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United States
Environmental Protection
Agency

Homeland Security

Strategic Research Action Plan, 2016-2019
(Preliminary Draft)

U.S. EPA
Office of Research and Development
Washington, DC 20460

PRELIMINARY DRAFT NOTICE: This Strategic Research Action Plan, 2016–2019 is a preliminary draft. It has not been formally released by the U.S. Environmental Protection Agency (EPA) and should not at this stage be construed to represent Agency policy, nor the final research program.

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I. Executive Summary

[To be completed in Final Strategic Research Action Plan]

II. Introduction

The sustainability of communities in the United States requires that they be both prepared for, and resilient to, disasters, whether caused by deliberate acts of terrorism or natural forces. The U.S. Environmental Protection Agency (EPA) has a responsibility to improve communities' ability to face and recover from environmental disasters. That role specifically includes assisting water utilities in making their systems more secure and resilient, and leading remediation of contaminated indoor and outdoor settings and water infrastructure.

EPA's Homeland Security Research Program (HSRP) was established in 2002 to conduct applied research and provide technical support that increases the Agency's capability to achieve its homeland security responsibilities. The program helps build systems-based [1]solutions by working with Agency partners to plan, implement, and deliver useful science and technology products. It maintains robust coordination efforts with other federal agencies, including the U.S. Department of Homeland Security, the U.S. Department of Defense, the Centers for Disease Control and Prevention, and others. Research is conducted and science products are constructed to address "all hazards," filling science gaps associated with chemical, biological and radiological contamination intentionally released by terrorists or caused by natural disasters or accidents.

To support that program, an EPA research team produced this *Homeland Security Strategic Research Action Plan, 2016-2019*. It was developed using considerable input and support from partnerships from within EPA program offices and regions, as well as using input from outside stakeholders listed above, as well as nonprofit organizations, private industry, and colleagues across the scientific community.

The plan builds upon and continues to advance the research outlined in the action plan released in June 2012: *Homeland Security Strategic Research Action Plan, 2012-2016* (U.S. EPA 2012). That plan is one of six released at that time, one for each of EPA's national research programs in the Agency's Office of Research and Development (ORD), the science arm of the Agency.

EPA's strategic research action plans lay the foundation for EPA's research staff and their partners to provide focused research efforts that meet the Agency's legislative mandates, as well as the goals outlined in the Agency's *Fiscal Year 2014 – 2018 EPA Strategic Plan* (U.S. EPA

[1] Systems approaches, including systems-based solutions, aim to understand a system in totality through analyzing its various components while still understanding how these components interact. These approaches also aim to understand the system at many levels. In this context, the "system" here is the incident response and recovery efforts composed on many interconnected activities such as constructing a sampling strategy, selecting a cleanup technology, and managing wastes.

2014). They are designed to guide an ambitious research portfolio that at once delivers the science and engineering solutions the Agency needs to meet such priorities, while also cultivating a new paradigm for efficient, innovative, and responsive government and government-sponsored environmental and human health research.

This *Strategic Research Action Plan* outlines the approach designed to achieve EPA's objectives for advancing homeland security and community stability. It highlights how the Homeland Security research program integrates efforts with other research programs across EPA's Office of Research and Development to provide a seamless and efficient overall research portfolio aligned around the central and unifying concept of sustainability, including its key component of community resiliency.

No other research organization in the world matches the diversity and breadth represented by the collective scientific and engineering staff of EPA's Office of Research and Development, their grantees, and other partners. They are called upon to conduct research to meet the most pressing environmental and related human health challenges facing the nation, and the world.

III. Program Purpose

The mission of EPA's Homeland Security Research Program (HSRP) is to conduct research and deliver scientific products to improve the capability of the EPA to carry out its homeland security responsibilities. Since the 2001 9/11 and subsequent anthrax attacks, EPA's homeland security efforts have focused on preparing for and responding to purposeful use of toxic chemical, biological, radiological, and nuclear (CBRN) substances by terrorists. HSRP has supported the agency by conducting a broad program of CBRN research for over a decade.

The U.S. Government has recognized that preparing for and responding to most disasters, man-made or natural, have common elements. Recent major disasters in the United States (Hurricanes Sandy in 2012, the Deepwater Horizon oil spill in 2010, and the Oklahoma tornados in 2013, West Virginia water contamination incident, 2014) and abroad (Fukushima Nuclear Power Plant Accident in 2011) illustrate the critical need for rapid recovery after all types of disasters.

Thus, the federal government's view of homeland security includes "all hazards" as described in *Presidential Policy Directive 21* (The White House 2013):

> *"The Federal Government shall…take proactive steps to manage risk and strengthen the security and resilience of the Nation's critical infrastructure, considering all hazards that could have a debilitating impact on national security, economic stability, public health and safety, or any combination thereof."*

Thus, EPA is called upon to help communities prepare for and recover from the environmental aspects of "all hazards"[2] or "all disasters." The HSRP has embraced this broader view of

[2] The term "all hazards" means a threat or an incident, natural or manmade, that warrants action to protect life, property, the environment, and public health or safety, and to minimize disruptions of government, social, or economic activities. It includes natural disasters, cyber incidents, industrial accidents, pandemics, acts of terrorism, sabotage, and destructive criminal activity targeting critical infrastructure (PPD-21).

homeland security in EPA's mission and is actively evolving our program from efforts strictly addressing issues associated with terrorism to the broader set of all disasters.

How does HSRP's mission relate to other ORD research programs? Except for a few minor components, HSRP exclusive mission is to conduct research that support EPA's responsibilities to prepare for and respond to acute disasters with short-term, applied science. The base of the HSRP program is focused on chemical, biological, radiological, or nuclear (CBRN) contamination resulting from terrorist incidents, however the HSRP also works to find multiple uses of its research and is looking at all hazards response and remediation gaps that are currently not being addressed. Figure 1 summarizes this approach.

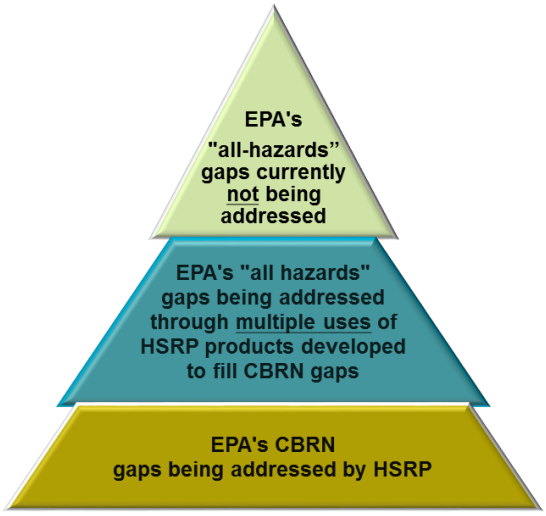

FIGURE 1. HSRP'S APPROACH TO ADDRESSING ALL HAZARDS RESEARCH GAPS.

Ultimately, EPA's efforts to improve communities' ability to face and recover from disasters helps build resilience in these communities. Improving community resilience is especially critical for populations that have greater exposure to disasters and are more vulnerable to their impacts. Developing resilience at the community and water utility level is a critical aspect of building sustainability: communities that "prepare for, absorb and recover" (NRC 2012) from disasters will, in turn, have more sustainable economic, environmental, and social systems. Our communities can prepare for and more rapidly recover from these incidents if effective tools, and guidance are developed and successfully delivered to community decision-makers, including water utilities. Figure 2 illustrates this how EPA research related to resilience ultimately supports sustainability.

FIGURE 2. HOW RESILIENCE RESEARCH SUPPORTS COMMUNITY SUSTAINABILITY

III.A. Problem Statement

Environmental disasters, including chemical, biological, radiological or nuclear terrorist incidents, can potentially result in loss of human lives and create long-term health, social, economic, and environmental issues. The HSRP aims to provide the science the Agency

needs to better prepare for and respond to disasters with environmental consequences and to support communities as they recover from these disasters.

III.B. Program Vision

Communities that are more resilient to disasters and an Agency prepared to support response and remediation activities after these disasters.

IV. Research Supports EPA Priorities and Mandates

IV.A. Statutory and Policy Context

EPA holds clearly defined responsibilities associated with responding to disasters or acts of terrorism. These responsibilities are established through a set of laws, Homeland Security Presidential Directives, Presidential Policy Directives, Executive Orders, and national strategies.[3]

EPA's disaster-related responsibilities can be summarized into three areas:

1. Water systems: (a) Protect water systems from intentional or unintentional contamination and (b) Detect and recover from successful attacks and the effects of disasters by leading efforts to provide States and water utilities with guidance, tools and strategies.
2. Indoors/outdoors: Remediate contaminated environments including buildings and outdoor areas impacted by terrorist attacks or by inadvertent disasters by leading efforts to establish clean-up goals and remediation strategies.
3. Laboratories: Develop a nationwide laboratory network with the capability and capacity to analyze for chemical, biological, or radiological (CBR) agents during routine monitoring and in response to terrorist attacks and other disasters.

EPA's homeland security mission is coordinated by the Office of Homeland Security and carried out by many of the Agency's program offices. Primary partners include the EPA's Office of Water (OW) and the Office of Solid Waste and Emergency Response (OSWER), and each of the Agency's ten Regional Offices across the country, with critical contributions by the Office of Chemical Safety and Pollution Prevention (OCSPP), the Office of Air and Radiation (OAR), and water utilities.

IV.B. EPA Priorities

Homeland Security Research is cataloged in the EPA' Fiscal Year 2014-2018 Strategic Plan under Goal 4 "Ensuring the Safety of Chemicals and Preventing Pollution" but more

[3] Bioterrorism Act, Presidential Policy Directive-8 *National Preparedness*, Presidential Policy Directive-21 *Critical Infrastructure Security and Resilience*, Homeland Security Presidential Directive-7 *Critical Infrastructure Identification, Prioritization, and Protection*, Homeland Security Presidential Directive-9 *Defense of United States Agriculture and Food*, Homeland Security Presidential Directive-22 *Domestic Chemical Defense*, Executive Order-13636 *Improving Critical Infrastructure Cybersecurity*, National Response Framework, and elements of: Comprehensive Environmental Response, Compensation and Liability Act, Emergency Planning and Community Right-to-Know Act, Clean Water Act, Safe Drinking Water Act, Oil Pollution Act, Clean Air Act, Resource Conservation and Recovery Act

significantly supports Goals 2 "Protecting America's Waters" and Goal 3 "Cleaning Up Communities and Advancing Sustainable Development." Specifically under Goal 2, HSRP's research supports the objective related to protecting human health by providing research that helps "protect and sustainably manage drinking water resources." The program's research supports Goal 3 to Promote Sustainable and Livable Communities and Restore Land Objectives by providing research to do so and help communities "prepare for and respond to accidental or intentional releases of contaminants and clean up." Its research also supports the cross-agency strategies within this plan, specifically "Working Toward a Sustainable Future" and "Making a Visible Difference in Communities" specifically, conducting research that will "advance sustainability science, indicators, and tools" (U.S. EPA 2014).

The program also has priorities that are directly informed by its partners' needs. Specifically, water infrastructure decontamination and remediation of the wide area after a biological or radiological incident are priority research areas. Making communities, including water systems, more resilient to disasters and constructing research that can support the broader science and technology needs associated with response to disasters, as well as response to traditional CBRN threats, are also priorities for the program.

V. Research Objectives

HSRP conducts research and delivers products to increase the capabilities of EPA to carry out its homeland security responsibilities. These responsibilities include assisting water utilities and communities prepare for and respond to disasters so that normal life can resume as soon as possible. To promote resilience pre-incident, the HSRP develops tools to support the design and operation of water systems and develops community decision making tools that aim to decrease their vulnerability and increase their adaptive capacity to the risks resulting from environmental disasters.

HSRP builds tools, technologies and data to support post-incident responses. Following a natural or man-made incident, HSRP research helps water utilities detect contamination, minimize exposure of the population through early detection and mitigation, determine extent of contamination, assessing risk, treat water (through removal or inactivation), and decontaminate infrastructure.

After a wide area contamination incident occurs, HSRP scientific products assist in determining the nature and extent of the problem, the assessment of risk, choosing the best cleanup approach, and managing the resulting contaminated wastes.

HSRP is filling critical gaps in the science and technology needed to accomplish each of these steps effectively. All of the program's research can therefore be divided into two objectives: develop methodologies, strategies, and tools to (1) support a systems approach to water security and resilience and (2) to support a systems approach to community resilience to disasters (including cleanup of contamination).

Because this program supports time-critical response to disasters, our results must be available in quickly assessable, usable, and concise formats for decision makers. This need yields the third

program objective which aims to deliver science syntheses in the hands of end users - EPA, water utilities, and communities – by locating this work on existing, widely used information databases and supporting this work with technical assistance to end users.

Each of the three research objectives and corresponding science challenges is listed in Table 1 along with their corresponding near and long term objectives. Fate and transport research supports many of these science challenges; therefore, it is not listed as a separate science challenge.

Table 1. Research objective areas, science challenges, near term objectives, and long term objectives for the Homeland Security Research Program.

HSRP Research Objective Area	Science Challenge	Near Term Objective	Long Term Objective
Systems approach to water security and resilience	Develop tools for utilities to be more resilient to disruptions.	Tools for water utilities to evaluate their security and operational resilience.	Tools for water utilities to improve their security and operational resilience.
	Develop technologies, methods, and strategies for detection, mitigation, and characterization of contamination in water systems.	Innovative sample strategy options and sampling methods and analytical protocols. Evaluations of detection and mitigation methods for water systems.	Optimized sampling strategy options and methods that improve laboratory capability and capacity. Effective methods for detection and mitigation for water systems.
	Data and tools to support risk assessment.	Evaluation of exposure models for water-related exposures.	Exposure assessment models incorporated into water security and resilience tools.
	Develop methodologies and strategies for water infrastructure decontamination and water treatment.	Assessments of methodologies and strategies for water infrastructure decontamination and water treatment.	Verified customizable approaches for decontamination and treatment suitable for incorporation into tools developed by OW/WSD to guide water utilities on how to respond to water contamination incidents.

Systems approach to community resilience to disasters (including cleanup of contamination of indoor/outdoor areas)	Indicators and tools for communities to be more resilient to disruptions.	Determination of the coupled human and natural system variables that affect community environmental resilience.	Tool to support community resilience to risks from environmental disasters.
	Methods and strategies for mitigation and characterization of contamination.	Innovative sample strategy options and sampling methods and analytical protocols. Evaluations of mitigation methods.	Optimized sampling strategy options and methods that improve laboratory capability and capacity. Effective methods for mitigation.
	Data and tools to support risk assessment.	Evaluation and modification of existing exposure assessment models for biological and chemical contaminants.	Models to support exposure assessment for biological and chemical. contaminants.
	Cleanup methodologies and strategies.	Assessments and development of effective cleanup methodologies and strategies (including waste management) for complex environments.	Informed decision support tools for wide area response and remediation (including waste management).
Technical support for partner preparedness, response, and remediation	Optimal approaches for placing program's research in a decision maker friendly format for use by EPA partners, water utilities, and community decision makers.	Incorporation of research results into widely used data bases and guidance documents (e.g., Office of Water's Water Contaminant Information Tool).	Use of HSRP water security and resilience and community resilience tools and data by EPA partners, water utilities, and communities.

VI. Anticipated Research Accomplishments

The HSRP will produce a number of research outputs from FY16 to FY19. The titles of the proposed outputs for this time period can be found in Appendix A. To give a better sense of the impacts of the research program, examples of anticipated research accomplishments are given below.

- *Tool to support community resilience to risks from environmental disasters* – It is important to understand the vulnerabilities of communities to environmental risks that disasters may pose, and their capacity to restore critical environmental and ecological services to function after these disasters. The HSRP will develop indicators that capture these vulnerabilities and modify existing supporting decision support tools to allow communities to utilize these indicators.
- *Field scale assessments of water system response tools, infrastructure decontamination methodologies, and treatment technologies* – Tools and methodologies, developed under the HSRP, must be assessed at the field scale to understand their applicability and to have a systems view of how these activities would tie together during an actual incident. The HSRP will examine their response tools (including water sensors), infrastructure decontamination methodologies and water treatment technologies at a facility with an above ground drinking water pipe system, a lagoon, a high rate groundwater pump, and storage tanks.
- *Tool to support exposure assessment after a biological contamination incident* – After a wide area biological agent contamination decision makers will require exposure assessments to determine whether areas require remediation and what engineering controls are required for responders to operate in the contaminated zone. This effort will specifically develop a probabilistic risk assessment tool for *B. anthracis* inhalation exposures.
- *Selected Analytical Methods 2017 and updated sample collection documents* – The Selected Analytical Methods document provides selected analytical methods for use by those laboratories tasked with performing confirmatory analyses of environmental samples in support of EPA response and remediation efforts following a homeland security incident. Innovative sampling methods and analysis protocols developed since the last update in 2012 will be included in this version. The sample collection procedures for radiological and chemical contamination will also be updated.
- *Tool to support a systems approach to clean up after a wide-area biological contamination incident* - For emergency planners and federal responders to scope out the waste and debris management issues resulting from a biological response and recovery effort, it is critical to understand not only the quantity, characteristics, and level of contamination of the waste but also the implications of response and cleanup approaches regarding waste generation. This tool will allow the user to examine how various cleanup strategies will impact waste generation.

VII. Program Design

VII.A. Existing Research Program Connection

The program was developed by considering EPA's homeland security responsibilities as interconnected systems of activities that help the nation prepare for or recover from a disaster building upon the previously developed program described under the 2012 to 2016 Strategic Research Action Plan (U.S. EPA 2012). This "systems" view helps the research program develop products that support systems-based problem solving including optimizing cleanup efficacy, minimizing cost and recovery time, while minimizing unintended consequences. The simple systems diagram for response and remediation after a CBRN incident is shown in Figure 3.

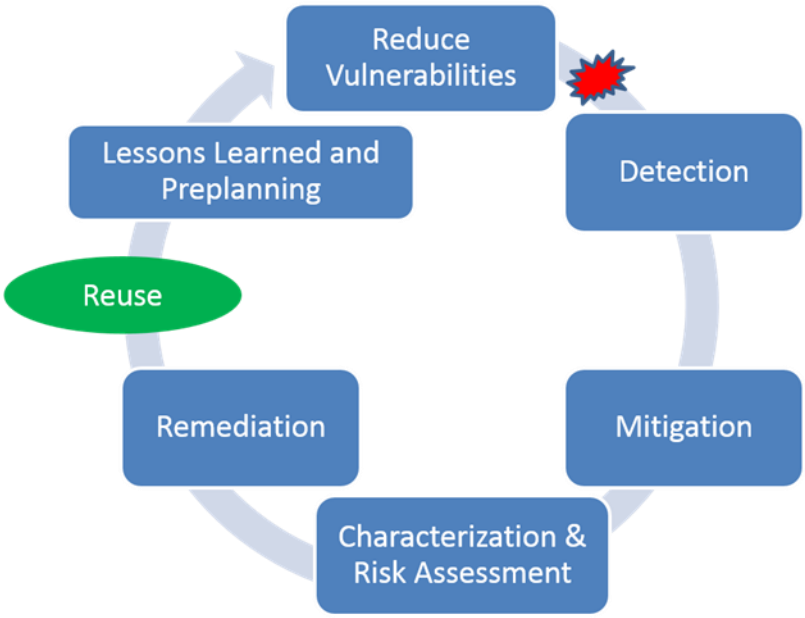

FIGURE 3. SYSTEMS DIAGRAM FOR RESPONSE AND REMEDIATION AFTER A CBRN INCIDENT.

HSRP initially focused much of its research on supporting Homeland Security Presidential Directive/HSPD-9 (The White House, 2004). This directive established a national policy to defend the agriculture and food system (including water systems) against terrorist attacks, major disasters, and other emergencies. For this reason, a significant portion of the program previously focused on development of contaminant warning systems. As the contaminant warning system program matures, the HSRP is moving its focus towards determining methods for response to contamination incidents and science to support development of resilient water systems.

Initial efforts related to community resilience to disasters including indoor/outdoor cleanup, were focused on remediation of buildings contaminated with traditional chemical, biological, and radiological (CBR) agents. Remediation and recovery exercises have highlighted that after a wide area contamination incident, numerous outdoor areas and semi-enclosed areas (e.g., subways) will also require remediation. The program is now examining clean up methodologies and strategies for these areas in addition to buildings. In addition, because the Agency is designated in the Food Safety Modernization Act (FSMA) as a support Agency to the United States Department of Agriculture for response to a food or agriculture emergency, the HSRP is developing methods for cleanup (including carcass disposal) after these incidents (FSMA 2011). In support of the Agency's new definition of homeland security, the program is also moving towards addressing the needs related to environmental disasters resulting in contamination beyond CBRN terrorist threats.

VII.B. Producing an Integrated Program

In association with this systems-approach, the HSRP is strongly driven by the science and technological needs expressed by our partners. Because the HSRP conducts research and develops scientific products that improve the capability of the Agency to carry out homeland security responsibilities, those that have primary responsibility within the Agency are the program's key partners (OW, OSWER, and the Regions). HSRP engages these partners as well as the other organizations that have a stake in homeland security activities (OAR, OCSPP, and water utilities).

The HSRP has created two processes to engage its partners: (1) the Program to Align Research and Technology with the Needs of Environmental Response (PARTNER) process for indoor and outdoor clean up research; and (2) a protocol to establish water resilience and security research. These efforts include our partners in each step of product development: research needs identification and prioritization, project implementation, and product formulation and delivery. Using this systems-approach and the high priority partner needs, research efforts and anticipated outputs are developed.

Because other federal agencies have missions to support response to environmental disasters, the HSRP collaborates extensively with these agencies (e.g., Department of Homeland Security, Department of Defense, Department of Health and Humans Services, Department of Energy, Department of Agriculture) to leverage their efforts in this area.

VII.C. Partner and Stakeholder Involvement

Because many of the other ORD programs conduct research that can support the Agency's HS responsibilities, the HSRP works closely with the other five programs on topics that support the needs of its partners. Figure 4 shows the research areas that the program leverages in the other five programs as well as its federal partners.

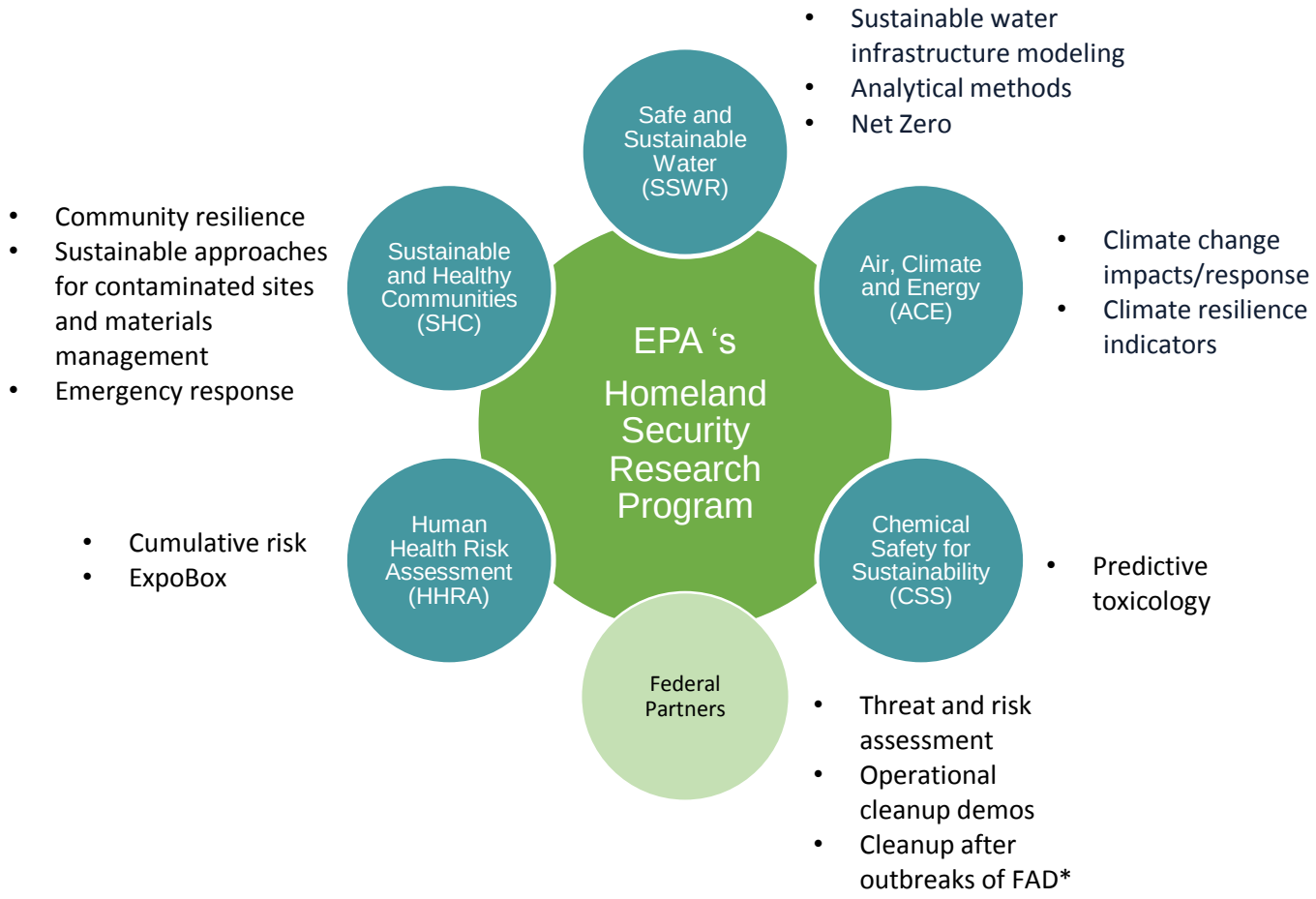

FIGURE 4. HSRP RESEARCH COLLABORATIONS. (*FAD= FOREIGN ANIMAL DISEASE)

VIII. Research Topics

The research program is organized into Research Topics. Below, each of the three Topics is described including its planned research areas, relationship to the science challenges, and relevant cross-ORD collaborations.

Topic 1: Systems Approach to Water System Security and Resilience

Resilience of water systems is key to rapid recovery following a terrorist attack, natural disaster, or other emergency. Research in this topic supports the objective to develop methodologies, strategies, and tools to support a systems approach to water security and resilience.

Innovative design and operation of water systems and technologies for resiliency

- Examine cyber security standards and best practices in the water industry as well as other sectors.

- Further develop real-time analytics to enable water utilities to use real-time field data to update control and management operations.
- Further develop quantitative metrics for security and resilience and incorporate them into a software tool that can be used to compare design and retrofit strategies for water systems.
- Collaborative effort with SSWR on sustainable water infrastructure modeling.
- *Challenge 1: Metrics and tools for utilities to be more resilient to disruptions.*

Fate and transport of contaminants and by-products in water and wastewater systems

- Develop suitable approaches, experimental data, and predictive models to address fate and transport technical challenges for a range of potential contaminants and infrastructure design features.
- *Supports all challenges (see Table 1)*

Evaluating potential exposure to contaminants and by-products

- Address knowledge gaps in the characterization of inhalation exposure pathways from water systems, develop quantitative microbial exposure assessment methodologies for biological threat agents and develop exposure advisory levels for chemical threat agents upon request.
- *Challenge 3: Data and tools to support risk assessment.*

Detection and mitigation methods and strategies

- Evaluate water security sensors and emerging detection technologies that can be coupled with existing automated systems within the water infrastructure.
- *Challenge 2: Technologies, methods, and strategies for detection and characterization of contamination in water systems.*

Development of sample collection methods, protocols and strategy options for known contaminants and development of analysis capabilities for contaminants

- Develop sampling strategy options, sampling methods, and analysis protocols to support characterization of contamination in water systems.
- Collaborate with SSWR on analytical methods for biological contaminants.
- *Challenge 3: Data and tools to support risk assessment and Challenge 4: Methodologies and strategies for water infrastructure decontamination and water treatment.*

Engineering, adaptation, and application considerations for decontamination methodologies

- Collect data on the persistence of priority contaminants on water infrastructure and develop effective decontamination procedures to remove persistent contamination.

- *Challenge 4: Methodologies and strategies for water infrastructure decontamination and water treatment*.

Treatment, disposal, minimization and handling of contaminated water and waste

- Focus on enhancing existing approaches for collecting, minimizing, treating, and disposing of large volumes of contaminated wash water as well as run off from precipitation events.
- Collaborate with SSWR on Net Zero (research on methods for communities to achieve Net Zero conditions). By definition this means "consuming only as much energy as produced, achieving a sustainable balance between water availability and demand, and eliminating solid waste sent to landfills"[4].
- *Challenge 4: Methodologies and strategies for water infrastructure decontamination and water treatment*.

Development and enhancement of decision-making tools and information to support a systems approach to response and remediation

- Develop and enhance computer-based decision-support tools that water utilities can use to quickly evaluate potential response and remediation options.
- *Supports all challenges.*

Systems analysis and demonstration of remediation approaches

- At the field scale, conduct a systems evaluation of contaminant detectors, water infrastructure decontamination methodologies, water treatment methodologies, and the tools that support decision making related to remediation.
- *Supports all challenges.*

Topic 2: Systems Approach to Resilience (Including Site Cleanup)

Communities that are more resilient are able to better absorb and recover from environmental disasters. Systems approaches to site cleanup result in a faster recovery after a contamination incident. Research under this topic develops methodologies, strategies, and tools to support a systems approach to community resilience to disasters (including cleanup of contamination).

Community Environmental Resilience

- Develop community resilience indicators and place these indicators into decision support tools for communities.
- This effort will leverage the urban climate change resilience indicators in the ACE program. It will also leverage SHC's efforts to understand community resilience and

[4] http://epa.gov/sustainability/netzero/

vulnerability to climate change and their sustainability indicators community outreach activities.

- *Challenge 1: Indicators and tools for communities to be more resilient to disruptions.*

Fate and transport of contaminants and by-products in indoor and outdoor environments

- Understand and predict selected CBRN agent behaviors to further enhance current response and remediation activities.
- *Support all challenges.*

Evaluating potential exposure to contaminants and by-products

- Address knowledge gaps in quantitative microbial exposure assessment methodologies for biological threat agents, develop exposure advisory levels for chemical threat agents upon request, and assess cumulative risk from environmental disasters
- Collaboration with HHRA on cumulative risk.
- *Challenge 3: Data and tools to support risk assessment.*

Mitigation methods and strategies

- Assess gross decontamination/mitigation technologies that are appropriate to wide area contamination incidents. This includes containment approaches to prevent spread of contamination beyond the original release points.
- *Challenge 4: Decontamination and waste management methodologies and strategies and tools to support cleanup decision making.*

Development of sample collection methods, protocols and strategy options and analysis capabilities for contaminants

- Develop sampling strategy options, sampling methods, and analysis protocols to support characterization of contamination of indoor and outdoor areas.
- *Challenge 3: Data and tools to support risk assessment.*

Development, identification and efficacy assessment of decontamination methodologies

- Identify decontamination technologies and methods that are effective and understand the impact of realistic conditions on their efficacy.
- *Challenge 4: Decontamination and waste management methodologies and strategies and tools to support cleanup decision making.*

Engineering, adaptation, and application considerations for decontamination methodologies

- Assess engineering solutions for application (including scale-up) of decontamination technologies.

- Identify and evaluate new decontamination methods that are widely available, user friendly, economical, and ideally have low human and environmental impact.
- *Challenge 4: Decontamination and waste management methodologies and strategies and tools to support cleanup decision making.*
- Collaboration with SHC on cleanup of contaminated sites.

Treatment, disposal, minimization and handling of contaminated water and waste

- Assess how contaminants are degraded in a variety of waste treatment processes, evaluate the effectiveness of commercially available and novel treatment methods, and address the minimization of solid waste and reduction of risk during solid waste treatment.
- *Challenge 4: Decontamination and waste management methodologies and strategies and tools to support cleanup decision making.*
- Collaboration with SHC on sustainable materials management.

Development and enhancement of decision-making tools and information to support a systems approach to response and remediation

- Develop and enhance computer-based decision-support tools that policy makers can use to quickly evaluate potential response and remediation options.
- *Supports all challenges.*

Systems analysis and demonstration of remediation approaches

- At the field scale, conduct a systems evaluation of cleanup including: characterization of contamination, decontamination, and waste management.
- *Supports all challenges.*

Topic 3: Technical support for customer preparedness, response, and remediation

Under this topic, the HSRP provides technical advice in a number of venues: HSRP supports end-users as they engage our products; experts within the program offer technical advice to EPA responders during incidents; and, program staff participate on intra- and inter-agency homeland security workgroups, often contributing to the development of guidance and research roadmaps. Program staff bring these experiences back to the program to improve the relevancy of the research. *This topic supports all of the science challenges.*

IX. Conclusion

[To be completed in Final Strategic Research Action Plan]

Appendix A. References

FSMA 2011 — 21 U.S.C. § 301. *U.S. Food and Drug Administration Food Safety and Modernization Act (FSMA)*. 2011.

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The White House 2004 — The White House, Executive Office of the President, *Defense of United States Agriculture and Food.* Washington DC; January, 2004.

The White House 2013 — The White House, Executive Office of the President, *Presidential Policy Directive-21, Critical Infrastructure Security and Resilience.* Washington DC; February, 2013.

Appendix B. Table of Proposed Outputs

Table of Proposed Outputs, Homeland Security Research Program FY16-19

Topic	Output	Challenge(s) Addressing
	FY17	
Systems Approach to Resilience (Including Site Cleanup)	Sampling procedures for CWA collection from environmental sample types during recovery and remediation	Methods and strategies for characterization of contamination.
	Selected Analytical Methods 2017	Methods and strategies for characterization of contamination.
	Update to *Sample Collection Document* for chemical and radiological agents	Methods and strategies for characterization of contamination.
	Efficacy of technologies for decontamination of outdoor areas contaminated with *B. anthracis*	Decontamination and waste management methodologies and strategies.
	Decontamination Decision Support Tool (DeconST) for facilities contaminated with chemical agents	Decontamination and waste management methodologies and strategies.
	Waste Estimation Support Tool (WEST) to address a wide-area biological response	Decontamination and waste management methodologies and strategies.

Topic	Output	Challenge(s) Addressing
FY16		
Systems Approach to Water System Security and Resilience	Real-time water system modeling open source software and documentation	Metrics and tools for utilities to be more resilient to disruptions.
	Technical brief on quantitative microbial risk assessment methodology for estimating inhalation exposure risks from water systems	Data and tools to support risk assessment.
	Summary of data provided to EPA Water Contaminant Information Tool (WCIT)	Technologies, methods, and strategies for detection and characterization of contamination in water systems. Data and tools to support risk assessment. Methodologies and strategies for water infrastructure decontamination and water treatment.
Systems Approach to Resilience (Including Site Cleanup)	Analytical protocol of wipe samples from surfaces for selected chemical contaminants	Methods and strategies for characterization of contamination.
	Analytical method for *B. anthracis* spores in soil	Methods and strategies for characterization of contamination.
	Building material collection procedure for radionuclides	Methods and strategies for characterization of contamination.
	Spreadsheet tool to estimate costs associated with wide-area response to contamination	Methods and strategies for characterization of contamination. Decontamination and waste management methodologies and strategies.

Topic	Output	Challenge(s) Addressing
	FY17	
Systems Approach to Water System Security and Resilience	Security and operational resilience evaluation software tool for water distribution systems	Metrics and tools for utilities to be more resilient to disruptions.
	Case studies for application of cyber security standards and best practices for water and wastewater	Metrics and tools for utilities to be more resilient to disruptions.
	Interactive tool for evaluating response tools methodologies based on real-time modeling of water systems	Metrics and tools for utilities to be more resilient to disruptions.
	Selected Analytical Methods 2017	Technologies, methods, and strategies for detection and characterization of contamination in water systems.
	Update to *Sample Collection Document* for chemical and radiological agents	Technologies, methods, and strategies for detection and characterization of contamination in water systems.
	Technical brief summarizing the contaminant removal performance of commercially available water treatment processes	Methodologies and strategies for water infrastructure decontamination and water treatment.
	Summary of data provided to WCIT	Technologies, methods, and strategies for detection and characterization of contamination in water systems. Data and tools to support risk assessment. Methodologies and strategies for water infrastructure decontamination and water treatment.

Topic	Output	Challenge(s) Addressing
	FY18	
Systems Approach to Water System Security and Resilience	Water Security Toolkit for use by utilities	Technologies, methods, and strategies for detection and characterization of contamination in water systems. Data and tools to support risk assessment. Methodologies and strategies for water infrastructure decontamination and water treatment.
	Summary of data provided to WCIT	Technologies, methods, and strategies for detection and characterization of contamination in water systems. Data and tools to support risk assessment. Methodologies and strategies for water infrastructure decontamination and water treatment.
Systems Approach to Resilience (Including Site Cleanup)	Tool to support resilience of communities to risks from disasters	Indicators and tools for communities to be more resilient to disruptions.
	Probabilistic risk assessment tool for *B. anthracis* inhalation exposures	Data and tools to support risk assessment.
	Summary exposure assessment for foot and mouth disease groundwater and soil contamination	Data and tools to support risk assessment.

Topic	Output	Challenge(s) Addressing
FY19		
Systems Approach to Water System Security and Resilience	Summary of lessons learned from systems evaluations of response to and return to service after a water system contamination incident	Metrics and tools for utilities to be more resilient to disruptions. Technologies, methods, and strategies for detection and characterization of contamination in water systems. Data and tools to support risk assessment. Methodologies and strategies for water infrastructure decontamination and water treatment.
	Summary of lessons learned from the study of the value of cyber standards to a water utility	Metrics and tools for utilities to be more resilient to disruptions.
Systems Approach to Resilience (Including Site Cleanup)	Summary of processes for determining fate and transport of chemical contaminants and effective decontamination approaches	Methodologies and strategies for water infrastructure decontamination and water treatment.
	Summary of recommended approaches for containment and mitigation of RDD and IND contamination	Decontamination and waste management methodologies and strategies.
	Tool to aid in the selection of carcass disposal technologies following a foreign animal disease incident	Decontamination and waste management methodologies and strategies.