Board of Scientific Counselors Meeting of the Homeland Security Subcommittee

February 14 – 16, 2017

Research Triangle Park Campus

U.S. EPA

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AGENDA

Board of Scientific Counselors
Homeland Security Subcommittee
Face-to-Face Meeting

February 14 – 16, 2017
Classroom A015
U.S. EPA RTP Campus

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8:15 – 8:25	Welcome	Paula Olsiewski Tammy Taylor
8:25 -9:15	Overview Presentation	Gregory Sayles Emily Snyder
9:15 – 9:45	Presentation: What are the fate of and transport mechanisms for biological agents in the urban *environment* to inform mitigation and cleanup decisions?	Paul Lemieux
9:45-10:00	Break and walk to demo site	
10:00-12:00	Demos: Small Wind Tunnel Water Wash-off Water Wash Off	Russell Wiener Anne Mikelonis
12:00 – 1:00	Lunch	
1:00 – 1:30	Presentation: What are effective and efficient tools, strategies and methods to characterize and assess exposure from biological contamination in the environment?	Sarah Taft
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8:00-8:30	Presentation: What are effective methods for decontamination after a wide area biological contamination incident for indoor and outdoor areas?	Shawn Ryan
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2:30 – 3:00	Presentation: How can decision support tools be best designed to support a systems approach to environmental response decision making after a wide area biological contamination incident?	Hiba Ernst
3:00 – 3:15	Public Comment	
3:15 – 5:30	Subcommittee work time	

Day Three – February 16

8:00 – 8:30	Presentation: Integration of Tools	Timothy Boe
8:30 – 9:00	Presentation: Transitioning Research	Gregory Sayles
9:00 – 9:30	Underground Transport Restoration video	Lukas Oudejans
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10:00 – 1:00	Subcommittee work time	

Board of Scientific Counselors Homeland Security Subcommittee

Face-to-Face Meeting

February 14 - 16, 2017, Research Triangle Park, NC

Charge to the Subcommittee

The BOSC Homeland Security Subcommittee was established to provide program-specific advice to EPA's Homeland Security Research Program (HSRP). The mission of the HSRP is to conduct research and deliver products that improve the capability of EPA to carry out its homeland security responsibilities. The Program conducts applied, relevant research and aims to deliver useful products to the end users of this work. HSRP plans to engage the Subcommittee over the next several years to provide advice on the Program's portfolio and to assess progress in addressing EPA's needs.

In 2015, at the first face-to-face meeting of the Subcommittee, EPA asked the Subcommittee to provide program-level advice to HSRP about how the program is organized to address its mission, how it engages its partners, and how to infuse more social science into the program. HSRP is actively following this advice.

Here, and at subsequent meetings, EPA seeks the Subcommittee's advice about components of the scientific program that is underway. Specifically, this 2017 engagement asks for Subcommittee advice on the portion of the program that addresses EPA's mission on **cleanup following a wide-area release of a biological agent**. For example, the cleanup following a wide-spread release of *B. anthracis* spores across the national mall in Washington, DC, or across downtown San Francisco. "Cleanup" encompasses all aspects of EPA's duties when responding to indoor or outdoor contamination incidents – site characterization, exposure assessment, decontamination, and waste management.

We would greatly appreciate your advice on HSRP's research aimed to improve **cleanup of a wide-area release of biological agents** by addressing the following charges:

1. **Are we doing the right research? In other words, how well does the HSRP's current research portfolio address high-priority Agency needs in this area? Taking resource limitations into consideration, should the HSRP increase or decrease the emphasis of certain areas of research?**

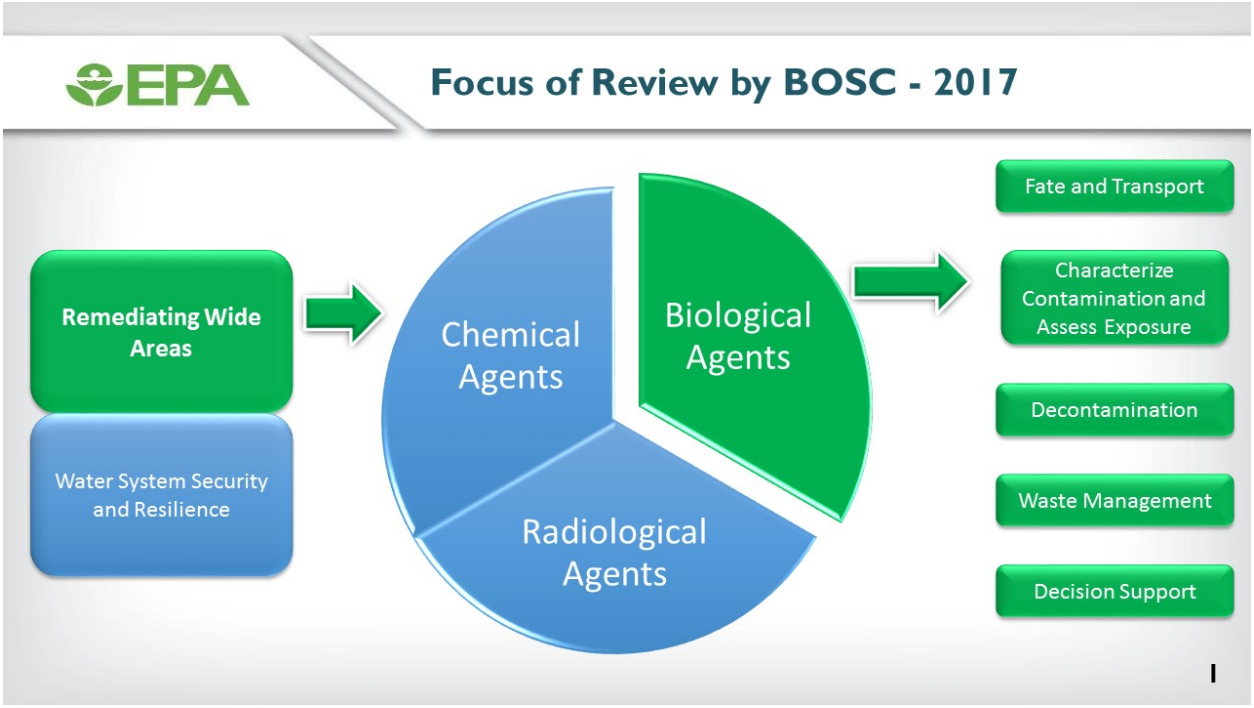
   Context: Given limited resources and the urgency of its mission, HSRP must conduct a research portfolio that is closely aligned with the high-priority needs of the Agency. The EPA end-users of the program's research work closely with the program to delineate these needs, help define the science questions that must be addressed, advise on the research as it is conducted, help design and deliver effective products. These high-priority needs are cross-walked with the science questions that are designed to address the needs. The research aimed at addressing these science questions is outlined in the science questions narratives. We seek advice from the Subcommittee on the resultant, current portfolio.

2. **Assess the current approaches that the HSRP uses to transition research to end-users. How might these approaches be improved?**

   Context: The HSRP is not fully successful unless its scientific products are transitioned effectively to the partners who will use them. However, this transition is an important challenge because it requires that products are formulated and delivered so that they meet end-users' needs and so the users can understand the utility and limitations of the products and are comfortable with and confident in using them. HSRP will present the current practices it uses for research transition and seeks the Subcommittee's assessment of these practices and advice on how to advance its transition capabilities.

3. **To what extent will the program's work provide multiple benefits to our nation by addressing critical needs beyond those directly related to terrorist attacks? In other words, will the research, while designed primarily to improve our partners' capabilities to respond to acts of terrorism, result in science that is useful in addressing other environmental problems?**

   Context: HSRP develops data and tools to help EPA address acts of terrorism while attempting to build in relevancy to multiple hazards. HSRP seeks the Subcommittee's assessment of the program's progress in this effort and advice on opportunities for how the program's work can be used for various purposes.



Crosswalk of Science Questions to Partner-Stated Needs

Science Questions	Partner-Stated Needs Driving the Questions[1]
What are the fate of and transport mechanisms for biological agents in the urban environment to inform mitigation and cleanup decisions?	• To understand fate and transport of spores in wide areas to inform sampling and analysis and remediation, including the impact of weathering on spore concentrations. • To understand fate and transport of spores through a waste water treatment (WWT) system and their impacts on plant operations (including bio-solids) and the impacts of washdown additives on the fate and transport. • Tools for predicting the fate and transport of biological contaminants in the wide area (including in water and wastewater infrastructure) to inform decontamination strategies and methods, and identify risk reduction strategies.
What are effective and efficient tools, strategies and methods to characterize and assess exposure from biological contamination in the environment?	• To understand how best to conduct and utilize results from air sampling, including analytical methods for various types of air filters (e.g., car filters). • To optimize deployment of composite-based sampling (e.g. street sweepers). • Best practices for determining biological agent data quality objectives, data interpretation, and data utilization/extrapolation of field-collected samples characterized by semi-quantitative laboratory methods (e.g. culture and PCR). • Appropriate sample methods and interpretation of results for exposure assessment.

[1] Needs are focused on *Bacillus anthracis* unless the term biological agent or a different biological agent is mentioned within the need statement.

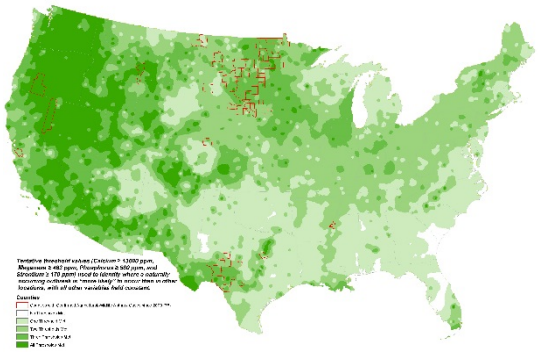
Science Questions	Partner-Stated Needs Driving the Questions[2]
What are effective methods for decontamination after a wide area biological contamination incident for indoor and outdoor areas?	• The effectiveness of various types of washdown in reducing spore concentrations on surfaces. • The efficacy of the common cleaning equipment used in decontamination activities as well as their potential contribution to Reaerosolization. • Research to support the development of self-help decontamination guides for the public (including non-governmental contractors) for home, pets, vehicles, and electronics. • New decontamination methods to improve capabilities and capacity. • Effective decontamination procedures for all vehicle types. • Methodologies for decontamination of critical infrastructure including how to decon rail cars and isolate a section of subway tunnel given air inflows and outflows.
What science is needed to inform waste management decisions during a wide area bio-contamination incident?	• Optimal methods for treatment and disposal of *B. anthracis*-contaminated biosolids from WWT plants. • To determine how to reduce the volume of waste produced during cleanup operations. • Efficient management of wastewater generated during washdown activities. • Collection, treatment, sampling, and disposal options for large volumes of biological agent contaminated water. • Best management practices for staging waste. • Tested technologies for onsite waste treatment.
How can decision support tools be best designed to support a systems approach to environmental response decision making after a wide area biological contamination incident?	• Anticipated partner need for systems-based, decision support tools to guide decision-makers during response

What are the fate of and transport mechanisms for biological agents in the urban environment to inform mitigation and cleanup decisions?

Overview: The body of research described here examines the fate and transport of chemical, biological, and radiological (CBR) contamination to support environmental response and cleanup following a wide-area biological attack. Understanding the fate and transport of contaminants is critical to risk reduction, sampling, and remediation activities. The research will help determine where to sample for biological contaminants, will help identify methods and strategies for remediation, and may facilitate risk assessment.

The remediation of the outdoor, urban environment presents greater and different challenges than remediation of the indoor environment. For example, contamination between buildings can impact remediation inside the buildings due to spread of contaminants through reaerosolization, tracking or other mechanisms, precipitation events, and the potential use of natural attenuation for remediation. Outdoor contamination can impact the ability to identify and construct staging areas for response personnel and waste management.

This body of research includes studies on the persistence of biological agents and the transport of *Bacillus anthracis* spores in the urban outdoor environment are studied. Methods for mitigating the spread of contamination are also assessed and new methods developed where needed. This will result in more effective response and remediation activities, which will improve the Environmental Protection Agency's (EPA's) capability to respond to a biological contamination incident.



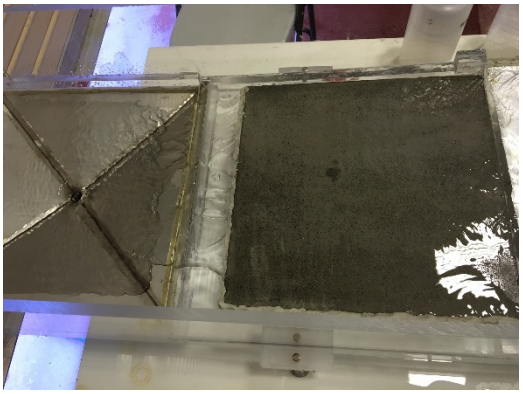
Map of likelihood of naturally-occurring anthrax outbreak based on soil composition indicators.

Research Components: EPA's Homeland Security Research Program (HSRP) supports the objective to "Promote Sustainable and Livable Communities and Restore Land," under Goal 3 of EPA's 2014-2018 Strategic Plan, by providing tools and information to help communities "prepare for and respond to accidental or intentional releases of contaminants and cleanup." Serving this objective, this research informs public health decisions and environmental response including sampling, mitigation and decontamination strategies.

The scope of this effort is wide-ranging, and includes literature-based studies, experimental work, and field studies. Literature reviews summarize the processes and parameters influencing spore transport in the environment and the most important of these mechanisms following a spore release. *B. anthracis* environmental persistence and transport methods are also summarized in useable formats based on literature reviews. For example, an interactive

map to help visualize data on natural *B. anthracis* levels in soil around the U.S. is being developed.

Planned experimental work includes evaluating persistence of priority bioagents under a range of weather conditions and on various surfaces, which helps determine whether natural attenuation is appropriate for cleanup. Additionally, the fate of *B. anthracis* in and around equipment and vehicles used during response and cleanup will be evaluated under various operating conditions. Vehicles used during response and cleanup operations are of particular concern due to their potential contribution to waste streams, because their mass is so great relative to other items that may require disposal.



Water flowing over concrete coupons during wash-off experiment.

Portions of the previously completed SPORE (Scientific Program on Reaerosolization and Exposure) program fell under this body of research. The SPORE program aimed to understand the degree to which *B. anthracis* spores reaerosolize from surfaces, ways to mitigate this reaerosolization and the potential exposures resulting from this reaerosolization. One particularly significant component of the SPORE program was a direct comparison between potential surrogates for *B. anthracis* and live *B. anthracis* spores to determine if non-pathogenic surrogates could be reliably used to simulate atmospheric fate and transport and reaerosolization of *B. anthracis*. The comparison was made by performing parallel experimental studies in-house at EPA facilities using candidate surrogate organisms and at the Army's laboratory at Dugway Proving Ground using live *B. anthracis* spores. The results from this study demonstrated the practicability of simulating atmospheric fate and transport, and reaerosolization, of *B. anthracis* by using certain non-pathogenic surrogate organisms.

This body of research focuses on the following aspects of wide-area biological cleanups:

1) How do spores reaerosolize and move about in the environment after the initial contamination incident?
2) How long do vegetative bacteria survive in the environment and what are the implications for natural attenuation as a cleanup approach?
3) How do we address background levels of a contaminant when setting cleanup goals for that same contaminant?

The results from these research efforts will be combined with the results from other HSRP areas (e.g., decontamination efficacy) to support the development of overall wide-area remediation strategies and to feed into the development of decision support tools to support site-specific decision making to minimize the public health, environmental, and economic impacts of cleaning up following a wide-area biological contamination incident.

Current Planned Outputs: The currently planned outputs from this effort will move forward from the work that was done in the past using previously identified methodologies and appropriate surrogate organisms to feed into the overall effort to address a wide-area biological contamination incident. These outputs include:

- Further studies on the transport of *B. anthracis* surrogate spores in the environment and the persistence of non-spore-forming microorganisms in the environment. Although spores persist in the environment, their propensity to reaerosolize can significantly change with time depending on environmental conditions. Non-spore forming organisms might die over time, enabling natural attenuation to be a potential remediation approach.
- Experimental and modeling studies of fate and transport of *B. anthracis* spores or surrogates due to precipitation and flooding events. A recent HSRP study observed that precipitation is the largest contributor to contaminant movement in an outdoor biological contamination incident involving spores. This will aid in the understanding of potential methods to capture or divert contaminated water to appropriate treatment processes as well as to understand how spores migrate into soil under flooding conditions.
- Application of geographic information system approaches to develop interactive maps of naturally-occurring microorganisms of interest as a function of environmental conditions and soil composition.
- Designs for exposure field studies that could be implemented immediately after the onset of a contamination incident. These studies will use existing measurement methods as well as potentially new innovative measurement methods. These studies propose to evaluate the sensitivity of exposure to both naturally occurring environmental conditions as well as the impact of human activity (e.g., vehicular traffic).
- Investigations into transport of *B. anthracis* surrogate spores due to subways or vehicular traffic, including normal operations as well as maintenance and response activities.

These studies will hopefully culminate in a multi-agency field study that examines the system-of-systems involved when a wide-area biological contamination incident occurs.

Demonstrations of Specific Research Efforts/Product Development:

Small Wind Tunnel: Reaerosolization, as a transport mechanism, is of particular concern after a wide area biological agent release. To address this concern, this small wind tunnel was constructed to examine particle reaerosolization from common outdoor urban surfaces. Previous studies, done in parallel with an identical chamber, showed that *B. thuringiensis* was a viable *B. anthracis* surrogate for reaerosolization studies and outdoor release studies. These findings allow this wind tunnel to provide data on reaerosolization as a function of variables like surface type and wind speed that can be extrapolated to *B. anthracis*.

Water Wash-Off Experiment: To address the finding that precipitation is the largest contributor to contamination movement following a biological contamination incident involving bacterial spores, this experimental apparatus was developed to investigate what impact precipitation events have on the movement of spores in an urban area. This experiment allows

for the study of outdoor transport due to water, as well as air, in order to assess the complex system-of-systems involved in a wide-area contamination incident.

Partners: The primary partners for the HSRP in this area include the EPA's Office of Land and Emergency Management and each of the Agency's Regional Offices across the country. The partners typically use these Outputs to develop training modules for EPA responders, to provide technical support on incoming requests, and to prioritize operational needs. Although this effort is primarily directed at a deliberate biological contamination incident, it is specifically designed to be generically applicable to accidental biological releases or naturally occurring contamination.

What are effective and efficient tools, strategies and methods to characterize and assess exposure following a biological contamination incident in the wide-area environment?

Overview: Following a wide-area release of a biological contaminant, the U.S. Environmental Protection Agency (EPA) has the lead role in site characterization and remediation of contaminated indoor and outdoor areas, with the overall objective of protecting human health and the environment. Decisions regarding remediation of a contaminated site are largely based on the results of site-characterization sampling to establish extent of contamination, and clearance sampling to evaluate the efficacy of the cleanup. The rapid and efficient recovery of contaminated areas will be greatly stymied by lack of consensus on sample collection strategies, on how to address uncertainties and variability in the field data, and on how to estimate potential human exposures from sampling results.

The Homeland Security Research Program (HSRP) is developing tools, strategies, and methods to support the three general steps in characterizing environmental contamination and assessing exposure as depicted in Figure 1. The first step in the process is to determine the spatial distribution of contaminant concentrations in the relevant environmental matrices (e.g., water, air, soil) through sampling and analysis. Although advances have been made in environmental sampling strategies, sample collection, and sample analysis, major gaps remain in all of these areas especially as they apply to wide-area biological releases. The accepted surface sampling methods are not practical for wide-area response because they are time consuming, labor intensive, and require a large number of samples due to their small and discrete sample areas. Development of sampling methods and strategies that significantly reduce the cost and time associated with site-characterization and clearance sampling are needed to effectively respond to a wide-area incident.

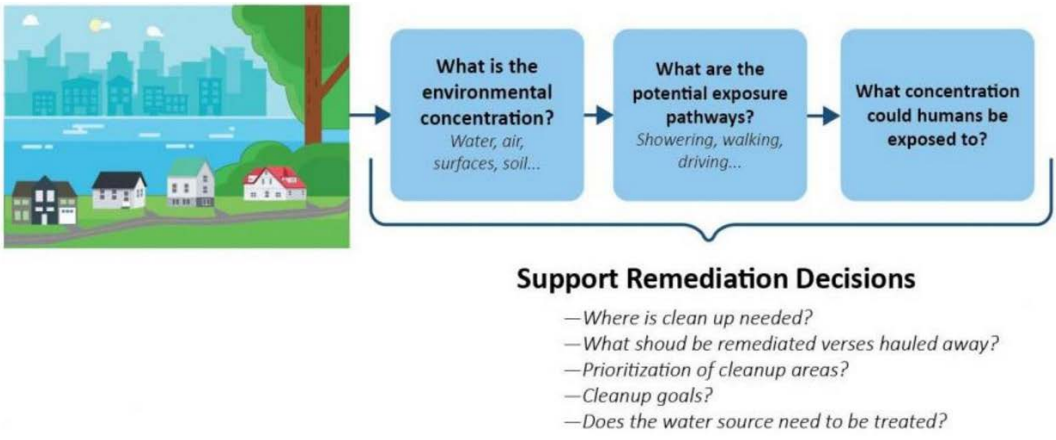


Figure 1. Characterizing contamination and assessing exposure.

After environmental data are interpreted, the next steps in the process are to determine the potential exposure pathways that are relevant for human exposures and the environmental concentration that humans could be exposed to through these pathways (Figure 1). There are significant challenges in these steps as there are no standard protocols or methodologies for the use of microbial exposure assessment to inform response decisions during a wide-are biological incident. Substantial research is needed to understand how data collected in the field can be used to estimate exposure following a release and can be utilized for remediation decisions (e.g., prioritization of areas for cleanup, informing cleanup goals).

Research Components: The HSRP research to address the site characterization gaps described above is focused on development and/or refinement of sample strategies, innovative sample collection techniques, understanding how to use and manage field data, and understanding potential exposure pathways. The goal of this research is to develop, synthesize, and compile methodologies into user-friendly and readily-available tools for the EPA response community and homeland security partners.

The site characterization research program reviews the strengths and weaknesses of traditional sampling strategies to assess how these strategies have been used to estimate exposure, to mitigate exposure risks, and to develop innovative sampling strategy options. Composite surface sampling approaches, a main research focus of this research, have demonstrated the potential to achieve effective sampling coverage while reducing the sampling and laboratory resources required, compared to the currently-accepted sampling methods. Additionally, this research assesses the utility of air sampling methods to characterize airborne biological contaminants after a wide-area outdoor release.

Figure 2. Surface sample collection of biological agent.

Working with internal EPA response partners and other federal agencies, sample collection research is being conducted to refine historical methods, or develop new and innovative approaches to tackle the sampling and analysis of complex environmental matrices such as underground transit systems as is shown in Figure 2. Recovering viable biological agents from the environment is challenging because the stability of biological agents varies greatly, especially under the stresses of sampling collection, transport, and processing prior to sample analysis. The ideal sample collection technique would be quick and easy for the sample collector and provide the sample in a stabilizing media for quick and easy extraction during laboratory analysis. This research is working to develop field-deployable protocols using novel and pioneering techniques. Sample collection methods being evaluated include pathogen concentration techniques, commercially available robotic cleaners, wet vacuum-sampling devices, native air filters (e.g., heating, ventilation, and air conditioning filters), and activity-based air sampling.

Data management during response to a wide-area contamination incident is crucial. The usability of biological data needs to be thoroughly planned and appropriate data quality objectives defined. Research is being conducted to develop a user-friendly tool that facilitates the creation of a biological environmental sampling plan allowing for a standardized approach for assessing the usability of biological field sampling data.

Exposure assessment is a valuable tool that estimates the likelihood of potential interactions between the contaminant, the environment, and the individual based on the exposure magnitude, frequency, and pathways. Methods to assess exposure pathways and exposure models for biological contaminants are critical to support risk-based, site-specific decisions during response to contamination incidents. Research is being conducted that develops or modifies existing exposure assessment chemical modeling tools to support development of these strategies for biological releases.

Planned Products/Outputs: Research products and outputs (products or synthesis of products intended for direct use by HSRP partners) focus on summarizing the development of site characterization capabilities for a wide-area biological release. Some of the anticipated products and outputs include:

- Sampling procedure using commercially available robotic cleaners for *Bacillus anthracis* spores
- Development of a wet-vacuum anthrax sampling device
- Microbial data usability tool for field sample collection planning incorporating lab analytical data interpretation
- Review of biological agent sampling methods and application to a wide-area incident scenario to characterize time and resource demands
- Biological agent composite sample collection approaches and strategies summary
- Synthesis of research to inform air sampling strategy for wide-area anthrax incident
- Sample collection information document for pathogens and biotoxins
- Evaluation of outdoor human activity forces for reaerosolization of *Bacillus anthracis* spores
- Assessment of existing exposure assessment methodology for microbial data; connecting exposure assessment to sampling data

Demonstrations of Specific Research Efforts/Product Development

- ***Composite Sampling:*** The demonstration will include hands-on trials of the currently-used surface sampling methods and also emerging composite sampling methods that HSRP has recently developed. The participants will be briefed on the results of a recent resource analysis for sampling following a wide-area bio incident. Technical videos that demonstrate laboratory and field scale evaluations of sampling methods will also be shown.

- ***MicroSAP Tool:*** This tool is being developed to provide environmental samplers with a user friendly and fast way to develop biological sampling and analysis plans while incorporating data quality objectives, a step that is often overlooked. This demonstration will provide a walkthrough of each of the steps in developing the plans. The demonstration will also take a look at the examples, helpful tool features, privacy, and workflow options built into the tool to make it user friendly.
- ***SHEDS Modeling for Biologicals:*** The Stochastic Human Exposure and Dose Simulation (SHEDS) model is currently being assessed for application to biological agents such as *Bacillus anthracis* following an outdoor release within an urban area. The model estimates population distributions of exposure and dose using US Census demographic data to generate the population to be simulated, and human activity pattern data are randomly assigned to each simulated individual to account for the way people interact with their environment. This demonstration will show how a user can select input data files, specify model run parameters, and analyze the output using modeled concentrations from a hypothetical outdoor release of a biological agent.

Partners: Planning and responding with sampling and analysis methods for biological agents is a multi-agency effort. There is much coordination internally with EPA Regional On-scene Coordinators, Removal Managers and Regional Risk Assessors along with the Office of Land and Emergency Management, specifically the Office of Emergency Management's Consequence Management Advisory Division (CMAD) for all site-characterization related sampling research.

What are effective methods for decontamination after a wide-area biological contamination incident for indoor and outdoor areas?

Overview: An area-wide release of a persistent biological agent, such as *Bacillus anthracis* spores, is anticipated to present significant decontamination challenges. Numerous private and public facilities (including residences), critical infrastructure (e.g., utilities, hospitals, airports), semi-enclosed environments (e.g., subways, arenas), vehicles, and outdoor areas (including roadways, sidewalks, outsides of buildings, vegetation, and soil) could become contaminated and could require some level of decontamination. Since the Amerithrax incidents in 2001, considerable progress has been made to develop our capabilities for facility decontamination. Numerous decontamination methods have been further developed or refined under the HSRP including improved understanding of the benefits, consequences, resource requirements and limitations of each method. A wide-area incident may contaminate many buildings and critical infrastructure; however, the capacity to deploy the most effective remediation methods at this large scale does not exist. Additionally, some of the most effective decontamination methods will damage sensitive equipment and some materials. Effective, widely and rapidly available decontamination methods are needed to be able to address numerous types of facilities and particularly for potentially contaminated areas outside of the immediate hot zone (areas directly contaminated by the initial release). Effective decontamination methods that are compatible with sensitive equipment and high value materials integral to critical infrastructure and other facilities (e.g., historical sites, museums), need to be identified or developed. Methods for urban areas (e.g., roadways, outsides of buildings), vegetation, and soil also remain a critical capability gap, both in terms of having effective laboratory proven methods and the ability to apply such methods over wide areas.

Research Components: EPA's Homeland Security Research Program (HSRP) supports the objective to "Promote Sustainable and Livable Communities and Restore Land," under Goal 3 of EPA's 2014-2018 Strategic Plan, by providing tools and information to help communities "prepare for and respond to accidental or intentional releases of contaminants and cleanup." HSRP research supports this goal by assessing the effectiveness of decontamination methods, the impact of effective methods on equipment and materials, and enhancing the capability of deploying or

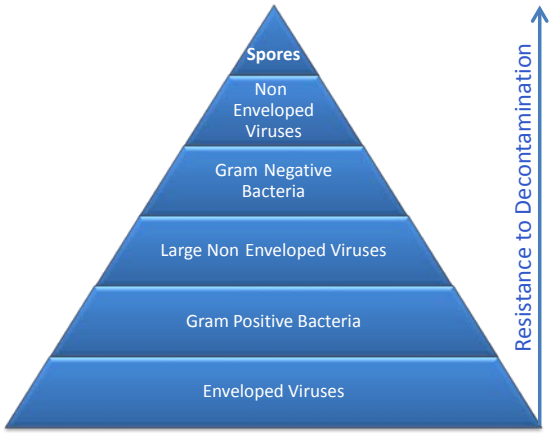


Figure 1: Generalized depiction of order of resistance to decontamination (after McDonnell and Russell (1999), *Clinical Microbiology Review* 12(1): 147-179.

utilizing the method in the field. Effectiveness is generally measured as the ability to reduce the biological contamination as a function of the biological organism, contaminated material types, and decontaminant application conditions. For laboratory testing, a six-log reduction in viable bacterial spores is the standard used to demonstrate sporicidal properties of a decontaminant (and hence, effective against bacterial spores). For viruses, a four-log reduction is the standard used to demonstrate virucidal properties of a decontaminant. Research is primarily focused on *B. anthracis* spores; bacterial spores represent one of the greatest challenges for physical or chemical inactivation. Resistance to inactivation, as a function of organism type, can be represented by the pyramid shown in Figure 1 with the most challenging organisms to inactivate at the top. Some research is devoted to other biological organisms of concern in order to provide effective methods that are more widely available, less costly, more easily applied, or have less negative consequences than methods that can be required for use against *B. anthracis* spores.

Biological agent research includes work with suitable surrogates to enable scale up of experimental design (e.g., number of tests) or set-up (e.g., release in a room size chamber). A surrogate is a non-pathogenic organism with similar characteristics to, or non-pathogenic strain of, the target organism. In general, testing with a surrogate organism is less expensive and safer to conduct. Comparative studies are still conducted to verify the findings against the actual virulent organism.

Figure 2: Example scale of research studies.

The materials onto which the biological organisms are deposited or inoculated have a significant impact on decontamination efficacy, perhaps a greater impact than the microorganism's own resistance to the decontaminant. Porous materials, or those with high organic constituent, are generally more difficult to decontaminate; hence these materials have been the focus of the research for outdoor areas. Application conditions, such as decontaminant concentration, delivery method (such as fog or spray), dwell or contact time with the material, temperature, relative humidity, and application amount can highly impact efficacy. The efforts are designed at a scale to provide the information required for supporting their effective field use. For example, unproven decontaminants can initially be tested at the bench top on small pieces of materials (coupons) that are dosed with a known amount of the target organism. Once effective conditions are determined for specific materials, scaled-up testing can be done to look at application conditions or methods. The impact of the use of decontaminants or application methods can then also be assessed, via determination of the impact on equipment and materials. Figure 2 depicts the generalized concept of the order and scale of our testing, with research at each scale dependent upon or influencing each other.

Planned Products/Outputs: HSRP has published a number of EPA reports and NHSRC staff authored peer-reviewed papers on the efficacy of numerous decontamination methods against *B. anthracis* spores and other biological organisms on indoor and outdoor material types. Technical summaries of much of this work have been published for indoor-type materials, representing the main area of capability enhancement since the Amerithrax incidents. Based upon the body of work at the laboratory scale, the Bioresponse Operational Technology Demonstration (BOTE) project was conducted to demonstrate and assess the developed capabilities at the facility scale. More recently, the EPA participated in the DHS led Underground Transport Restoration (UTR) program, completing laboratory studies to assess effective decontamination methods for subway environments and operationally testing such methods in the field at a mock subway station and tunnel. The planned HSRP research will continue to build upon the foundation established through the BOTE project and the UTR program. Products and outputs (products or synthesis of products intended for direct use by HSRP partners) will focus on summarizing the development of capabilities for a wide-area biological incident. Some of the anticipated outputs include:

- Assessment of self-help decontamination methods and their potential uses and precautions for wide-area anthrax contamination incidents
- Summary of low-tech, readily available bio-decontamination methods suitable for large indoor areas
- Impact of decontamination methods on sensitive equipment, materials, and high value or historic items
- Effectiveness of decontamination options for critical infrastructure and outdoor environments contaminated with biological agents.

Demonstrations of Specific Research Efforts/Product Development:

- ***Underground Transport Restoration Video***: This video will demonstrate how laboratory testing was completed to inform an operational technology demonstration, incorporating the testing of lab-developed or enhanced methods for sampling, decontamination and waste management. The effort represents a mechanism of translating laboratory research to operational capability that is used by the HSRP.
- ***Application of a street sweeper for decontamination of urban surfaces***: Decontamination testing at the bench scale and larger chamber studies can be used to assess how well a decontaminant could perform when applied to a material type (e.g., asphalt or concrete). The actual application method such as using a backpack sprayer or other decontaminant dispensing methods, can impact the overall effectiveness. This research effort demonstrates one method of deploying decontaminants that might be applicable to urban surfaces and reduce the amount of runoff (that can lead to spread of contamination or subsequent wastewater management issues).
- ***Assessment of fogging with sporicidal decontaminants***: This effort utilizes the NHSRC's room size decontamination chamber (COMMANDER) to assess the

effectiveness of delivering a sporicidal decontaminant in the form of a fog. Such dissemination methods can be performed with readily available equipment and materials and offer benefits over spraying or other fumigation methods that required specialized equipment and training.

- ***Impact of sporicides on sensitive equipment***: This effort assesses the impact of effective decontamination methods on equipment and materials. Together with efficacy results, this information is used to contribute information on capabilities and for guidance on the decontamination of critical infrastructure including equipment, high value items, and difficult-to-replace materials.

Partners: The partners for the research products and outputs under this science question are the EPA Regional On-scene Coordinators and Removal Managers and the Office of Land and Emergency Management, specifically the Office of Emergency Management's Consequence Management Advisory Division (CMAD). Additional stakeholders include the EPA's Office of Chemical Safety and Pollution Prevention (specifically the Office of Pesticide Programs), state and local governments, and private and public facility owners. To address this science question, NHSRC researchers seek the involvement of these EPA partners for their input in steering the products and for ultimate transition of the research products and information (cf. Figure 3). Transfer of the products generally means that the research findings influence the guidance or capability assessment developed by the EPA program offices.

Figure 3: Depiction of the interconnection of HSRP research planning, implementation, and delivery or transition of research products.

Systems-based Efforts: The research under these efforts informs and feeds into research efforts on sampling and analysis, waste management, and the development of decision support tools. NHSRC and CMAD are working together to initiate an area-wide testing and demonstration project that would aid in transferring the laboratory research to wide-area field testing. Akin to the BOTE and the UTR projects, this effort would involve a significant number of federal, state and local stakeholders to demonstrate and assess remediation capabilities over a wide area. Decontamination would be incorporated within the response framework that also includes application of biological agent fate and transport information, sampling and analysis, and waste management. EPA is currently seeking additional federal collaborators to conduct this large scale effort.

What science is needed to inform waste management decisions during a wide-area bio-contamination incident?

Overview: An area-wide release of a persistent biological agent, such as *Bacillus anthracis* spores, is anticipated to present significant remediation challenges. Widespread contamination will stress current capabilities for sampling, decontamination, and waste management. From past experiences, challenges associated with the waste management effort may drive the timeline for remediation. Developing waste management strategies that are not an hindrance to completing remediation and reoccupancy activities will help to assure a rapid return of the affected area to normal operations.

All activities have the potential to generate waste. For example, sampling generates solid and liquid waste such as disposable personal protective equipment (PPE) and the wash water used to decontaminate PPE. Further, decontamination method decisions impact the amount and types of materials that will be generated as waste. For outdoor surfaces, selecting water wash down as a decontamination method may generate large volumes of contaminated water. When decontaminating indoor areas, some materials might be able to be treated *in situ* as part of the facility decontamination process before being removed as conventional solid waste for disposal. Other materials might need to be removed prior to decontamination and either treated on-site with alternative waste treatment methods or off-site prior to ultimate disposal. These waste management decisions are influenced by the extent of the incident, the types of materials contaminated, the contaminant properties, the site decontamination decisions, and the availability of waste handling options. Waste handling options include determining areas and methods for temporary storage and staging, treatment methods for waste volume reduction, and ultimate disposal methods.

Research Components: EPA's Homeland Security Research Program (HSRP) supports the objective to "Promote Sustainable and Livable Communities and Restore Land," under Goal 3 of EPA's 2014-2018 Strategic Plan, by providing tools and information to help communities "prepare for and respond to accidental or intentional releases of contaminants and cleanup." Serving this goal, HSRP is focused on providing scientific information and solutions to inform waste management decisions. This research involves assessing the effectiveness of treatment methods for materials contaminated with biological agents and understanding waste disposal options. Assessing treatment options involves: (1) determining the effectiveness of decontamination methods for complex materials and the impact of such materials on the entire decontamination process, (2) developing and assessing methods that can be used on-site to treat waste, and (3) assessing the effectiveness of methods that can be used off-site. With

regards to (1), certain materials may make it difficult or impossible to conduct an effective decontamination in an area if left in place. Understanding which materials might be problematic for decontamination methods informs decision-makers whether that method is suitable for a site and what can be done to ensure optimal effectiveness, such as removing certain materials prior to decontamination.

Figure 1: 96 Ton/Day Medical Waste Autoclave.

Bacterial spores represent one of the greatest challenges for physical or chemical inactivation during waste treatment; however, some research is devoted to other biological organisms of concern to provide effective methods that are more widely available, less costly, more easily applied, or have less negative consequences than methods required for use against highly resilient *B. anthracis* spores. Figure 1 shows an example of an autoclave treatment method evaluated for *B. anthracis* spores.

Planned Products/Outputs: There have been a significant number of EPA published reports and NHSRC staff authored peer-reviewed papers reporting on factors supporting waste management decisions. The information in these reports informs decision support tools such as EPA's Waste Estimation Support Tool (WEST) and EPA's Incident Waste Assessment and Tonnage Estimator (I-WASTE). This information includes the effectiveness of off-site treatment methods (e.g., incineration, gasification, autoclaving), onsite treatment methods (e.g., spraying with bleach), and the environmental impacts of disposal decisions (e.g., persistence of organisms in landfill leachate). Further, waste and cost estimates from the multi-agency Bioresponse Operational Technology Demonstration (BOTE) project and from the DHS-led and multi-agency Underground Transport Restoration (UTR) program have been published.

The planned HSRP research will continue to build upon the foundation established through the BOTE project and the UTR program, by improving capabilities for reducing waste during decontamination operations, treating waste on-site, and assessing waste treatment and disposal options. An example of waste being collected at the UTR Operational Technology Demonstration is shown in Figure 2. Products and outputs (products or synthesis of products intended for direct use by HSRP partners) generated by this line of research will focus on summarizing the development of capabilities for a wide-area

Figure 2. Collection of waste at Underground Transportation Restoration Operational Technology Demonstration.

biological incident. Some of the anticipated outputs include:

- Information on the persistence of biological agents in landfill leachate and development of *in situ* method for *B. anthracis* remediation in a landfill
- Summary of integrated waste management approaches, including on-site waste treatment and staging
- Methods for containment and treatment of bio contaminated wash down water
- Development of an all-hazards tool for estimating the resource demand associated with transporting large volumes of waste

Demonstrations of Specific Research Efforts/Product Development: The following demonstrations will be provided as examples of the research efforts and methodology used to address this science question:

- ***Underground Transport Restoration Video***: This video will demonstrate how laboratory testing was completed to inform an operational technology demonstration, incorporating the testing of lab-developed or enhanced methods for sampling, decontamination and waste management. The effort represents a mechanism used by the HSRP for translating laboratory research to operational capability.
- ***Development of on-site waste treatment methods***: Waste treatment by dunking waste into bleach solutions is being assessed to determine the types of materials that can be treated and the contact time needed for effective inactivation of the contaminant. This research effort demonstrates one method of on-site treatment that is being investigated and was operationally assessed during the UTR operation technology demonstration.

Partners: The partners for the research products and outputs under this science question are the EPA Regional On-scene Coordinators and Removal Managers and the Office of Land and Emergency Management, specifically the Office of Emergency Management's Consequence Management Advisory Division (CMAD) and Office of Resource Conservation and Recovery (ORCR). Additional stakeholders include state and local governments, and private and public facility owners. To address this science question, NHSRC researchers seek the involvement of these EPA partners for their input in steering the products and for ultimate transition of the research products and information (Figure 3). Transition of the products generally means that the research findings influence the guidance or capability assessment developed by the EPA program offices.

Figure 3: Depiction of the interconnection of HSRP research planning, implementation, and delivery or transition of research products.

Systems-Based Efforts: The research under this effort informs and feeds into efforts conducted to understand sampling and analysis, decontamination, and the development of decision support tools. NHSRC and CMAD are working together to initiate an area-wide testing and demonstration project that would aid in transferring the laboratory research to wide-area field testing. Akin to the BOTE and the UTR projects, this effort would involve a significant number of federal, state and local stakeholders to demonstrate and assess remediation capabilities over a wide area. This effort would incorporate waste management within the response framework that also includes the application of developments in the understanding of biological agent fate and transport, sampling and analysis, and decontamination. EPA is currently seeking additional federal collaborators to conduct this large-scale effort.

How can decision support tools be best designed to support a systems approach to environmental response decision making following a wide-area biological contamination incident?

Overview:
Responding to a wide-area contamination incident, or the aftermath of a natural disaster, requires rapid decision-making to identify an effective approach to mitigate potential public health, environmental, and economic consequences. The Environmental Protection Agency's Homeland Security Research Program (HSRP) is developing and enhancing computer-based decision-support tools, for use by policy and decision makers, to quickly evaluate options and consequences for response and remediation decisions.

The response to an environmental disaster is often composed of a complex, interdependent "system" of processes that can include 1) hazard characterization, 2) sampling strategies and approaches, 3) exposure assessment, 4) hazard mitigation, including assessment of decontamination options and 5) identification of waste management approaches. Effective decision-making during responses must be informed by an understanding of each process and their interdependence. This complexity can be taken into account by decision makers by using systems-based tools built on a systems approach to response. For example, decision-support tools can account for the time and cost tradeoffs between interconnected decontamination, waste management, and sampling activities.

The tools described herein can be used in preparedness activities (e.g., planning, exercises) and post-incident activities (e.g., response, recovery). Note that the tools developed here are *decision-support* tools, intended to provide, and possibly prioritize, options for the user, rather than expert systems that tell the user what to do.

Research Components:

Under EPA's 2014-2015 Strategic Plan, HSRP's research supports the Goal 3 objective to "Promote Sustainable and Livable Communities and Restore Land" by providing tools and information to help communities "prepare for and respond to accidental or intentional releases of contaminants and clean up and restore polluted sites for reuse." Making decisions regarding response to, and remediation of wide area biological contamination incidents and natural disaster is difficult due to the complexity of the situation. Under this effort, HSRP is developing and enhancing computer-based decision-support tools for contamination incidents, which can be used to quickly evaluate the efficacy and impacts of potential response and remediation options on a range of scale (i.e., local and wide area incidents). These tools are developed with the intention that they would be used along with other tools developed both inside and outside the EPA. Additionally, HSRP's tools are continuously evaluated for their ability to assess resilience to all environmental disasters not just traditional biological threat agents like *Bacillus anthracis*.

Three key efforts provided significant motivation, as well as operational data, for development of these decision-support tools: 1) the multi-agency Bio-Response Operational Technology Evaluation (BOTE) study performed in 2011 at Idaho National Laboratories; 2) the development of the Bio-Response Guide, an EPA-led collaboration between the EPA and New York City's Department of Mental Health and Hygiene; and 3) the Department of Homeland Security's

Underground Transportation Restoration project. BOTE was a multi-agency field demonstration and exercise for remediation of a single facility contaminated with *B. anthracis*. The demonstration conducted sampling, decontamination, waste management for three different decontamination technologies. Resource requirements, in addition to technology efficacy, were determined. The Bio-Response Guide effort developed initial planning documents and strategies for remediating a densely populated urban area, consisting of hi-rise buildings, after a wide-area biological contamination incident. The Underground Transportation Restoration Project is a DHS-led effort intended to facilitate rapid return to service of subway systems following a biological contamination incident. These field-scale cross-agency collaborations provided important operational perspectives which made HSRP products more relevant and effective for the responders and end-users.

Past tool development efforts for wide-area remediation is informing the ongoing development of decision-support tools. Figure 1 is a screen shot demonstrating the use of color coding for decontamination options (green = more desirable; yellow = less desirable; red = not recommended) in the Decontamination Selection Tool (DeconST). Another tool that was developed is the I-WASTE tool (see Figure 2 home screen shot) to aid in management of incident-generated waste. These tools continue to be updated as needed and also help inform the current development efforts.

RESULTS SUMMARY (least desirable)

Note: The numbers shown are for comparison purposes only. The values should be considered order-of-magnitude estimates, rather than accurate predictions due to multiple uncertainties. *Note: Rounding of numbers can cause totals to not equal the sum of the component parts.*	Volumetric Decontamination: HVAC is decontaminated as part of volumetric decontamination		
	Chlorine Dioxide Gas 3000 ppmv, 3 hrs, >70% RH, >75 deg F	**Methyl Bromide** 211 mg/l, 37 degees C, 75% RH, 18 hour contact time	**Vaporous Hydrogen Peroxide®** 225 ppmv, 4 hrs
% of Exterior Structural Materials Decontaminated	**100%**	**100%**	**10%**
% decontaminated and reusable	90%	100%	10%
% decontaminated and destroyed (treated waste)	10%	0%	0%
% of Interior Materials Decontaminated	**90%**	**90%**	**10%**
% decontaminated and reusable	80%	90%	10%
% decontaminated and destroyed (treated waste)	10%	0%	0%
% of Contents Decontaminated	**60%**	**60%**	**60%**
% decontaminated and reusable	40%	60%	50%

Figure 1. Screenshot from DeconST displaying color-coded decontamination options.

Current Planned Outputs

Planned decision-support tools include improvements to already-developed and tested tools and the application of data collected from the above-mentioned operational demonstrations to validate the tools. Additionally, this body of research supports response and remediation activities by: 1) evaluating already developed technologies, such as virtual reality, to augment situational awareness for responders; 2) building databases to house decontamination efficacy results to rapidly inform decontamination decisions; and 3) by building tools to support specific activities such as carcass disposal. Tool development may be done through collaboration with other agencies. The following tools are under adaptation to other threat agents or are under development:

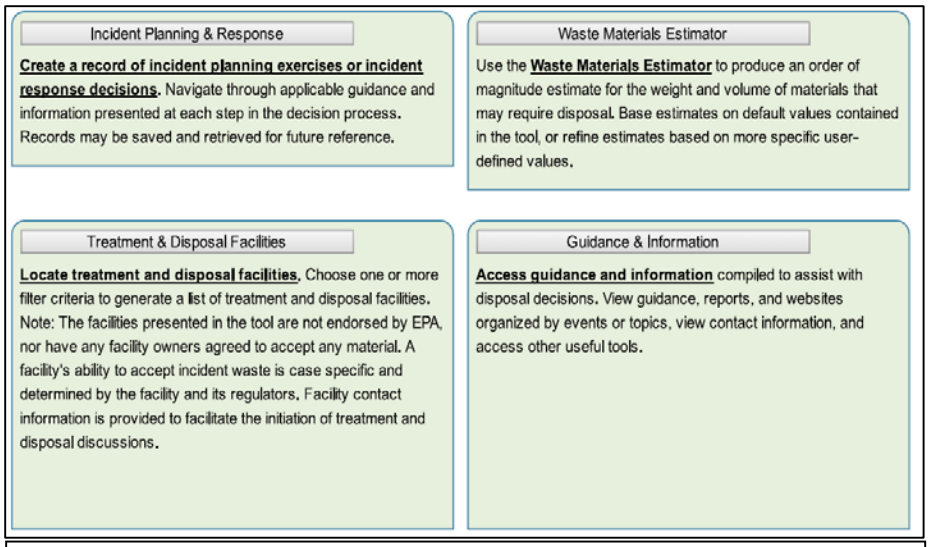


Figure 2: I-WASTE home screen.

- ***EPA's Waste Estimation Support Tool (WEST)*** is being developed to address wide-area biological response. WEST uses Geographic Information System (GIS) techniques to look strategically at the tradeoffs between various remediation strategies in a wide-area incident. WEST was previously developed to support wide-area decision-making for a radiological incident. It was used previously in the LibertyRadEx National Level Exercise (exercising environmental response to a radiological dispersal device) and the Northern Lights Nuclear Power Plant accident exercise to assess big picture implications of the overall remediation (see Figure 3 home screen shot).
- ***EPA's Wide Area Decontamination Estimator (WADE)*** cost estimation spreadsheet tool is being enhanced to include cost estimates. WADE uses information from the BOTE project as well as expert input from EPA responders to aid in the development of independent government cost estimates (e.g.,

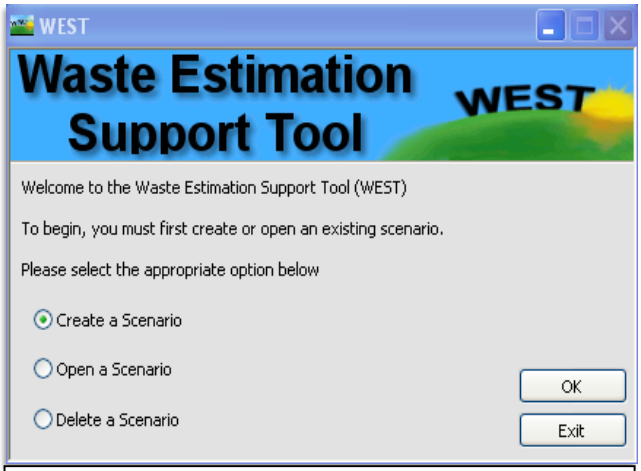


Figure 3. WEST home screen.

labor, materials, other resources) to effectively deploy EPA cleanup contractors during responses.

- The use of ***virtual reality to augment situational awareness and training*** efforts by means of a head-mounted display is being developed. This effort will use commercial off-the-shelf technology to significantly improve the efficiency of responses by visualizing the impacted areas and allowing responders to identify potential problems before they enter a contaminated area.
- A tool to aid in the ***selection of carcass disposal techno***logies following a foreign animal disease incident is under development. This tool, under development in collaboration with the US Department of Agriculture (USDA), allows the selection, on an incident-specific basis, of the most appropriate disposal approaches for animal carcasses resulting from a wide-scale foreign animal disease incident or other agricultural emergency involving mass animal mortalities.
- A ***database for storing and distributing data*** for use in all-hazards response and recovery research, operations, and tools is under development. This tool would provide us with a consistent set of underlying data that could be used in all of HSRP's decision support tools, and could provide HSRP subject matter expertise when technical support is needed.

A key element in the development of decision-support tools is to plan the tool based on its entire life cycle. The life cycle of these tools includes the initial scoping of the need, development and testing, ongoing maintenance, and transition to the ultimate user base, for example, the EPA program offices and responders in HSRP. The program is currently exploring ways to extend the life of our tools, reduce development costs by moving data to the cloud or online repositories, and abide by open source development protocols (i.e., free and open source software). In many ways, the development of decision-support tools is a logical outcome of many of the HSRP research areas.

Partners:

HSRP's primary partners in this area include the Office of Land and Emergency Management (OLEM) and each of the Agency's ten Regional Offices across the country. The Partners typically make use of the products by: 1) running the tools themselves; 2) working with HSRP to run the tools; and 3) establishing a Technical Working Group (TWG) as part of a response or exercise and asking the TWG to run the tools and make recommendations.

Transitioning Research to Partners

The HSRP is not fully successful unless its scientific products are transitioned effectively to the partners who will use them. The table below outlines the current mechanisms that HSRP employs for research transition including descriptions and purposes for the various mechanisms as well as hyperlinks to examples of many of them.

Mechanism	Description and purpose
Reports and journal articles	• Provide research results to scientific community, increasing the body of knowledge to further advance the science • Document the scientific foundation for our synthesis products (including tools) specifically, the quality and legitimacy of the research
Technical Briefs Example 1 Example 2 Example 3	• Field/lab applicable information extracted from reports and journal articles for the end user • Information presented in tabular form when possible: information "at a glance"
Technical Support	• Provide support to partners during incidents, exercises, and operational demonstrations • Provide instruction on the use of HSRP tools
Decision Support Tools	• Supports decision making by combining research data along with analytics
Webinars	• Communicate HSRP research and products to a broad audience consisting of EPA Regions, Program Offices, water utilities, and state and local governments, and professional organizations
Blogs and Social Media	• Communicate with the public about our research and events
Stakeholder Notification	• Semi-annual newsletter containing summaries of and links to all recent products of the HSRP • Informs interested stakeholders and partners about our recent research
Participation in groups that develop guidance documents	Incorporation of our research findings in: • National Response Team Quick Reference Guide for *Bacillus anthracis*[3] • EPA/CDC Interim Clearance Strategy for Environments Contaminated with Anthrax [4] • New York City Department of Health and Mental Hygiene Environmental Response and Remediation Plan for Biological Incidents • Interagency Interim Planning Guidance for the Handling of Solid Waste Contaminated with a Category A Infectious Substance Released [5]

[3] https://www.nrt.org/sites/2/files/120502_Anthrax_QRG_Final%203.pdf

[4] https://www.epa.gov/emergency-response/epacdc-interim-clearance-strategy-environments-contaminated-anthrax

[5] http://phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Interim_Planning_Guidance_for_Handling_Category_A_Solid_Waste.pdf

Mechanism	Description and purpose

Training	• For partners:
	  • Provide sessions on a variety of topics to On-Scene Coordinators at the annual OSC Academy most recently a session on the biology of threat agents, bio-specific sampling techniques, and emerging research in biological agent response and decontamination
	  • Assist OEM in constructing training for the Regions
	• Training incorporates the latest research increasing the chance it used to make decisions during a bio-response

International Decontamination Research Conferences	• Share information with a broad audience of scientists and other professionals involved in Chemical Biological and Radiological cleanup throughout the world
Conference attendance	• Share information on our research with the scientific community to further advance the scientific field
Product Teams	• Ensure product produced is of maximum use to partners • Keep partners informed about the progress of research
Annual Briefings	• Keep Agency partners and other end-users up to date on our research and products
Demonstrations	• Collaborate with inter and interagency partners (including end users) to jointly demonstrate and/or evaluate cleanup methods at full scale to generate additional data and identify additional gaps. • Inform the public, through the media, of our work
Homeland Security Research Website	• Provides basic information on the research program • Provides access to all non-sensitive product of the research program.

Examples of Recently-Provided Technical Support

Ebola Outbreak: The Ebola Virus Disease Outbreak of 2014 originating in West Africa, resulted in two imported cases and two locally acquired cases in the U.S. These cases raised heightened awareness regarding appropriate decontamination of PPE and decontamination of environmental surfaces in patient's residence and public facilities as well as vehicles and equipment.

Waste generated from an Ebola patient's residence.

EPA prepared for the domestic response jointly with CDC, developing guidance documents and training materials, much of which was based on HSRP research. The program's biological agent research was extrapolated to the Ebola virus, specifically its findings from studies on decontamination of porous materials, self-help decontamination methods, and decontamination and donning/doffing of personal protective equipment.

The Ebola outbreak also highlighted issues related to management of waste. The domestic cases generated waste from patients' residences that could not be disposed of and medical waste that could not be removed from medical facilities without treatment. HSRP, with its EPA Office of Land and Emergency Management partners and inter-agency stakeholders (e.g., Occupational Safety and Health Administration, Centers for Disease Control), drafted an interim planning guidance for handling, transport, and disposal of waste from a person with a suspected or known exposure to a Category A infectious substance[6]. This guidance assists state and local agencies in identifying handling considerations for contaminated waste, developing/evaluating contaminated waste protocols, protecting worker health and safety, and developing Category A waste management and response plans. This guidance incorporated HSRP research findings on autoclave cycles with porous materials, determined through testing against *B. anthracis* surrogates, to enable treatment of Category A waste.

Bird flu outbreak: During the High Pathogenic Avian Influenza (HPAI) bird flu (H5N2) outbreak, that affected nearly 8 million turkeys and chickens on poultry farms in 13 states, HSRP provided technical assistance on management of the potentially infected carcasses, estimated to be over 30 million pounds, and options to decontaminate poultry houses. HSRP's technical assistance was based upon its disinfection studies for HPAI, and on decontamination and waste management studies focused on other biological agents. In addition, the North Carolina Department of Agriculture, preparing for a potential spread of an HPAI outbreak to North Carolina, contacted

Construction of windrow for composting of bird mortalities in 2015
(WATTAgNET.com)

[6] "A form capable of causing permanent disability or life threatening or fatal disease in otherwise healthy humans or animals when exposed" (defined in the 49 CFR 173.134)

EPA about the readiness and applicably of using its mobile gasifier to conduct on-site treatment of animal carcasses. The gasifier design, fabrication, and testing was a collaborative effort between EPA and Department of Homeland Security.

Lab clean-ups from DoD *Bacillus anthracis* samples: Historically the Department of Defense's Dugway Proving Grounds has created non-viable, "anthrax" samples, by irradiating live *B. anthracis* spores. These spores were used by government, contract, including university, labs with BSL-1 laboratories to conduct research and test technologies. In 2015, a private lab under DoD detected growth of live *B. anthracis* from an inactivated sample. CDC recommended that labs that received, handled or processed these samples, in the year prior to the discovery of the live sample, decontaminate their labs using EPA/CDC provided recommendations. HSRP, in collaboration with its EPA partners and in coordination with CDC, developed these recommendations based upon HSRP research. The recommendations included decontaminants that were not Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)[7] registered for *B. anthracis*. EPA's Office of Chemical Safety and Pollution Prevention issued FIFRA exemptions to affected labs as a result of HSRP research data. EPA HSRP then provided technical support to labs as they implemented these recommendations from CDC Emergency Operations Center. In addition, HSRP provided technical support to labs and public health agencies in Region 3 (MD) and Region 5 (WI).

[7] Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) - Requires all pesticides sold or distributed in the United States (including imported pesticides) to be registered by EPA. See https://www.epa.gov/pesticide-registration/selected-epa-registered-disinfectants for further information.

Recently Completed Bio-Focused Webinars

Description of Webinar	Target Audience
Overview of Methodologies for Decontamination of Sensitive Equipment – Outlines research on the impacts of decontaminants (specifically fumigants) on models of sensitive equipment.	OLEM/OEM, Regions
Wide area B. anthracis cleanup – Describes research on effective operational parameters for fumigation and effectiveness decontamination methods for outdoor surfaces, including soil.	OLEM/OEM, Regions
Selected Analytical Methods for Environmental Remediation and Recovery (SAM) includes analytical methods for chemical, biological, radiological and nuclear samples. EPA created SAM because homeland security incidents could involve a large number of samples that would require the involvement of many labs to analyze. For analysis results to be comparable, it's necessary that all labs use the same methods. SAM provides the preferred methods for the labs to use.	OLEM/OW, Regions