






Roadmap to a Secure and Resilient Water and Wastewater Sector

DEVELOPED BY:

Water and Wastewater Sector
Strategic Roadmap Work Group

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Acknowledgements

Working at the behest of the Water Sector Coordinating Council and the Government Coordinating Council the Water and Wastewater Sector Strategic Roadmap Work Group undertook to update the May 2013 *Roadmap to a Secure & Resilient Water Sector* to reflect sector progress and changes in conditions since 2013. The Work Group members identified below devoted a significant amount of time, energy, and effort to the creation of the 2017 Roadmap.

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Introduction

The Water and Wastewater Systems Sector, commonly known as the Water and Wastewater Sector, has engaged in a considerable effort to expand mutual aid and assistance, develop critical Water and Wastewater Sector security standards, enhance local, state and federal partnerships, address cybersecurity concerns, provide research and studies, and release new risk assessment tools designed to enhance preparedness and resiliency. The Water and Wastewater Sector has approached these risk reduction activities through a partnership among the full range of sector participants, including federal and state governments, individual water and water resource recovery facilities, and national water associations. These partners assist in improving resilience by identifying joint priorities and engaging in coordinated action. As the understanding of risk and the sector's preparedness and resiliency capabilities continue to evolve, the Water and Wastewater Sector partnership must regularly review progress and revise its priorities to reflect the current environment. This *2017 Roadmap to a Secure & Resilient Water and Wastewater Sector* updates priority activity areas for the partnership over the next five years.

In 2009, the Water Sector Coordinating Council (WSCC) and Water Government Coordinating Council (WGCC) released the first *Roadmap to a Secure and Resilient Water Sector*, which identified the joint priority activity areas needed to improve Water and Wastewater Sector resilience and meet the sector's shared vision:

> The Water and Wastewater Sector's vision is a secure and resilient drinking water and wastewater infrastructure that provides clean and safe water as an integral part of daily life, ensuring the economic vitality of and public confidence in the Nation's drinking water and wastewater services through a layered defense of effective preparedness and security practices in the sector.

In 2013, the WSCC and WGCC produced an updated Roadmap that provided a review of major Water and Wastewater Sector accomplishments between 2009 and 2013, and identified three Top Priority Activity Areas and associated near-term and long-term actions in support of a more resilient Water and Wastewater Sector.

In late 2016, the WSCC and WGCC chartered the Water and Wastewater Sector Strategic Roadmap Work Group to undertake an update of the 2013 Roadmap. This 2017 Roadmap reflects the Work Group's efforts to review key threats and vulnerabilities of the Water and Wastewater Sector, identify gaps in Water and Wastewater Sector capabilities relative to the key threats and vulnerabilities, and formulate Top Priority Activity Areas and associated near-term and mid-term actions to address those gaps. This 2017 Roadmap also highlights key accomplishments achieved since the 2013 Roadmap was released. The Roadmap Work Group convened in February 2017 for a one-day workshop to review progress, identify evolving threat areas, identify Top Priority Activity Areas, and formulate needed actions. This 2017 Roadmap update lays out those Top Priorities and related recommended actions.

Purpose

The purpose of the Roadmap is to establish a strategic framework that achieves the following:

- Articulate the priorities of industry and government in the Water and Wastewater Sector to manage and reduce risk.
- Produce an actionable path forward for the WGCC, WSCC, and security partners to improve the security and resilience of the Water and Wastewater Sector over the near-term (within two years) and mid-term (within five years).
- Guide sector partners in developing new products and services and formulating budgets.
- Create a shared understanding of and collectively advocate for sector priorities, while recognizing sector partners' institutional constraints and different accountabilities.
- Encourage extensive engagement among all key stakeholders to strengthen public-private partnerships and reduce risk throughout the Water and Wastewater Sector.

Water Sector Partnership

The Water Government Coordinating Council (WGCC) is chaired by the U.S. Environmental Protection Agency (U.S. EPA) with the Department of Homeland Security (U.S. DHS) as a vice-chair; it consists of representatives from federal, regional, state, local, and tribal government programs.

The Water Sector Coordinating Council (WSCC) members include municipal and investor-owned water and wastewater utilities, associations, and regional organizations.

Together, these coordinating councils form the public-private Water and Wastewater Sector partnership through which security partners collaborate to plan and implement programs aimed at achieving a common vision.

How the Roadmap Is Used

The Roadmap was developed primarily for the WSCC and WGCC to support collaboration and leverage resources among the sector's partners, as well as ensure that joint activities contribute to a common vision. Water and wastewater utility owners and operators, associations, and government agencies can also use the Roadmap as a reference to support their planning processes. The priority activity areas contain actions that address key gaps in the Water and Wastewater Sector's capabilities relative to key threats to the operation of Water and Wastewater Sector utilities. These actions should ultimately serve to improve the Water and Wastewater Sector's resilience not only to the highest priority threats, but also to any hazard that jeopardizes the environmental and public health mission of the sector.

As a secondary purpose, the Roadmap provides a basis for WSCC and WGCC representatives to educate stakeholders on the Water and Wastewater Sector's joint accomplishments and planned activities for the future. Such stakeholders include federal homeland security entities, state emergency planning agencies, public commissions, and interdependent sectors.

2017 Updates

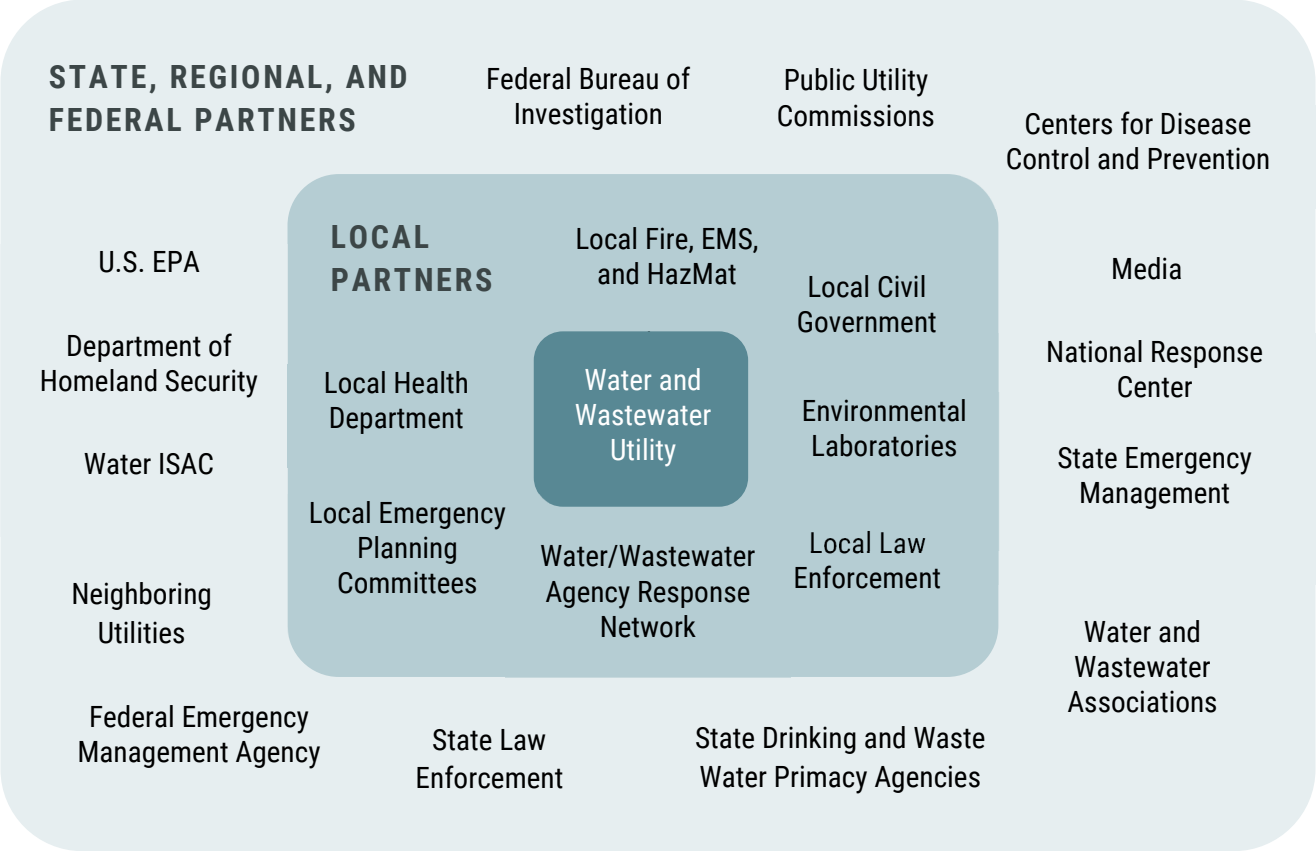
The 2017 Roadmap was revised using a similar process and format to the 2009 and 2013 Roadmaps. The most notable changes to the 2017 update include the revision of the priority threat areas and the Top Priority Activity Areas. Other updates include a review of significant partner progress since the 2013 Roadmap was created, the identification of which helped inform the development of 2017 Top Priority Activity Areas. The 2017 update also includes a

reorganization of content for greater alignment with the 2015 Water and Waste Water Systems Sector-Specific Plan (SSP).

Water and Wastewater Sector Partnerships

As illustrated in Figure 1, the Water and Wastewater Sector coordinates planning and response among a broad number and scope of partners. The figure includes primary actors, such as local partners to water and wastewater utilities, along with federal, state, and regional partners that regularly engage in some facet of the Water and Wastewater Sector. Other Water and Wastewater Sector partners, such as manufacturers and vendors are not included in this illustration, though they can play an important role in the sector. Over the past eight years, the Water and Wastewater Sector has worked to engage all of these stakeholders.

Figure 1: Examples of Security Partners in the Water and Wastewater Sector



Threats Addressed

2017 Strategic Roadmap Work Group members identified four categories of threats that should drive consideration of Top Priority Activity Areas for the Water and Wastewater Sector over the next two to five years: Natural Disasters; Contamination Incidents; Infrastructure Degradation; and Cyber Risk Management.

Natural Disasters

Natural disasters were identified among the "most significant risks" in the 2013 Roadmap. The focus in 2013 was on "acute" disasters such as floods, hurricanes, and earthquakes. For the 2017 Roadmap, these threats remained, while the Work Group also identified "chronic" hazards such as drought and sea level rise. This formulation reflects the Work Group's interest in building long-term strategic considerations into the sector's thinking.

Contamination Incidents

Contamination incidents emerged during Work Group member interviews as a critical priority threat area. Work Group members observed that high-profile contamination incidents including Elk River, WV; Corpus Christi, TX; Toledo, OH; and the Potomac River, DC metropolitan area have placed pressure on public confidence in the safety of drinking water and have pointed to weaknesses in both source water protection/preparedness and the emergency response and recovery framework.

Infrastructure Degradation

Infrastructure degradation was identified among the "most significant risks" in the 2013 Roadmap. The focus in 2013 was on the economic implications of aging infrastructure. For the 2017 Roadmap, Work Group members believe the focus should be on the water quality and operational reliability aspects of aging and failing infrastructure, as well as reflecting the effects that economic pressures within a community (e.g., loss of economic base, and an aging population) can have on the operational capacity of utilities. Work Group members also acknowledged that this is an endemic sector problem not specific to water security considerations.

Cyber Risk Management

Cyber events were identified among the "most significant risks" in the 2013 Roadmap. For the 2017 Roadmap, Workgroup members identified that the use of and reliance on technology systems including process control systems, industrial internet of things, cloud services, and other connected technology have increased as have the cyber threats, cyber vulnerabilities, and capabilities of malicious actors.

2017 Top Priority Activity Areas

The Strategic Roadmap Work Group identified four Top Priority Activity Areas based on a review of the 2013 Roadmap and related accomplishments, as well as the consideration of recent Water and Wastewater Sector incidents. These four areas:

- Support the Water and Wastewater Sector's vision and goals as stated in the 2015 SSP.
- Reflect a cohesive, near-term (within two years) and mid-term (within five years) approach to advance the capabilities of the Water and Wastewater Sector.
- Identify practical efforts that, if implemented, will meaningfully address the key threat areas.
- Fall within the capabilities of WSCC and WGCC associations and agencies (e.g., resources, authorities, span of control).

Scope

The scope of the Roadmap security and resilience activities encompasses:

- Prevention, detection, response, and recovery
- Water and wastewater infrastructures
- All hazards, such as natural disasters, economic crises, accidental releases, and intentional physical and cyber attacks
- Top-priority issues for the WSCC and GCC
- Five-year time frame

Roadmap Work Group members believe these Top Priority Activity Areas must be pursued to enhance the resiliency of the Water and Wastewater Sector. Top Priority Activity Areas are summarized below, followed by a series of tables that provide more detailed descriptions of each activity, along with the recommended near-term and mid-term actions to improve capabilities in these areas.

- *Establish the critical lifeline status of the Water and Wastewater Sector and translate that definition into strong support for the sector's needs and capabilities.* Two- and five-year actions identified for this area overlapped substantially with those in the 2013 Roadmap. Work Group members discussed improvements to site access, the desire to improve the efficiency and efficacy of Emergency Support Functions (ESFs), and to conduct tabletops and other exercises to underscore cross-sector interdependencies. Actions in this activity area are designed to enhance the Water and Wastewater Sector's ability to develop meaningful partnerships with other emergency response actors—from the local to federal levels—as well as attract the needed resources to ensure adequate response and recovery capabilities. Improvements in this area will increase the sector's resilience relative to natural disasters, contamination incidents, and technology failures, as well as help to address the all hazards aspects of infrastructure degradation.
- *Improve detection, response, and recovery to contamination incidents.* Two- and five-year actions identified for this area include a focus on clarifying and clearly communicating (through training, quick guides, etc.) incident response decision structures, access to information on potential sources of contamination, and research and development related to decontamination procedures, key pathogens, and unknown contaminants. This activity area is designed specifically to address the contamination incidents threat.

- *Advance preparedness and improve capabilities of the Water and Wastewater Sector for area-wide loss of water and power.* Work Group members focused actions in this area on establishing an understanding of current capabilities at local, state, and federal levels to respond to an area-wide loss of water and power, integrating area-wide loss of water into planning exercises, and highlighting public preparedness needs. This activity area seeks to address the Work Group's concerns that natural disasters such as catastrophic earthquakes and severe solar and terrestrial weather, as well as man-made threats such as coordinated cyber or physical attacks and electromagnetic pulse weapons can create a wide scale outage of water and power. Contamination events can also create a wide scale outage of drinking water. Both types of threats can be beyond the scope and scale of conventional response and recovery planning.
- *Advance recognition of vulnerabilities and needed responses related to cyber risk management.* Actions in this area reflect a focus on implementing procedures to support full manual operation at a utility, promoting cybersecurity guides and tools, deploying cybersecurity resources to small and medium utilities, and developing a more robust cybersecurity culture at utilities of all sizes. This activity area is designed to speak specifically to the cyber risk management area.

Table 1: Top Priority Activity Areas for the Water and Wastewater Sector

Top Priority Activity Areas for the Water and Wastewater Sector
• Establish the critical lifeline status of the Water and Wastewater Sector and translate that definition into strong support for the sector's needs and capabilities. • Improve detection, response, and recovery to contamination incidents. • Advance preparedness and improve capabilities of the Water and Wastewater Sector for area-wide loss of water and power. • Advance recognition of vulnerabilities and needed responses related to cyber risk management.

Roadmap contributors have defined the following roles and responsibilities for implementing each Top Priority Activity Area:

- **Coordination Lead:** The WSCC and WGCC are responsible for providing direction and guidance to keep the activity on track, establishing work groups when needed, and bringing in other organizations and experts to help execute the activity.
- **Principal Partner:** Sector associations and government agencies are responsible for initiating and managing activity plans, contributing the necessary financial and technical resources, encouraging active stakeholder participation, collaborating with Coordination Leads to stay on track, and delivering tangible results.

Top Priority Activity: Establish the critical lifeline status of the Water and Wastewater Sector and translate that definition into strong support for the sector's needs and capabilities.
Opportunity: Provide and maintain a clear understanding by local, state, and federal emergency planners, regulators and water utility customers of the benefits of a secure and resilient Water and Wastewater Sector. This understanding will enable decision makers to make well-informed choices about Water and Wastewater Sector priority needs in resilience and emergency response planning.

Challenges to Implementation:

- The concept of a lifeline sector is not commonly understood among all levels of government, critical infrastructure sectors, and the communities they serve.
- The failure to include the Water and Wastewater Sector as a key priority increases the risk of cascading consequences during a catastrophic event.
- Institutional knowledge loss resulting from staff turnover requires an ongoing commitment to education and training to maintain recognition of and responsiveness to the Water and Wastewater Sector's needs.

Most Aligned with SSP goals:

- Goal 3: Maintain a Resilient Infrastructure
- Goal 4: Increase Communication, Outreach, and Public Confidence

Description/Application: Lifeline sectors—including the Water and Wastewater Sector—ensure the resilience, safety, prosperity, and rapid recovery of the communities they serve.[1] Defined priorities and ongoing support for resource requests from drinking water and wastewater utilities can help mitigate or avoid public health and environmental impacts during and following emergencies. For example, the Water/Wastewater Agency Response Network's (WARN's) Superstorm Sandy After-Action Report found that a clear and recognized priority status between emergency management organizations and the power utilities could have directed greater attention to loss of power at water and wastewater facilities. Furthering awareness of the priority status of the Water and Wastewater Sector should include the following actions.

Near-Term Actions (within two years):

- Prioritize the restoration of critical support services, such as power, to rapidly recover or sustain continuity of Water and Wastewater Sector services.
- Improve the efficiency and efficacy of response under the National Response Framework where current practice segments water response needs into multiple Emergency Support Functions (primarily 3, 4, 6, and 8).[2]
- Establish site access protocol for critical lifeline services through coordination with FEMA and other emergency response agencies.
- Develop resources that communicate the relationship of infrastructure investment to overall community economic vitality and resilience.
- Conduct tabletops and state/local exercises or workshops that improve understanding of Water and Wastewater Sector interdependencies with other sectors, impacts of loss of service during a disaster, and use this information to raise awareness of Water and Wastewater Sector criticality.
- Develop and implement public messaging to increase household preparedness in addition to local, state, and federal support for pre-disaster risk reduction and resilience activities.
- Promote eligibility criteria for various financial assistance programs to support Water and Wastewater Sector preparedness and hazard mitigation.
- Improve engagement with the State, Local, Tribal, and Territorial Government Coordinating Council (SLTTGCC) to raise awareness of Water and Wastewater Sector criticality at the state/local level.
- Perform after-action analyses for incidents and events that evaluate response effectiveness for the Water and Wastewater Sector.

Mid-Term (within five years):

- Provide support for State DW/WW programs to implement security/emergency planning programs.

[1] The Water Sector is identified as a lifeline sector in the following documents, among many others: National Infrastructure Advisory Council (NIAC) Regional Resiliency Working Group, Report to the NIAC Quarterly Business Meeting, 2012; State, Local, Tribal, and Territorial Government Coordinating Council, Landscape of State and Local Government Critical Infrastructure Resilience Activities and Recommendations, 2011.

[2] Water Sector Resilience: Final Report and Recommendations (2016); Framework for Dealing with Disasters and Related Interdependencies (2009)

Top Priority Activity: Improve detection, response, and recovery to contamination incidents.

Opportunity: Provides the Water and Wastewater Sector with a clear set of guidelines for establishing protocols with key emergency response partners and enables a more timely, coordinated, and effective approach to detection, response, and recovery actions that hold the potential to substantially reduce the consequences of contamination incidents.

Challenges to Implementation:

- Recent incidents have placed pressure on public confidence in the safety of drinking water.
- Weaknesses in decision protocols that support a rapid emergency response and recovery framework.
- Gaps in knowledge relative to location and type of potential contamination sources, as well as gaps relative to key decontamination needs.
- Gaps in technological capabilities for detecting specific types of contaminants in real-time (e.g., pathogens or low levels of almost any contaminant).
- Low likelihood of a contamination incident occurring at any specific utility presents a challenge for building a business case to address the threat.

Most Aligned with SSP goals:

- Goal 2: Recognize and Reduce Risk
- Goal 3: Maintain a Resilient Infrastructure
- Goal 4: Increase Communication, Outreach, and Public Confidence

Description/Application: Since 2013, the Water and Wastewater Sector has experienced several high-profile contamination events including: Elk River, WV; Corpus Christi, TX; Toledo, OH (Lake Erie); and the Potomac River, DC metropolitan area. These events have placed pressure on public confidence in the safety of drinking water and have pointed to weaknesses in decision protocols that support rapid emergency response and recovery. An array of contamination threats to both source and distributed water (e.g., chemical storage tanks, outfalls, and cross-connections) and the paucity of accessible information about these threats, present utilities and state partners with a challenge in identifying and characterizing the specific contamination threats in their area. Water utilities also have a need for rapid notification of contamination incidents in sufficient time to implement a response. Further, certain deficiencies identified in the 2008 Critical Infrastructure Partnership Advisory Council (CIPAC) report, "Recommendations and Proposed Strategic Plan: Water Sector Decontamination Priorities" remain unaddressed. Taken together, these pressures point to a compelling need for the Water and Wastewater Sector to revisit current approaches to source and distributed water preparedness/protection and the response/recovery framework, including decontamination, as it applies to both acute and chronic contamination events. Actions that need to be taken include the following.

Near-Term (within two years):

- Review recommendations from the 2008 CIPAC/Decontamination report and 2010 CIPAC/CWS to identify the gaps remaining relative to their recommendations; take action to respond to the identified gaps.
- Conduct exercises and trainings using recent contamination events as case studies and engage all actors involved in incidence response and recovery (e.g., local, city, state, federal, FEMA, FBI, etc.).
- Develop a contamination incident response plan template (Quick Guide) that details the roles and responsibility of key stakeholders—who makes what decisions. Outline and promote an incident response decision-making structure for multi-jurisdictional events to ensure there is proper planning and partnership relationships and decision protocols established in advance of emergency conditions.
- Assist state agencies and local communities to improve source water assessments and protection plans by providing information on the nature and quantity of potential contaminant sources (e.g., such as EPA's approach under the Toxic Substances Control Act for considering chemical storage near significant sources of drinking water).

- Expand electronic data sharing (e.g., DWMAPs, E-Plan) among federal offices and agencies to bring the most current and complete datasets possible to bear on source water assessments and protection plans.
- Explore options for including water utilities as a "need to know" stakeholder for EPRCA Tier 2 pipeline and railroad data to facilitate information sharing and data access associated with chemical storage in source water areas.
- Develop guidelines to enhance a water utility's ability to quickly detect source water quality changes.
- Develop a consequence management plan blueprint and promote the guidelines for source water and finished water monitoring and response.
- Review options to enhance alert protocols associated with upstream spill incidents that ensure rapid notification of downstream utilities.
- Update CDC's Patient Waste Handling Protocol to prevent risk transfer to water utility personnel and operations, ideally to align with the Nebraska Biocontainment Patient Care Unit protocol.

Mid-Term (within five years)

- Form a strike team to assist in decision-making. Building on existing resources (e.g., the Federal-State Toxicology and Risk Analysis Committee, health advisory database, and the RACER team of EPA's Office of Research and Development that is led by the National Homeland Security Research Center), develop a strike team to assist those making judgments as to public health protection.
- Conduct research and develop pilot and field-scale testbeds inform and facilitate decontamination procedures, emergency response, and cross-sector collaboration.
- Conduct research and development relative response protocols for key pathogens (e.g., Ebola) or other contaminants (e.g., NTAs).
- Conduct research and development for source water and finished water monitoring equipment and procedures.
- Conduct research and development for response to contaminants that have little available data to inform response and return to service (e.g., Charleston, WV scenario).
- Develop a contaminant treatment technology testing, certification, and verification database for use by states. Consider developing a 3-tiered certification system based on basic containerized treatment systems (e.g., pathogen removal, inactivation, select contaminant removal) plus energy requirements, residuals production, costs, and operational requirements.[3]

[3] Planning for an Emergency Water Supply (EPA 600/R-11/054, June 2011)

Top Priority Activity: Advance preparedness and improve capabilities of the Water and Wastewater Sector for area-wide loss of water and power.

Opportunity: Provide the Water and Wastewater Sector with the building blocks to develop emergency drinking water and wastewater plans to expedite community recovery in the event of an area-wide loss of water and/or power services in which the scope, duration, and/or scale exceed those addressed in conventional response and recovery planning.

Challenges to Implementation:

- The magnitude of such an event surpasses response and recovery infrastructure as it currently exists.
- The low-probability nature of and potential cost of up-front investments to address such events makes proactive engagement difficult.

Most Aligned with SSP goals:

- Goal 3: Maintain a Resilient Infrastructure

Description/Application: Disasters such as Hurricane Katrina, Superstorm Sandy, and the earthquakes in Haiti, Chile, and Pakistan demonstrate that large-scale disasters can quickly move communities beyond the realm where conventional planning for water and power outage events are adequate. The Water and Wastewater Sector has not yet sufficiently planned around scenarios in which the scope, duration, and/or scale exceed conventional response and recovery planning (e.g., the need to meet all forms of water and sewer needs over an entire region and over an extended period of time), leaving residents as well as critical services and activities, such as hospitals, fire protection, and industrial production, vulnerable to a complete collapse. Actions needed to address this Top Priority Activity Area include the following.

WATER:

Near-Term (within two years):

- Develop an assessment of federal and state capabilities to address large-scale events.
- Identify the gap between projected needs, local capacity, and available state-federal and NGO resources to better plan for post-disaster emergency water supply.
- Research options for alternate supplies of bulk water production and delivery, including a certification database for containerized treatment units.
- Aggregate gaps identified at local and state levels[4] to assess existing and supplemental resources for emergency water supply, and integrate the substantial and long-term loss of water into planning exercises.
- Develop guidance for pre-approval of alternate water supplies and portable treatment units in terms of certification, operation, monitoring, siting, and water utility system interface.
- Provide guidance on procurement considerations in local, state, and federal planning exercises.
- Develop an approved vendor database and prepare contracting strategies to allow vendors to be more responsive to fulfilling rapid mobilization (e.g., multi-year contracts, price premiums).
- Educate consumers by highlighting the need for public preparedness.
- Identify and evaluate bulk sludge transport and disposal options.

[4] 42 U.S.C. 300g–2, which provides, in part: "A State has primary enforcement responsibility for public water systems during any period for which the Administrator determines . . . that such State . . . has adopted and can implement an adequate plan for the provision of safe drinking water under emergency circumstances including earthquakes, floods, hurricanes, and other natural disasters, as appropriate" (42 U.S.C. 300g-2(a) (5)).

POWER:

Near-Term (within 2 years):

- Institutionalize prioritization for power restoration for DW/WW assets, including sustaining fuel for generators.
- Assess DW/WW backup power needs with expanded support from the 249th Prime Power Battalion.

Mid-Term (within five years):

- Address the policy-regulatory limits under the Federal Clean Air Act that constrain return on investment (ROI) for generators, specifically NESHAP for Reciprocating Internal Combustion Engines.

Top Priority Activity: Advance recognition of vulnerabilities and needed responses related to cyber risk management.

Opportunity: Signal and reinforce the need for an understanding of cyber vulnerabilities created by the increased use of technology systems and automated operations. Draw on the development since 2013 of an array of cybersecurity resources and trainings to enhance Water and Wastewater Sector capabilities and better strengthen cybersecurity culture through cybersecurity education and awareness. Overall, increase the potential for better preparedness and resilience of water and wastewater infrastructure during a cyber or other technology-related failure event.

Challenges to Implementation:

- Complex and evolving cyber vulnerabilities are time and resource-intensive to mitigate.
- The Water and Wastewater Sector continues to automate all aspects of business and operational functions increasing vulnerability to technology failures, while "old school" manual operational skills are fading.
- It is difficult to keep up with increasingly sophisticated, fast-changing cyber threats.

Description/Application: Since 2013, the Water and Wastewater Sector has worked to develop (at times with its cross-sector partners) a range of cybersecurity tools, guides, and other resources to motivate and enable attentiveness to cyber vulnerabilities. The sector has made progress addressing cyber threats. At the same time cybersecurity education, tools, and resources remain an on-going and evolving need for the sector. Compounding this need is the continued uptake of automation and information technology dependent advancements that, while improving business and operational performance, can impart additional sector vulnerabilities. Maintaining focus on cybersecurity and automated process control dependencies and recognizing the differing impacts of cyber-attacks to business and operational systems remain a critical part of helping the Water and Wastewater Sector to withstand a cyber-attack or other technology failure. Actions to enhance Water and Wastewater Sector cybersecurity and other technology resilience include the following.

Near-Term (within 2 years):

- Develop resources that communicate the prospective economic and operational risks of cyber related attacks to support continued cyber investments—distinguish between business system risks and process control system risks.

Most Aligned with SSP Goals: • Goal 1: Sustain Protection of Public Health and the Environment • Goal 2: Recognize and Reduce Risk	• Educate regarding the obligations of utility management and boards/councils to include cybersecurity in overall risk management activities. • Identify and promote basic effective practices for responding to technology failures (e.g., manual operation exercises). • Enhance practices and resources to strengthen and maintain a culture of cybersecurity among utilities and stakeholder groups. • Conduct cyber event exercises and training for the Water and Wastewater Sector. • Create a program or system to increase the deployment of cybersecurity resources to small and medium utilities. • Maintain and expand focus on promoting basic practices and, for higher capacity systems, establish a system to move beyond "minimum practices" for cybersecurity implementation. • Develop a culture of maintaining cybersecurity protocols and following emergency frameworks during an event. • Demonstrate the impact of cyber breaches on operations (e.g., pumps, SCADA, PLCs).

Appendix A: Roadmap Update Process

The *Roadmap to a Secure and Resilient Water and Wastewater Sector 2017* was developed according to the process shown in Figure A.1 and described below.

Water and Wastewater Sector Strategic Roadmap Work Group Formed

In October 2016, the Water Sector Coordinating Council (WSCC) and the Water Government Coordinating Council (WGCC) chartered the Water and Wastewater Sector Strategic Roadmap Work Group.

Finalize Charter and Work Plan

On January 5, 2017, the Work Group held a conference call to review the charter and develop a work plan for updating the 2017 *Roadmap to a Secure and Resilient Water and Wastewater Sector*.

Understand Threats, Vulnerabilities, and Top Priority Needs

Individual interviews were conducted with each of the Work Group members to assess sector progress, identify threats and vulnerabilities, and understand top priority needs. A synthesis was prepared designed to inform discussions at the in-person meeting.

Establish Top Priority Activity Areas and Related Actions

On February 21, 2017, the Work Group held an in-person meeting to discuss threats and vulnerabilities identified in the individual interviews. During this convening, the Work Group identified the four priority activity areas and actions needed to address gaps in capabilities.

Figure A.1. Roadmap Update Process

Refine Implementation Strategy

The 2017 Roadmap was drafted and circulated among Work Group members for additional review and clarification. A conference call was held on April 19, 2017 to clarify key points and review and refine the draft.

Prepare, Review, and Publish Roadmap

Following the April 19th call, a final set of proposed changes to 2017 Roadmap document text was prepared and circulated among Work Group members for final approval. A full, final draft of the Roadmap was shared with the Work Group Co-Chairs for their final review and acceptance of the document. The comments of all reviewers have been integrated into this final Roadmap document.

Appendix B: Acronyms

AMWA	Association of Metropolitan Water Agencies
ASDWA	Association of State Drinking Water Administrators
AWWA	American Water Works Association
CDC	Centers for Disease Control and Prevention
CIPAC	Critical Infrastructure Partnership Advisory Council
DHS	U.S. Department of Homeland Security
DWMAPs	Drinking Water Mapping Application to Protect Source Waters
DW/WW	drinking water/wastewater
EMS	emergency medical services
EPRCA	Emergency Planning and Community Right-to-Know Act
ERP	emergency response plan
ESF	Emergency Support Function
FEMA	Federal Emergency Management Agency
ISAC	Information Sharing and Analysis Center
NACWA	National Association of Clean Water Agencies
NAWC	National Association of Water Companies
NGO	non-governmental organization
NIPP	National Infrastructure Protection Plan
NRWA	National Rural Water Association
NTA	non-traditional agent
RAMCAP	Risk Analysis and Management for Critical Asset Protection
ROI	return on investment
RRAP	Regional Resiliency Assessment Program
SLTTGCC	State, Local, Tribal, and Territorial Government Coordinating Council
SSP	Sector-Specific Plan
TSCA	Toxic Substances Control Act
U.S. EPA	U.S. Environmental Protection Agency
WARN	Water/Wastewater Agency Response Network
WaterISAC	Water Information Sharing and Analysis Center
WaterRF	Water Research Foundation
WE&RF	Water Environment & Reuse Foundation
WEF	Water Environment Federation
WGCC	Water Government Coordinating Council
WSCC	Water Sector Coordinating Council

Appendix C: Water and Wastewater Sector Accomplishment Highlights 2013–2016

Provided below are some of the Water and Wastewater Accomplishments between 2013 and 2016 organized by the 2015 SSP goals. Appendix D replicates the list of accomplishments contained in the 2013 Roadmap to provide a complementary, ready reference that completes the picture of progress from 2009 through 2016.

These inventories of Water and Wastewater Sector accomplishments provide a clear indication of the sector's commitment to improving the all hazards protective posture of Water and Wastewater Sector utilities and the communities they serve. The WSCC, EPA, and DHS also undertook to update the Water and Wastewater Sector-Specific Plan in 2015. Provided below are some key highlights of accomplishments relative to the 2015 SSP Goals. Importantly, many of the accomplishments apply to more than one SSP Goal—they have been listed under the Goal where they most apply.

2015 SSP Goal 1: Sustain Protection of Public Health and the Environment

- Developed "Risk Management for the Water Sector Training." (U.S. DHS)
- Conducted one-day *Water Sector Cybersecurity* training courses at eleven locations nationally. The courses covered cybersecurity threats, vulnerabilities, consequences, and incident response at Water and Wastewater Sector facilities. (U.S. EPA)
- Delivered "Collaborative Workshop on Handling, Management, and Treatment of High-Consequence Biocontaminated Wastewater by Water Resource Recovery Facilities." U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-16/054, 2016.
- Conducted multi-sector workshops and trainings on coordination of the Water, Emergency Services and Healthcare Sectors to increase understanding of interdependencies. (U.S. EPA)
- Developed and promoted Hazard Mitigation for Natural Disasters: A Starter Guide for Water and Wastewater Utilities to help utilities join existing community mitigation efforts and to provide suggestions for mitigating the impacts of floods, droughts, earthquakes, wildfires, tornadoes, and power outages. (U.S. EPA)
- Delivered reports and data to improve the infrastructure decontamination and treatment of the contaminated water capability of the Water and Wastewater Sector to inform response to any chemical, biological or radiological contamination incidents. (U.S. EPA)

2015 SSP Goal 2: Recognize and Reduce Risk

- Completed the "Infrastructure Sector Assessment: 2016 Wildland Fires and Potential Impacts to Critical Infrastructure"—other Assessments included: hurricanes; floods; as well as a projects focused on resilience to drought. (U.S. DHS)
- Undertook the Arizona Water Cybersecurity RRAP project focusing on seven owners and operators of Water and Wastewater Sector facilities and assessing the cybersecurity defensive posture of ICS/SCADA systems and networks required for operation of critical services to deliver water. (U.S. DHS)
- Completed the California Water RRAP project focusing on how drought and extreme weather impact the resilience of California's Central Valley water systems. (U.S. DHS/RRAP)
- Initiated development of VSAT Web—a Water and Wastewater Sector risk assessment tool intended for use on mobile devices. Compliant with the J100 Water Sector Risk Assessment Standard. (U.S. EPA)
- Issued cybersecurity guidance and use-case tool (first issued in 2014 and updated in 2016), which aligns with the NIST Cybersecurity Framework. (AWWA)
- Completed "Modeling and Experimental Testing and Decontamination in Drinking Water Pipes." U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-14/234, 2016.

2015 SSP Goal 3: Maintain a Resilient Infrastructure

- Published the document: *States and Water/Wastewater Agency Response Networks (WARNs) Working Together – State WARN Perspectives Study Highlights.* (ASDWA/U.S. EPA)
- Conducted Interstate Mutual Aid and Assistance workshops in four EPA Regions to investigate mechanisms for interstate mutual aid, including the role that existing WARNs and EMAC coordinators could play. (U.S. EPA)
- Conducted multi-sector workshops and trainings on coordination of the Water, Emergency Services and Healthcare Sectors to increase understanding of interdependencies. (U.S. EPA)
- Conducted *Water and Energy Nexus in Disasters* webinars and workshops to raise awareness and understanding of the interdependency between the Water and Wastewater Sector and the Power Sector (U.S. EPA)
- Established the Association of Bay Area Governments Lifelines Council. This initiative focuses on the formation of a regional lifelines council in the San Francisco Bay Area aimed to foster collaboration among water districts, cities, and counties in order to enhance regional water availability and resilience of the water system. (U.S. DHS)
- Supported the National Drought Resilience Partnership (NDRP), which harnesses and coordinates the distinct efforts of the federal interagency with roles/responsibilities in planning for and/or responding to drought to facilitate community preparedness and strengthen the nation's resilience to drought. (U.S. DHS)

2015 SSP Goal 4: Increase Communication, Outreach, and Public Confidence

- Improved communications to the Water and Wastewater Sector through implementation of a well-defined outreach cycle that includes webinar presentations, industry conference and exhibit exposure, an 8,000 recipient quarterly electronic newsletter (*WSD What's Going On*), widget highlights, hazard and national awareness campaigns (e.g., National Preparedness Month), videos (e.g., *Your Water, Your Community*) and an ongoing web presence. (U.S. EPA)

- Developed the *Water Utility Public Awareness Kit* to assist utilities in communicating the value of Water and Wastewater Sector services to customers and other stakeholders through easy to use and customizable outreach materials. (U.S. EPA)
- Posted the *Water/Wastewater All-Hazards Boot Camp Training* for water utility operators, an interactive online course that explains why and how to implement a comprehensive all-hazards program. (U.S. EPA)
- Developed and promoted *Hazard Mitigation for Natural Disasters: A Starter Guide for Water and Wastewater Utilities* to help utilities join existing community mitigation efforts and to provide suggestions for mitigating the impacts of floods, droughts, earthquakes, wildfires, tornadoes, and power outages. (U.S. EPA)
- Developed the *Water Utility Response On-The-Go* mobile website to enhance real-time access to information and tools that water utility operators and their response partners may need during an emergency. (U.S. EPA)
- Conducted a workshop for state primacy agencies and EPA Headquarters and Regions to enhance security and resiliency partnerships in areas such as hazard mitigation, cybersecurity, mutual aid, and available tools and resources. (ASDWA)

Appendix D: 2009–2013 Key Water Sector Successes

2009–2013

Water and Wastewater Sector partners have made many large contributions to the *Water Sector-Specific Plan* goals since the first *CIPAC Roadmap to a Secure & Resilient Water Sector* was issued. Highlights of achievements (2009–2013) are provided in the following table:

Expanded Mutual Aid Programs

- Established 50 Water/Wastewater Agency Response Networks (WARN) in the United States and Canada and continued efforts to support their operational plans, outreach and communications
- Conducted nationwide table top exercises to enhance the effectiveness of state WARNs
- Developed the Water & Wastewater Mutual Aid & Assistance Resource Typing Manual

Developed Key Standards

- SAFETY Act designation granted by DHS for ANSI/AWWA G430-09: Security Practices for Operations and Management and ANSI/AWWA J100-10: Risk Analysis and Management for Critical Asset Protection (RAMCAP®) Standard for Risk and Resilience Management of Water and Wastewater (AWWA)
- Issued ANSI/AWWA G440-11: Emergency Preparedness Practices (AWWA)
- ANSI/American Society of Mechanical Engineers-Innovative Technologies Institute/AWWA J100-10: Risk Analysis and Management for Critical Asset Protection® -Standard for Risk and Resilience Management of Water and Wastewater

Developed Key Strategic Planning Resources

- Updated emergency response plans, enacting a shift in focus from terrorism to all-hazards
- EPA-NHSRC and AWWA collaborated to develop Planning for an Emergency Water Supply in response to provisions of the 2002 Bioterrorism Act
- CDC and AWWA collaborated to develop the Emergency Water Supply Planning for Hospitals and Healthcare Facilities and the Drinking Water Advisory Communication Toolbox
- Developed the Climate Ready Water Utilities initiative to assist water and wastewater with integrating climate change considerations into near- and long-range planning
- Water Research Foundation, AWWA, and EPA developed Business Continuity Plan Tool Kit for water utilities
- Developed All-Hazard Consequence Management Planning for the Water Sector
- Developed Projects and Activities to Support a Secure and Resilient Water Sector
- Developed (2010) and updated the 2011 Water Emergency Roundtable Outline for Discussion Guide
- Developed the 2012 Bridging the Gap: Coordination between State Primacy Agencies and State Emergency Management Agencies guide
- Developed the 2013 State Drinking Water Program All-Hazard Preparedness, Mitigation, Response, and Recovery Checklist to provide state drinking water programs with internal emergency checklists and best practices

Enhanced Partnerships

- Expanded the Water Information Sharing and Analysis Center (Water ISAC) with important increases in membership and products and services, such as webcasts and threat briefings
- Leveraged the Critical Infrastructure Partnership Advisory Council (CIPAC) framework to develop sector priorities, build partnerships, and increase collaboration among public and private sector stakeholders
- Improved dialogue between government and industry partners, which has enhanced mutual understanding of water industry issues
- Improved communication with state and local officials on Water Sector issues, including the establishment of annual meetings
- Water ISAC established information-sharing partnerships the National Cybersecurity and Communication Integration Center, ICS-CERT, the National Infrastructure Coordinating Center, U.S. Cyber Command, other ISACs, and state and local intelligence fusion centers

Expanded Use of Tools, Programs, Exercises, and Training

- Completed deployment, commenced analysis, and began publication of results from EPA's five Water Security Initiative pilots, which involved designing and testing contamination warning systems
- Conducted numerous state tabletop exercises focusing on natural disasters with state drinking water and wastewater agencies, state and Federal emergency response officials, and water utilities
- Conducted full-scale exercises in participation with 25 Federal, state, local and commercial laboratories
- Developed the Water Laboratory Alliance training center to provide tools and other resources to water utility and state laboratories
- Completed development of the Water Health and Economic Analysis Tool drinking water and wastewater modules for hazardous gas and loss of operating assets scenarios

Expanded Use of Tools, Programs, Exercises, and Training

- Conducted 20 water-specific training courses on how to use the Incident Command System (ICS) and the National Incident Management System (NIMS) effectively during emergency response situations
- Developed the Community Based Water Resiliency Tool to assist water utilities in enhancing the preparedness of their communities
- Partnered with the Federal Bureau of Investigation (FBI), U.S. Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA) to sponsor four Multi Sector Infrastructure Protection and Threat Workshops
- Completed integration of the National Environmental Methods Index for Chemical, Biological, and Radiological Methods data into the Water Contaminant Information Tool
- Developed the Tabletop Exercise Tool for Water Systems: Emergency Preparedness, Response, and Climate Resiliency to aid in the development of customized scenario-driven, discussion-based tabletop exercises
- Developed Containment and Disposal of Large Amounts of Contaminated Water: A Support Guide for Water Utilities
- Worked with the Preparedness, Emergency Response, and Recovery CIPAC Workgroup to develop the All-Hazard Consequence Management Planning for the Water Sector guide to developing and implementing emergency response plans
- Developed and published updated versions of Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events
- Developed and tested new methods for the detection and sensing of contaminants in water systems
- Developed data for use in risk and threat assessment from chemical, biological and radiological contaminants
- Provided new versions for cyber-based tools for physical infrastructure protection, for example, a sensor event detection algorithm and a sensor placement optimization tool, and a new real time extension for EPANET; provided user manuals and conducted training and user group sessions to support the use of these tools
- Developed Need to Know: Anticipating the Public's Questions during a Water Emergency, a tool for risk and hazard communication for water utilities
- Produced data on the persistence, fate, and decontamination of a variety of contaminants for integration into the Water Contaminant Information Tool
- Developed and demonstrated tools and processes for managing contaminants in wastewater and runoff
- Developed the EPA Waste Estimation Support Tool (WEST) that incorporates wastewater considerations in development of integrated response/recovery strategies from radiological incidents
- Developed Federal Funding for Utilities—Water/Wastewater—in National Disasters (FedFUNDS) tool to provide tailored information to utilities about applicable Federal disaster funding programs
- Developed the RDD Wash Aid program to demonstrate mitigation of radioactive cesium contamination