Ohio State University and a master's degree in geography from Portland State University, where her thesis explored the equity implications of water efficiency tradeoffs.

Rachel Will

Rachel Will joined the Pacific Institute in 2023 as a Researcher in Water and Climate Equity. She co-produces research focused on equitable and climate resilient water systems in rural communities and WASH. Before joining the Pacific Institute, Rachel worked as a regional planner, focusing on social equity and climate resilience projects. She has extensive experience leading and contributing to interdisciplinary research on water equity, environmental justice, and climate resilience issues. Rachel holds a master's in geography from Kent State University, and a doctorate in integrative conservation and geography from the University of Georgia.

Jessica Dery

Jessica Dery is a Research Associate at the Pacific Institute. Her work addresses impediments and incentives for the use of recycled water in agriculture by merging science, policy, and outreach to promote communication and trust. Jessica has worked on a variety of interdisciplinary projects related to water quality and water reuse including agriculture and food safety, water treatment technologies, power generation, and public perception. Her experience includes conducting synthesis research, co-developing outreach products, and working directly with agriculture communities, utilities, and regulatory agencies. She received a bachelor's degree in microbiology from Arizona State University and a master's degree in soil, water, and environmental science from the University of Arizona.

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DEDICATION

We dedicate this report to the communities who
feel the impacts of climate change first and most strongly.

Water is life.

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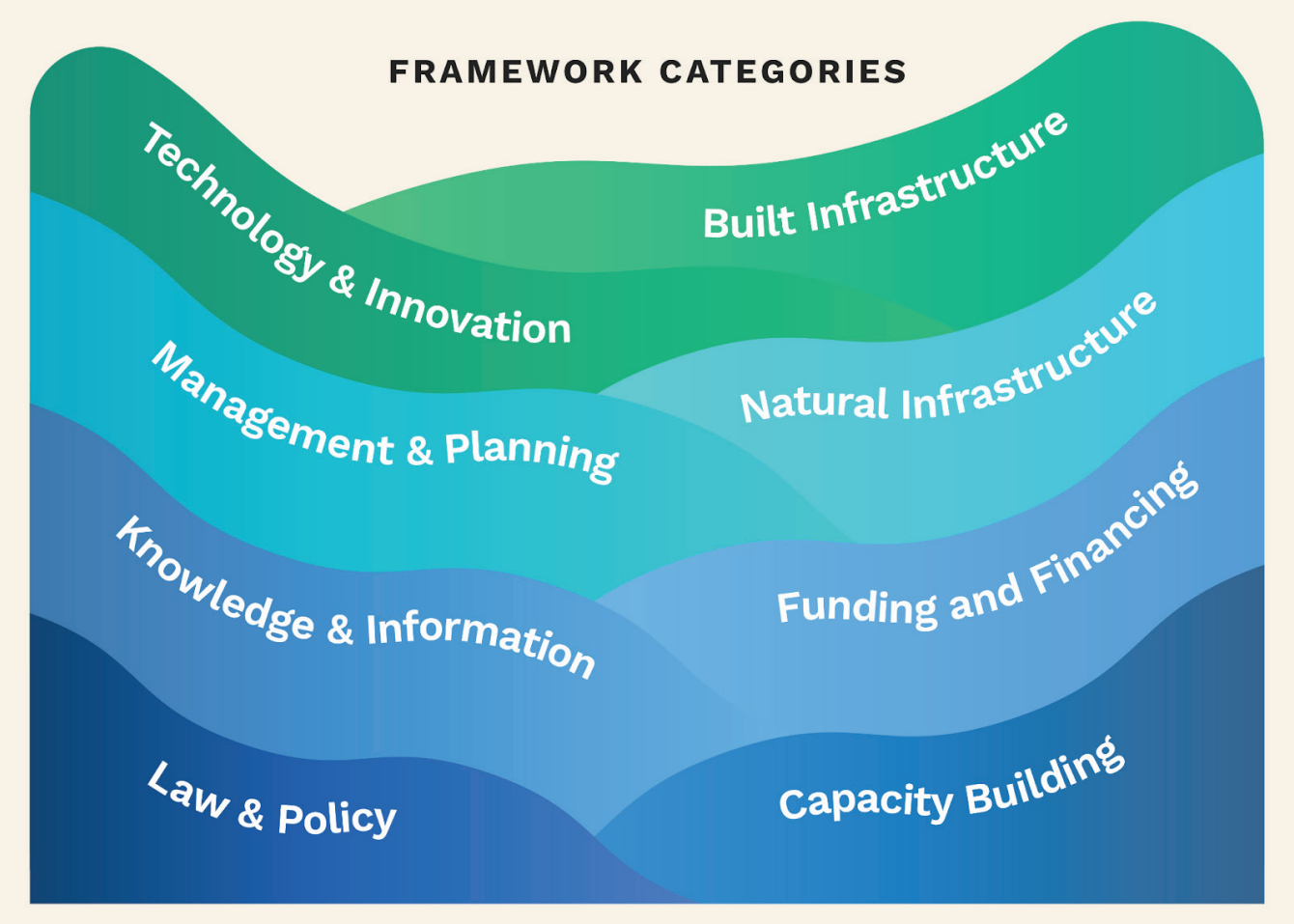
Summary

As climate change intensifies and causes more frequent extreme storms and catastrophic floods, raises sea level, intensifies heat waves and droughts, and sparks more intense wildfires, frontline communities in the US will be at greater risk of losing access to safe, reliable drinking water and functional plumbing (Pacific Institute and DigDeep 2024). However, frontline communities are resilient, and they are finding ways to overcome the myriad barriers and challenges they face from climate change to create equitable, climate-resilient water and sanitation access and systems. This report aims to identify documented strategies and approaches for achieving equitable, climate-resilient water and sanitation for frontline communities in the US. To do this, we first asked: What is equitable, climate-resilient water and sanitation? What are its characteristics or attributes? And what are communities, organizations, and government agencies doing to achieve it? We developed an eight-part framework to organize, categorize, and communicate the attributes, and then we identified documented strategies and approaches for achieving this goal (Figure S1). In doing this we reviewed academic publications, government and NGO reports, and online resources and tools. In addition, we solicited input from experts in the field at convening events and through online meetings and discussions. We primarily focused on literature, resources, and case examples from the US but drew on literature from non-US contexts when relevant.

This report aims to identify documented strategies and approaches for achieving equitable, climate-resilient water and sanitation for frontline communities in the US.

FIGURE S1. Framework for Achieving Equitable, Climate-Resilient Water and Sanitation



Note: The figure depicts the eight categories of climate-resilient and equitable water and sanitation, which serves as the organizing framework for the attributes and corresponding strategies in the report. The visualization incorporates themes and colors from the Pacific Institute's logo, using wave imagery to emphasize the eight framework categories and their interconnections in building equitable, climate-resilient water and sanitation systems.

Figure designed by Pacific Institute and DigDeep, graphic design by Max Olson, DigDeep

While the framework includes the law and policy category, this report does not include this section. We will address this topic in a future report that focuses on law and policy attributes and criteria for identifying laws and policies necessary for achieving equitable, climate-resilient water and sanitation in frontline communities. We also covered law and policies in part 2 of this series titled *Law and Policies that Address Equitable, Climate-Resilient Water and Sanitation: Water, Sanitation, and Climate Change in the United States Series, Part 2*. Table S1 presents the 31 attributes and their definitions from the seven categories that are addressed in this report.

TABLE S1. Attributes of Equitable, Climate-Resilient Water and Sanitation

ATTRIBUTE TYPE DESCRIPTION	ATTRIBUTES	ATTRIBUTE DEFINITION
BUILT INFRASTRUCTURE		
New or improved built infrastructure aimed at providing equitable, climate-resilient water and sanitation for frontline communities.	Access to water and sanitation infrastructure and services	Frontline communities have access to drinking water and sanitation infrastructure and services that allow them to perform basic everyday tasks and personal hygiene in their homes.
	Built infrastructure performing reliably under a range of climate change impacts	Built infrastructure performs reliably under a wide range of climatic conditions, delivering safe, sufficient, and acceptable water and sanitation for frontline communities.
	Inclusive and climate-resilient siting, design, and construction	Processes for siting, designing, and constructing climate-resilient water and sanitation infrastructure are inclusive and equitable and ensure centering of frontline community values and needs.
	Equitable, climate-resilient operations and maintenance (O&M)	The O&M of water and sanitation build climate resilience and ensure equitable outcomes for frontline communities.
TECHNOLOGY AND INNOVATION		
Innovative technologies help to develop or expand climate resilience and equitable outcomes for water and sanitation access and systems.	Sustainable, climate-resilient, and equitably implemented water technologies	Sustainable, climate-resilient water and sanitation technologies are equitably implemented at the community level, with attention to factors such as local cultures and values, financial context, and ecological benefits.
	Cost-effective water-saving technologies for frontline communities	Water fixture upgrades, water-saving appliances, and water reuse technologies are equitably installed to save water and reduce cost-burden on water, wastewater, and electricity bills of frontline households.
	Sustainable and equitable water and sanitation technologies implemented at the commercial and industrial scale	Sustainable water-use technologies are implemented for significant commercial and industrial users (including agriculturalists, energy suppliers, manufacturers, tourism industries, and others) and increase equity and climate resilience for frontline communities.
	Tested and safe water and sanitation technologies	New, innovative climate-resilient water technologies are tested and evaluated to ensure dependability and safety for frontline communities.

ATTRIBUTE TYPE DESCRIPTION	ATTRIBUTES	ATTRIBUTE DEFINITION
NATURAL INFRASTRUCTURE (NI)		
Nature and natural features and processes are used to build and protect equitable, climate-resilient water and sanitation systems and to help conserve and manage water resources.	Constraints for NI implementation removed	Governance, policy, legal, and financial constraints for NI implementation are addressed and removed through context-specific practices to support equitable climate resilience.
	Centering communities in NI planning	Communities, community benefits, and equity are included and centered in NI planning for climate resilience.
	NI projects proactively removing displacement risks	Potential displacement of communities in all NI programs, policies, and projects are identified and removed.
	NI benefits valued for achieving equitable climate resilience	Context-specific approaches to the valuation of NI for equitable, climate-resilient water and sanitation are used in decision making.
MANAGEMENT AND PLANNING		
Equity is centered in how environmental protections, community input, financial sustainability, climate impacts and risks, multi-sector coordination, and monitoring and evaluation are incorporated into planning and management of water and sanitation access.	Source water protections incorporated into water, sanitation, and climate plans and programs	Source water and other environmental protections are part of water and sanitation planning and management to increase frontline communities' resilience to climate change.
	Frontline communities centered in climate, water, and sanitation planning and management	Equitable involvement and empowerment of community members in planning and management are reflected by centering frontline communities' priorities.
	Water and sanitation providers financially sound in the face of climate change	The financial health of utilities and cities is supported by proactive, long-term planning and management strategies that result in accessible, affordable, and climate-resilient water and sanitation for frontline communities.

ATTRIBUTE TYPE DESCRIPTION	ATTRIBUTES	ATTRIBUTE DEFINITION
	Water and sanitation systems prepared for climate disasters and inequitable impacts	There is regular planning and management for climate disasters and inequitable climate disruptions to water and sanitation systems.
	Cross-sectoral coordination to achieve equitable, climate-resilient water and sanitation	Equitable and climate-resilient management and planning efforts are coordinated across sectors, departments, agencies, plans, and different scales of government.
	Equitable, climate-resilient planning and management continually monitored and evaluated for effectiveness	Managers and planners continually monitor and evaluate water and sanitation to achieve equitable and climate-resilient outcomes for frontline communities.
FUNDING AND FINANCING		
Adequate, sustainable, equitable funding, financing, and disaster insurance strategies for frontline communities to build, adapt, maintain, and restore climate-resilient water and sanitation.	Funding and financing for climate-resilient water and sanitation infrastructure	Climate-resilient infrastructure projects for water and sanitation systems serving frontline communities and households can obtain and sustain funding or financing for planning and infrastructure.
	Funding and assistance for climate-resilient O&M	Climate-resilient O&M for water and sanitation systems in frontline communities have adequate and sustainable funding and assistance.
	Funding and financing for climate disaster preparedness, mitigation, response, and restoration of water and sanitation	Frontline communities have access to adequate funding, financing, and disaster insurance for disaster preparation, response, and restoration so that water and sanitation can be equitably restored after a climate disaster.
	Funding and financing for alternative approaches to equitable, climate-resilient water and sanitation	Nature-based solutions (NBS), green infrastructure (GI), and water efficiency and reuse have sustainable, adequate funding sources to be implemented at scale in support of climate-resilient water and sanitation for frontline communities.
	Affordable climate-resilient water and sanitation for households	Frontline communities can afford climate-resilient water and sanitation in their homes without compromising their ability to pay for other necessities like food, housing, health care, and transportation.

ATTRIBUTE TYPE DESCRIPTION	ATTRIBUTES	ATTRIBUTE DEFINITION
KNOWLEDGE AND INFORMATION		
Equitable, transparent, accessible integration and application of technical and community knowledges,[1] data, and information are needed to achieve equitable, climate-resilient water and sanitation.	Usable water and climate data at appropriate scales for communities	Water resource, climate, and other relevant data are at the appropriate temporal and spatial scales and readily accessible to decision makers, water managers, and frontline communities.
	Inclusivity in the use of climate data, projections, and assessments	Climate data and projections are used with the inclusion of frontline communities to inform water and sanitation and water resources risk assessments, planning, management, and development.
	Incorporation of local and technical knowledges and ways of knowing	Local, place-based knowledges, Indigenous knowledges, and different ways of knowing and observing are equally respected, supported, and incorporated with technical data and information for equitable, climate-resilient water and sanitation.
	Equitable data and information translation, communication, and dissemination	Data and information collection centers the needs and perspectives of frontline communities and is shared openly and in culturally appropriate formats and languages that are accessible to frontline communities.
CAPACITY BUILDING		
Water managers, communities, and households are equipped with the technical, managerial, and financial capacity to equitably engage communities and adapt to climate change.	Climate-literate, robust, and representative water and sanitation workforce	Water and sanitation workforce in frontline communities is climate-literate, robust and representative of the communities being served.
	Community empowerment in water and climate decision making	Communities are supported and have increased capacity for inclusive, equitable, and culturally appropriate participation in climate, water, and sanitation decision making.
	Capacity to work with interdependent sectors for climate resilience	People managing water and sanitation systems have the ongoing capacity to coordinate with other people in sectors with whom they are interdependent for climate resilience.
	Technical, managerial, and financial (TMF) skills for equitable climate resilience	Water managers are empowered with the TMF and leadership skills to equitably create, adapt, and maintain climate-resilient water and sanitation systems for their communities.
***Law and Policy: the law and policy attributes will be addressed in a forthcoming report in 2025**		

1 Although "knowledge" is considered a singular, uncountable noun, we intentionally use the plural "knowledges" to indicate that there is no one monolithic knowledge to understand and address complex issues at the nexus of water and climate equity and that problems and solutions to address climate change require many types of knowledges from myriad disciplines and sources, including local and Indigenous knowledges.

This report contains numerous documented efforts of ways that frontline communities are making progress toward equitable, climate-resilient water and sanitation. Built infrastructure is being adapted to better withstand the impacts of extreme storms, floods, and drought. Technologies and innovations are being designed and deployed in remote, hard-to-reach communities to deliver climate-resilient water and sanitation to homes for the first time. Natural infrastructure strategies are being used to enhance the climate resilience of water and sanitation by helping recharge aquifers and attenuate floodwaters, for example. Water managers and planners are incorporating climate resilience and centering frontline communities in efforts to deliver equitable, climate-resilient water and sanitation access to all. Frontline communities are overcoming barriers to accessing the financial resources that they need to pay for climate adaptation of water and sanitation or recover and respond to climate disasters. Climate and water knowledge and information from government agencies, water managers, local experts, and climate scientists are being integrated with place-based knowledges to ensure frontline communities and people in positions of power and authority can understand and access the data and information they need for decision making. The capacity of water and sanitation systems staff and decision makers is growing to better center the needs of frontline communities, educate and support the water and sanitation sector workforces in improving climate-resilience, and build connections with interdependent sectors.

Here we summarize key findings on more than 100 strategies across the seven categories documented in this report. The strategies and approaches are not for a single audience. Rather, they were developed by and for frontline communities, their supporters (e.g., community-based organizations or nonprofits), water resource managers, water and wastewater utilities, policy and law makers, and Tribal, federal, state, and local governments to advance equitable, climate-resilient water and sanitation in the US. These strategies are a sampling of diverse approaches without prescribing one-size-fits-all solutions. No doubt there are numerous others that were not included or have not yet been documented.

The strategies outlined in this report are expected to remain relevant over time, though some are more time-bound and may not be available in the future.[2] This is particularly relevant for funding and financing mechanisms, which are likely to shift at the federal level with political and administrative changes. Notably, the research and writing for this report was completed in 2024. However, as we are preparing the document for publication in January 2025, some federal resources and funding mechanisms herein became unavailable following the White House administration change on January 20th. Wherever possible, archived versions of websites and documents have been provided, although additional resources may become unavailable after this report is published.

Along with the more than 100 strategies, the report includes numerous case examples of equitable and climate-resilient water and sanitation from across the country, including three place-based stories of DigDeep's work with individuals and communities from Navajo Nation (Section 5.5), Appalachia (Section 8.6), and *colonias* along the US-Mexico border (Section 10.5).

2 The report reflects strategies available as of January 2025.

BUILT INFRASTRUCTURE

The built infrastructure attributes describe new or improved built infrastructure aimed at providing equitable, climate-resilient water and sanitation for frontline communities. Each built infrastructure attribute and the respective descriptions are listed in Table S2, and the strategies and approaches to achieve them follow.

TABLE S2. Built Infrastructure Attributes

BUILT INFRASTRUCTURE	
Attributes	**Attribute Definition**
Access to water and sanitation infrastructure and services	Frontline communities have access to drinking water and sanitation infrastructure and services that allow them to perform basic everyday tasks and personal hygiene in their homes.
Built infrastructure performing reliably under a range of climate change impacts	Built infrastructure performs reliably under a wide range of climatic conditions, delivering safe, sufficient, and acceptable water and sanitation for frontline communities.
Inclusive and climate-resilient siting, design, and construction	Processes for siting, designing, and constructing climate-resilient water and sanitation infrastructure are inclusive and equitable and ensure centering of frontline community values and needs.
Equitable, climate-resilient operations and maintenance (O&M)	The O&M of water and sanitation build climate resilience and ensure equitable outcomes for frontline communities.

1. **Access to water and sanitation infrastructure and services. Strategies include:**
    a. initiate and support community-led water and sanitation infrastructure projects with nonprofit organizations and other entities dedicated to closing the water and sanitation access gap; and
    b. create local programs to connect households and communities with water and sanitation systems at risk from climate impacts to more climate-robust centralized water and/or sanitation systems.

2. **Built infrastructure performing reliably under a range of climate change impacts. Strategies include:**
    a. create tools and frameworks for water and sanitation systems staff to evaluate the climate resilience of existing water and sanitation infrastructure;
    b. improve water supply reliability through water reuse, fixing leaks in distribution systems, recharging aquifers (with floodwater where possible), and deepening groundwater wells;
    c. consider consolidation through a range of partnership forms to improve supply reliability during climate emergencies;
    d. elevate coastal infrastructure to protect infrastructure from sea level rise;

e. adapt infrastructure to be better prepared for wildfire by adding backflow prevention devices on service lines, installing meters with the ability to automatically shutoff and keeping plastic infrastructure away from heat sources; and

f. when necessary, relocate community water stations and other infrastructure to protect them from damage and destruction.

3. **Inclusive and climate-resilient siting, design, and construction. Strategies include:**

   a. create and utilize practical guidance for utilities and other groups involved in infrastructure projects that address equity and climate resilience; and

   b. change existing or establish new processes and policies for inclusive and equitable siting and design of climate-resilient water and sanitation infrastructure with direct input from frontline communities.

4. **Equitable, climate-resilient O&M. Strategies include:**

   a. identify specific O&M tasks that must be performed or adapted to protect infrastructure from climate impacts;

   b. put emergency response systems in place to help operators perform necessary actions during climate emergencies;

   c. work with technical assistance providers to perform regular O&M to ensure infrastructure remains in good condition to withstand climate disruptions;

   d. use materials, trainings, and tools from technical assistance providers and other supporting entities to learn about tasks needed for improving climate resilience; and

   e. engage directly with frontline communities by prioritizing O&M work that addresses long-standing inequities in service from racism, disinvestment, and marginalization.

To achieve equitable, climate-resilient water and sanitation is to close the water and sanitation access gap in the US; built infrastructure, like dams, water distribution systems, and treatment plants must be adapted to ensure that they can reliably function under an increasingly broad range of climate-related conditions. Through these efforts, the engineers, contractors, utilities, and other agencies that often lead the construction processes need to ensure that siting, design, and construction of water and sanitation infrastructure address climate resilience and do so equitably by including and centering frontline communities throughout the process. Finally, the ongoing O&M of water and sanitation systems needs to be made more inclusive and equitable and must help build climate resilience for communities.

TECHNOLOGY AND INNOVATION

The technology and innovation attributes describe how innovative technologies help to develop or expand climate resilience and equitable outcomes for water and sanitation access and systems. Each technology and innovation attribute and the respective descriptions are listed in Table S3, and the strategies and approaches to achieve them follow.

TABLE S3. Technology and Innovation Attributes

TECHNOLOGY AND INNOVATION	
Attributes	**Attribute Definition**
Sustainable, climate-resilient, and equitably implemented water technologies	Sustainable, climate-resilient water and sanitation technologies are equitably implemented at the community level, with attention to factors such as local cultures and values, financial context, and ecological benefits.
Cost-effective water-saving technologies for frontline communities	Water fixture upgrades, water-saving appliances, and water reuse technologies are equitably installed to save water and reduce cost-burden on water, wastewater, and electricity bills of frontline households.
Sustainable and equitable water and sanitation technologies implemented at the commercial and industrial scale	Sustainable water-use technologies are implemented for significant commercial and industrial users (including agriculturalists, energy suppliers, manufacturers, tourism industries, and others) and increase equity and climate resilience for frontline communities.
Tested and safe water and sanitation technologies	New, innovative climate-resilient water technologies are tested and evaluated to ensure dependability and safety for frontline communities.

1. **Sustainable, climate-resilient, and equitably implemented water technologies. Strategies include:**
    a. engage with stakeholders, with special attention to local values and cultures, when designing and implementing water and sanitation technologies and innovations;
    b. develop respectful partnerships between universities, technology companies, and frontline communities to co-develop technologies tailored to communities' needs;
    c. implement knowledge sharing about climate-resilient technologies, especially to communities with unequal access to information; and
    d. integrate equity-centered frameworks in the planning and design of technologies that consider environmental, economic, and social equities.

2. **Cost-effective water-saving technologies for frontline communities. Strategies include:**
    a. develop water efficiency programs tailored to low-income residents to ensure that they benefit from cost-saving technologies;
    b. partner with community-based organizations to build trust within frontline communities and enhance participation in tailored low-income water efficiency programs; and
    c. leverage corporate investments to implement water and cost saving technologies in frontline communities, such as affordable housing complexes.

3. **Sustainable and equitable water and sanitation technologies implemented at the commercial and industrial scale. Strategies include:**
    a. establish policies that promote the commercial adoption of water technologies offering broad climate resilience benefits for communities;
    b. build partnerships between water and wastewater utilities and industries to implement large-scale technologies, such as water reuse systems;
    c. design and implement commercial and industrial water technologies and innovations collaboratively with nongovernmental organizations (NGOs) and technology companies; and
    d. utilize existing support programs to scale up the implementation of innovations across commercial and industrial sectors, such as university extension support programs for agricultural producers to install efficient irrigation technologies.

4. **Tested and safe water and sanitation technologies. Strategies include:**
    a. engage the community during the pilot phase of a new technology to understand local conditions, values, cultures, and needs before widespread implementation; and
    b. apply a systematic and integrated management approach, such as Integrated Water Resource Management, to prioritize the safe and effective deployment of climate-resilient innovations within the intricate framework of water and sanitation systems.

Water and sanitation technologies and innovations offer significant potential to enhance the climate resilience of frontline communities, but their success depends on equitable design and implementation. These technologies must be culturally appropriate, socially acceptable, affordable, and sustainable, while also addressing the specific barriers faced by low-income and historically marginalized groups. Strategies like robust stakeholder engagement, equity-centered frameworks, and partnerships are critical to ensure that frontline communities benefit from technology and innovations. In addition, water efficiency and reuse technologies can reduce costs for frontline communities, although challenges like high upfront costs persist. Programs that involve direct-install services, community-based partnerships, and corporate investments offer pathways to overcome these barriers. Beyond residential use, commercial and industrial water users have a role in advancing equity and resilience by adopting technologies that reduce water demand and improve water quality, which can be facilitated through policies, partnerships, and support programs. Finally, the effective deployment of these innovations requires a deep understanding of local contexts and a systematic planning approach to ensure that technologies address root causes of vulnerability and avoid maladaptation.

NATURAL INFRASTRUCTURE

The natural infrastructure (NI) attributes describe how nature and natural features and processes are used to build and protect equitable, climate-resilient water and sanitation systems and to help conserve and manage water resources. Each natural infrastructure attribute and the respective descriptions are listed in Table S4, and the strategies and approaches to achieve them follow.

TABLE S4. Natural Infrastructure Attributes

NATURAL INFRASTRUCTURE (NI)	
Attributes	**Attribute Definition**
Constraints for NI implementation removed	Governance, policy, legal, and financial constraints for NI implementation are addressed and removed through context-specific practices to support equitable climate resilience.
Centering communities in NI planning	Communities, community benefits, and equity are included and centered in NI planning for climate resilience.
NI projects proactively removing displacement risks	Potential displacement of communities in all NI programs, policies, and projects are identified and removed.
NI benefits valued for achieving equitable climate resilience	Context-specific approaches to the valuation of NI for equitable, climate-resilient water and sanitation are used in decision making.

1. **Constraints for NI implementation removed. Strategies include:**
    a. create integrated NI management plans to coordinate knowledge and information exchange, planning, and management across departments, sectors, and jurisdictions;
    b. implement policies to overcome constraints to equitable NI project outcomes;
    c. form strong partnerships, coalitions, and interdisciplinary working groups to address conflicts and build NI project support and consensus; and
    d. use innovative and diverse funding solutions appropriate to the local context.

2. **Centering communities in NI planning. Strategies include:**
    a. clearly define justice and equity in NI projects;
    b. ensure communities experiencing injustice have a say throughout the planning process using two-way communication;
    c. incorporate transparency, trust building, and mutual learning in community engagement; and
    d. partner with trusted local institutions to engage hard-to-reach groups.

3. **NI projects proactively removing displacement risks. Strategies include:**
    a. utilize and adapt existing toolkits to identify local risk factors for displacement and to evaluate the strength of anti-displacement strategies;

b. implement locally appropriate and feasible anti-gentrification and displacement policies prior to project construction; and

c. co-create equity scorecards with residents and other stakeholders to evaluate how well an NI project mitigates gentrification and displacement.

4. **NI benefits valued for achieving equitable climate resilience. Strategies include:**

a. utilize comprehensive valuation models that center climate resilience, human and ecological well-being, and impacts for multiple sectors and stakeholders;

b. incorporate equity-centered guidelines alongside valuation models to understand the distribution of tradeoffs and benefits for frontline communities; and

c. incorporate non-market-based valuations and recommendations that center equity.

NI has great potential to enhance the climate resilience of water and sanitation systems. However, they must be equitably designed and implemented. Barriers to NI implementation can prevent their uptake at a greater scale but can be overcome through strategies such as integrated management plans, the formation of strong partnerships, coalitions, and interdisciplinary working groups, and the use of comprehensive valuation models. Because NI projects come with tradeoffs, care is needed to ensure that equity and community benefits are central to decision making and that tradeoffs do not disproportionately accrue to frontline communities and underserved residents. Solutions such as centering impacted communities in decision making, building trust with local communities, and implementing anti-displacement policies are critical to ensuring that frontline communities benefit from these projects. Ultimately, attention to local context and impacted communities is critical to achieving equitable and climate-resilient water and sanitation.

MANAGEMENT AND PLANNING

These attributes describe how equity is centered in the management and planning of environmental protections, community input, financial sustainability, climate impacts and risks, multi-sector coordination, and monitoring and evaluation. Each management and planning attribute and the respective descriptions are listed in Table S5, and the strategies and approaches to achieve them follow.

TABLE S5. Management and Planning Attributes

MANAGEMENT AND PLANNING	
Attributes	**Attribute Definition**
Source water protections incorporated into water, sanitation, and climate plans and programs	Source water and other environmental protections are part of water and sanitation planning and management to increase frontline communities' resilience to climate change.
Frontline communities centered in climate, water, and sanitation planning and management	Equitable involvement and empowerment of community members in planning and management are reflected by centering frontline communities' priorities.
Water and sanitation providers financially sound in the face of climate change	The financial health of utilities and cities is supported by proactive, long-term planning and management strategies that result in accessible, affordable, and climate-resilient water and sanitation for frontline communities.
Water and sanitation systems prepared for climate disasters and inequitable impacts	There is regular planning and management for climate disasters and inequitable climate disruptions to water and sanitation systems.
Cross-sectoral coordination to achieve equitable, climate-resilient water and sanitation	Equitable and climate-resilient management and planning efforts are coordinated across sectors, departments, agencies, plans, and different scales of government.
Equitable, climate-resilient planning and management continually monitored and evaluated for effectiveness	Managers and planners continually monitor and evaluate water and sanitation to achieve equitable and climate-resilient outcomes for frontline communities.

1. **Source water protections incorporated into water, sanitation, and climate plans and programs. Strategies include:**
   a. use remediation projects as an opportunity to implement NI that protects source water quality for frontline communities;
   b. include technologies and innovations, such as managed aquifer recharge, in plans and programs to enhance source water security;

c. collaborate with frontline communities, scientists, and managers to co-produce tools, plans, and programs that safeguard source water; and

d. integrate education, awareness, and support for private well water quality testing into management frameworks.

2. **Frontline communities centered in climate, water, and sanitation planning and management. Strategies include:**

   a. begin with a visioning stage to incorporate frontline communities' insights into climate-resilient water and sanitation planning from the outset;

   b. integrate community-based organizations into climate adaptation and water and sanitation planning and management efforts to improve the representation of marginalized groups;

   c. foster collaborative research partnerships that act as boundary organizations, connecting frontline communities with regional and national planning efforts while developing locally tailored resources for self-reliance; and

   d. provide financial resources, such as stipends, to empower individuals and communities to meaningfully engage in management and planning processes.

3. **Water and sanitation providers financially sound in the face of climate. Strategies include:**

   a. include asset management in long-term planning that takes into consideration climate change impacts to water and wastewater infrastructure;

   b. conduct demand forecasting to help ensure that future water demand projections account for both climate change scenarios and efficiency initiatives; and

   c. employ proactive rate setting to prevent reactive rate increases that could render water and sanitation services unaffordable for frontline communities.

4. **Water and sanitation systems prepared for climate disasters and inequitable impacts. Strategies include:**

   a. develop emergency response plans that address climate disruptions and prioritize equitable access to water and sanitation for frontline communities;

   b. include community input in risk assessments to inform climate-preparedness plans and programs that equitably address the needs of those most affected;

   c. incorporate a diverse range of water sources into programs and plans to enhance redundancy and resilience, especially for frontline communities;

   d. participate in trainings and workshops, focused on equity, to prepare water and sanitation systems for climate disruptions; and

   e. integrate resilience hubs into climate, water, and sanitation planning and management to strengthen community resilience and social equity after climate disasters.

5. **Cross-sectoral coordination to achieve equitable, climate-resilient water and sanitation. Strategies include:**
    a. align management and planning structures strategically, using frameworks like Integrated Water Resource Management and One Water as foundations for equitable, resilient practices;
    b. include interagency working groups in climate, water, and sanitation plans to clarify sector roles in climate disruption responses, establish coordinated technical assistance programs for frontline communities, and promote climate resilience and equity;
    c. integrate coordinated frameworks between government agencies and nonprofits to address and manage cross-sector, complex water and sanitation challenges together; and
    d. participate in specialized trainings and exercises to learn how to address climate impacts on frontline communities equitably and collaboratively across sectors.

6. **Equitable, climate-resilient planning and management continually monitored and evaluated for effectiveness. Strategies include:**
    a. involve community members and community-based organizations in the design and implementation of monitoring frameworks to promote inclusive, attainable, and locally informed processes;
    b. allocate a specific budget for monitoring and evaluation when designing programs and plans to ensure that small and underresourced communities have the financial capacity to monitor and evaluate climate, water, and sanitation initiatives;
    c. use equity-focused indicators to track climate resilience outcomes of water and sanitation plans and programs effectively across communities; and
    d. apply monitoring and evaluation to both new initiatives and existing practices to comprehensively address systemic inequities and enhance accountability.

Protecting the source water for overburdened and underserved communities is critical as these communities face historical challenges to access drinking water and sanitation that are now exacerbated by climate change. Actively engaging frontline communities helps to ensure that their needs, cultures, and priorities are centered in planning processes and management frameworks. Water and sanitation providers can implement strategies like asset management, proactive rate setting, and demand forecasting to maintain financial stability and provide affordable services for low-income populations in the face of climate change. Additionally, integrating disaster preparedness into planning is key, and incorporating community input helps identify vulnerabilities and design adaptive strategies tailored to communities' needs. Cross-sector coordination dismantles silos and fosters collaboration among stakeholders, enhancing the effectiveness and climate-resilient outcomes of water and sanitation plans and initiatives. Finally, embedding monitoring and evaluation frameworks within climate, water, and sanitation strategies promotes accountability and transparency and tracks progress toward equitable water access, ultimately improving resilience for frontline communities.

FUNDING AND FINANCING

The funding and financing attributes describe adequate, sustainable, equitable funding and financing and disaster insurance strategies for frontline communities to build, adapt, maintain, and restore climate-resilient water and sanitation systems. Each funding and financing attribute and the respective descriptions are listed in Table S6, and the strategies and approaches to achieve them follow.

TABLE S6. Funding and Financing Attributes

FUNDING AND FINANCING	
Attributes	**Attribute Definition**
Funding and financing for climate-resilient water and sanitation infrastructure	Climate-resilient infrastructure projects for water and sanitation systems serving frontline communities and households can obtain and sustain funding or financing for planning and infrastructure.
Funding and assistance for climate-resilient operations and maintenance (O&M)	Climate-resilient O&M for water and sanitation systems in frontline communities have adequate and sustainable funding and assistance.
Funding and financing for climate disaster preparedness, mitigation, response, and restoration of water and sanitation	Frontline communities have access to adequate funding, financing, and disaster insurance for disaster preparation, response, and restoration so that water and sanitation can be equitably restored after a climate disaster.
Funding and financing for alternative approaches to equitable, climate-resilient water and sanitation	Nature-based solutions (NBS), green infrastructure (GI), and water efficiency and reuse have sustainable, adequate funding sources to be implemented at scale in support of climate-resilient water and sanitation for frontline communities.
Affordable climate-resilient water and sanitation for households.	Frontline communities can afford climate-resilient water and sanitation in their homes without compromising their ability to pay for other necessities like food, housing, health care, and transportation.

1. **Funding and financing for climate-resilient water and sanitation infrastructure. Strategies include:**
    a. increase the amount of funding available through federal and state programs, including the Clean Water State Revolving Fund (CWSRF) and Drinking Water State Revolving Fund (DWSRF), that can be used to build and adapt climate-resilient water and sanitation infrastructure;
    b. ensure that funding and financing are accessible and do not have barriers for frontline communities to identify, apply for, and use to build and adapt climate-resilient water and sanitation infrastructure;
    c. enact policies that ensure frontline communities are receiving an equitable amount of benefits from climate and infrastructure funding;

d. implement technical assistance programs to address barriers experienced by frontline communities in identifying, applying for, and using funding for climate-resilient water and sanitation infrastructure; and

e. offer programs to help construct climate-resilient, decentralized water and sanitation infrastructure and/or to connect homes and communities with decentralized infrastructure to more climate-robust centralized systems.

2. **Funding and assistance for climate-resilient O&M. Strategies include:**

   a. create and fund federal and state grant programs that explicitly name climate resilience and O&M as funding priorities for water and sanitation systems;

   b. offer O&M as an activity available through technical assistance providers; and

   c. fund and train technical assistance providers on climate-resilient O&M.

3. **Funding and financing for climate disaster preparedness, response, and restoration of water and sanitation. Strategies include:**

   a. increase funding available through federal community preparedness and climate hazard mitigation programs and expand access to these programs for frontline communities;

   b. expand eligibility for federal flood insurance programs to cover all rural, Tribal, and currently unmapped households and communities;

   c. ensure that climate disaster response and recovery efforts do not exacerbate or increase wealth inequality;

   d. fill gaps in government aid with local efforts by grassroots coalitions and NGOs to create local financing options and climate disaster recovery; and

   e. provide households at risk of sewer backups or damage to their onsite water or sanitation systems with insurance and funding assistance to recover from climate disasters.

4. **Funding and financing for alternative approaches to equitable, climate-resilient water and sanitation. Strategies include:**

   a. increase the amount of funding available through federal and state programs that can be used to design and build alternative approaches to climate resilience;

   b. ensure that funding and financing for alternative approaches are accessible and do not have barriers for frontline communities to identify, apply for, and use the assistance;

   c. enact policies that ensure frontline communities are receiving an equitable amount of benefits of funding for alternative approaches; and

   d. offer programs to incentivize or pay for water efficiency upgrades in households in frontline communities.

5. **Affordable climate-resilient water and sanitation for households. Strategies include:**

   a. create and offer utility customers assistance programs and other affordability interventions like leak detection and repair for income-qualified households;

b. reinstate and fund federal water and wastewater assistance programs that ensure customers of all water and wastewater utilities have access to financial assistance for paying their utility bills; and

c. enact laws at the state, local, or federal level that prevent water disconnections during extreme weather or climate events.

Funding and financing are required for all the work necessary to build and adapt water and sanitation infrastructure, update and improve O&M to support climate resilience, prepare for climate disasters, respond equitably and effectively when they occur, apply alternative approaches to climate resilience in frontline communities, and ensure that water and sanitation remain affordable. While financial assistance is not a silver bullet to advancing equitable, climate-resilient water and sanitation for frontline communities in the US, it is critical for supporting major, necessary infrastructure transformation. It is also important to make funding for disaster preparedness, response, recovery, and disaster insurance equitably accessible, so that frontline communities can prepare for, survive, and recover from the inevitable climate impacts to come. If financial assistance is provided equitably for climate resilience of water and sanitation, it will help prevent future affordability burdens on communities and households already struggling to pay for their access to water and sanitation.

KNOWLEDGE AND INFORMATION

The knowledge and information attributes focus on how equitable, transparent, accessible integration and application of technical and community knowledges, data, and information are needed to achieve equitable, climate-resilient water and sanitation. Each knowledge and information attribute and the respective descriptions are listed in Table S7, and the strategies and approaches to achieve them follow.

TABLE S7. Knowledge and Information Attributes

KNOWLEDGE AND INFORMATION	
Attributes	**Attribute Definition**
Usable water and climate data at appropriate scales for communities	Water resource, climate, and other relevant data are at the appropriate temporal and spatial scales and readily accessible to decision makers, water managers, and frontline communities.
Inclusivity in the use of climate data, projections, and assessments	Climate data and projections are used with the inclusion of frontline communities to inform water and sanitation and water resources risk assessments, planning, management, and development.
Incorporation of local and technical knowledges and ways of knowing	Local, place-based knowledges, Indigenous knowledges, and different ways of knowing and observing are equally respected, supported, and incorporated with technical data and information for equitable, climate-resilient water and sanitation.
Equitable data and information translation, communication, and dissemination	Data and information collection centers the needs and perspectives of frontline communities and is shared openly and in culturally appropriate formats and languages that are accessible to frontline communities.

1. **Usable water and climate data are at appropriate scales for communities. Strategies include:**
    a. focus water and climate research and information on community needs and values instead of those of outsiders;
    b. make sure data and tools are scaled appropriately and meaningfully at the community level whenever possible;
    c. make data and information free, understandable, and easily accessible;
    d. use a co-production approach to ground technical data and information in local knowledge and expertise; and
    e. increase access to internal and trusted external support and expertise to increase capacity and overcome technical, legal, and policy barriers.

2. **Inclusivity in the use of data, projections, and assessments. Strategies include:**
    a. use an end-to-end co-production approach in assessing climate risks to include frontline communities in design, research, and development of decision-support information and tools;
    b. apply citizen science as an inclusive strategy for engaging locals in data gathering and monitoring to incorporate local observers and empower communities to build climate-resilience;
    c. ensure adequate funding for communities to engage in knowledge co-production and sharing; and
    d. recognize and address barriers and capacity constraints at the outset of any water and climate risk assessments by providing culturally appropriate and community-centered technical assistance.

3. **Incorporation of local and technical knowledges and ways of knowing. Strategies include:**
    a. ensure that local experts have consultation and leadership roles in any community research, data gathering, and monitoring efforts;
    b. use collaborative, participatory, and/or co-production approaches for equitable incorporation or integration in knowledge creation and sharing; and
    c. use appropriate protocols and agreements to protect local knowledge and communities.

4. **Equitable data and information translation, communication, and dissemination. Strategies include:**
    a. present a positive vision for the future and emphasize ongoing progress, rather than relying on fear appeals, because research suggests that audiences tend to reject fear-based messages;
    b. connect climate issues to real-world concerns that people already care about by framing challenges within their local cultural, socioeconomic, or geographic context, as well as aligning with their values and worldviews;
    c. embrace uncertainty by focusing on what is known and highlighting scientific consensus, while remaining open to new and improved information; and
    d. utilize storytelling to effectively convey data, acknowledging and respecting the emotions and psychology of the target audience while validating their experiences.

By valuing and incorporating diverse perspectives and knowledges, barriers can be overcome through inclusive governance structures and collaborative partnerships. Ultimately, these approaches not only enhance the ecological and social resilience of communities but also foster a deeper understanding and respect for the interconnectedness between humans and their environment. Integrating local, place-based knowledges and Indigenous knowledges with technical data and information is crucial for achieving equitable, climate-resilient water and sanitation systems in the US. This, along with accessible and usable water and climate data at appropriate temporal and spatial scales; inclusivity in the use of climate data for risk assessments; equitable data and information translation, communication, and dissemination can help build capacity for frontline communities to achieve equitable, climate-resilient water and sanitation.

CAPACITY BUILDING

The capacity building attributes describe how water managers, communities, and households are equipped with the technical, managerial, and financial capacity to equitably engage communities and adapt to climate change. Each capacity building attribute and the respective descriptions are listed in Table S8, and the strategies and approaches to achieve them follow.

TABLE S8. Capacity Building Attributes

CAPACITY BUILDING	
Attributes	**Attribute Definition**
Climate-literate, robust, and representative water and sanitation workforce	Water and sanitation workforce in frontline communities is climate-literate, robust and representative of the communities being served.
Community empowerment in water and climate decision making	Communities are supported and have increased capacity for inclusive, equitable, and culturally appropriate participation in climate, water, and sanitation decision making.
Capacity to work with interdependent sectors for climate resilience	People managing water and sanitation systems have the ongoing capacity to coordinate with other people in sectors with whom they are interdependent for climate resilience.
Technical, managerial, and financial (TMF) skills for equitable climate resilience	Water managers are empowered with the TMF and leadership skills to equitably create, adapt, and maintain climate-resilient water and sanitation systems for their communities.

1. **Climate-literate, robust, and representative water and sanitation workforce. Strategies include:**
    a. take advantage of national and local climate adaptation training and education programs to increase climate literacy in the water and sanitation workforce;
    b. provide opportunities for recognition and networking for upcoming utility leaders, especially those from underrepresented groups; and
    c. educate students about the water and sanitation sector and recruit the next generation of water and wastewater utility professionals.
2. **Community empowerment in water and climate decision making. Strategies include:**
    a. build trust between communities and water and wastewater utilities by promoting transparency, inclusivity, and community engagement, leveraging tools like the River Network and WaterNow Alliance's Building Blocks of Trust;
    b. co-produce information and co-develop strategies and educational tools for climate-resilient water and sanitation with frontline communities using community-based participatory research and an asset-based approach; and
    c. develop coalitions of community members, community-based organizations, and other NGOs to advance community-driven water and sanitation policies.

3. **Capacity to work with interdependent sectors for climate resilience. Strategies include:**
    a. leverage existing tools and resources, such as the Environmental Protection Agency's (EPA) Community-Based Water Resilience Guide, to understand interdependent sectors and initiate conversations;
    b. foster partnerships between neighboring water and wastewater utilities to provide mutual aid and support to recover from climate disruptions; and
    c. develop local or regional climate adaptation initiatives that foster education, information sharing, and communication across sectors to enhance preparation and response to climate impacts.

4. **Technical, managerial, and financial (TMF) skills for equitable climate resilience. Strategies include:**
    a. require TMF trainings for water system board members to support compliance with regulations, such as the Safe Drinking Water Act;
    b. establish formal and informal social networks among underserved systems to share information and resources for overcoming capacity challenges and better prepare for climate impacts;
    c. consider consolidation and regionalization of small, underresourced water and wastewater systems to enhance capacity; and
    d. take advantage of leadership training programs to develop leaders equipped with TMF skills to advance climate-resilient strategies.

CONCLUSION

Building water managers' and communities' capacities is essential for achieving equitable and climate-resilient water and sanitation in frontline communities. By fostering leadership, climate-literacy, and representation in the water and sanitation workforce through targeted training, networking, and educational opportunities, water and climate management and planning processes can be made more inclusive and responsive to local needs. Water and wastewater utilities can build trust with communities and prioritize participatory approaches to help ensure frontline communities are empowered to participate in decision making and co-develop climate-resilient strategies. Additionally, building capacity for cross-sector collaboration through partnerships between neighboring utilities, developing local or regional climate adaption initiatives, and using existing resources and tools to spark conversations can help frontline communities be more prepared to respond to climate disruptions to water and sanitation. Finally, investing in technical, managerial, and leadership skills through trainings, formal and informal networks, and consolidation and/or regionalization can equip water and sanitation managers to navigate the complexities of climate challenges. Together, these approaches not only build resilience but also address systemic inequities, laying the groundwork for a more climate-resilient future for frontline communities.

While this report provides ample evidence that there is a large and growing body of knowledge surrounding water, climate change, and equity, through our research we identified several gaps that indicate a need for future research and documentation at the nexus of water, climate, and equity.

These include:

- A comprehensive evaluation of climate adaptation plans for a focus on equitable, climate-resilient water and sanitation.
- Research on the effectiveness of climate-resilience tools and frameworks from nonprofit and government agencies.
- An evaluation of the outcomes from programs designed to connect homes with decentralized, onsite water or sanitation systems that are at risk of failure due to climate change to centralized systems.
- Quantification and understanding of the types and distributions of benefits achieved from consolidation of water systems, recognizing they are likely case and context dependent. How effective are physical consolidations for increasing climate resilience and creating equitable outcomes for frontline communities?
- Identify O&M activities of both centralized and decentralized water and wastewater systems that help prepare for and prevent disruption or destruction of these systems from climate events.
- How are technologies for commercial, agricultural, and industrial water users affecting climate-resilience and equity for frontline communities? Furthermore, guidance is needed for the equitable implementation of climate-resilient water and sanitation technologies in these sectors.
- Research on the intersection of utility financial capability, household affordability, and climate resilience. There is an especially significant dearth of guidance relevant for small, underserved utilities and communities on this topic.
- Research on the equity and climate-resilience outcomes of monitoring and evaluating climate plans, especially related to water and sanitation.

- There are examples of frontline communities that have been able to obtain climate resilience funding for water and sanitation, but very little documentation of how they overcame the myriad barriers to obtaining and using that funding.
- The Bipartisan Infrastructure Law allowed for additional subsidization up to 49% using State Revolving Funds (SRFs). Has this resulted in additional SRFs being distributed as grants?
- Are there more states like Washington that are issuing protections for water access for households unable to afford their water bills during climate events?

The solutions to achieving equitable, climate-resilient water and sanitation in the US will always be place-based and context-dependent, so there is no one-size-fits-all. We hope that the examples, lessons learned, and tools reviewed in this report can support advancement toward this goal in many different locations, but this will require careful consideration of how to adapt strategies and approaches from one place to another. More work is needed to better understand and support the needs of and opportunities for frontline communities to build and maintain climate-resilient water and sanitation systems. Until those needs and opportunities are at the center of efforts to adapt and transform water and sanitation in the face of climate change, the solutions will fall short of achieving the goal of equitable, climate-resilient water and sanitation. We present this report as a knowledge foundation upon which to build practical solutions for the communities who need them the most.

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