



**Office of Research and Development's Response to the  
Board of Scientific Counselors Report on  
ORD's Homeland Security Research Program  
(final report received December 2008)**

**May 2009**

**BOSC Homeland Security Subcommittee:**

Dr. Gary S. Sayler (Chair)

Ms. Ellen Raber (Vice Chair)

Dr. David L. Banks

Dr. Joseph W. Bozzelli

Mr. Leo E. Lebaj

Dr. Anil Nerode

Dr. Lindell Ormsbee

Dr. James A. Romano Jr.

Dr. Daniel C. Walsh

**Submitted by:**

Dr. Gregory Sayles

Associate Director

National Homeland Security Research Center

Office of Research and Development

The Homeland Security Subcommittee of the Board of Scientific Counselors (BOSC) conducted a review of the Office of Research and Development's (ORD's) Homeland Security (HS) Research Program, a program executed by ORD's National Homeland Security Research Center (NHSRC). The review process was carried out through a series of conference calls and a face-to-face meeting in May 2008. The draft report was vetted by the BOSC Executive Committee in September 2008, and the final report was transmitted to ORD by the BOSC Executive Committee in December 2008.

Overall, the BOSC found that the NHSRC has done a commendable job in analyzing and delineating the scope of its research program with the overall ranking of "meeting expectations". Both Long Term Goals (LTGs) were also ranked as meeting expectations. The BOSC reported on interacting with enthusiastic and high quality staff and managers, and stated that the expansiveness and complexity of the program led to the overall responsibility exceeding the available financial resources.

The following narrative restates each numbered recommendation found in the Summary (Section I) of the report as well as all recommendations found only in the text of Section III - Review Findings (recommendations were indicated by bold font). ORD's response follows each of the recommendations. The table following the narrative summarizes ORD's response and indicates action items and timing. Additional advice given in the body of the report is appreciated.

## **RESPONSE TO GENERAL RECOMMENDATIONS**

- 1. The NHSRC should consider opportunities for a more expansive extramural contribution to its research program with a significant STAR component, perhaps supported jointly by the Department of Homeland Security (DHS) and EPA, if not in direct collaboration with the National Center for Environmental Research (NCER). Additional collaboration with other government agencies and with programs of other countries also is encouraged.*

**Response:** At this time, the HS Research Program must dedicate its resources to addressing urgent science needs in water security and buildings and outdoor decontamination so that the Agency is prepared to carry out its homeland security responsibilities. As the program matures, the program will consider balancing this shorter-term research with longer-term studies, perhaps through the STAR program. The HS Research Program agrees with the BOSC's recommendation to leverage research dollars through collaborations with other agencies. This has been the program's policy from its inception. The extramural component of the HS Research Program continues to be significant but in many instances has to be aligned with institutions that have the ability to do specific agent and sensitive research.

- 2. The NHSRC should explore the use of an acquisition life cycle model for individual research program elements, perhaps aligned along the Department of Defense*

*(DOD) (Category 3), National Institute of Standards and Technology (NIST), or National Aeronautics and Space Administration (NASA) approaches, to provide a significant enhancement to the overall program.*

**Response:** The HS Research Program agrees that an acquisition life cycle model may be useful in helping manage the research program. The program will investigate the feasibility of such an approach.

The program has indirectly used this approach in several instances. For example, two products in the LTG1 research area have now matured to the commercialization phase. The Water Concentrator started off as a proof-of-concept, it was developed into a prototype that was bench and field-tested, and is currently in the commercialization phase. A license agreement has just been signed to commercialize the product. Another example is the Threat Ensemble Vulnerability Assessment (TEVA) Suite of tools. TEVA-SPOT, the sensor placement optimization tool, is now ready for commercialization. The HS Research Program is meeting with the vendors to gauge their interest making these tools more user-friendly and further develop and disseminate the tools. Finally, in LTG2, the Disposal Decision Support Tool continues to be developed as new modules are added to it on a yearly basis. Its life cycle plan is to ultimately place it on the EPA website and make it available to stakeholders at large. The tool will be updated whenever new information is available.

3. *The NHSRC should clarify the role and responsibility of the National Program Director (NPD) for the Center and more broadly across ORD.*

**Response:** Unlike most ORD research programs, ORD assigned the responsibility to plan and implement ORD's HS Research Program to a particular ORD Center, NHSRC. The Center was established and built over time with scientific and administrative staff, and with financial and laboratory resources to carry out the program mission. Given the tailored development of the Center, NHSRC conducts most of the research that the program has planned; however, NHSRC funds limited work in other ORD labs and centers when skills in those organizations are needed.

Given this approach to conducting the research program, a full-fledged ORD national program director (NPD) is not justified. However, there is a need to carry out some of the NPD-like activities including: 1) planning the annual research program for budget submissions, 2) leading the writing of the multi-year plan, 3) representing the program to review organizations such as the BOSC and Science Advisory Board, 4) ensuring effective communication with clients, 5) coordination of research across NHSRC Divisions and programs, and 6) coordinating the research program with other ORD Labs and Centers and relevant extramural research groups such as in Department of Homeland Security (DHS) and Department of Defense (DoD). At this time, the NHSRC Director has delegated this NPD-like role to the Center's Associate Director.

4. *Although the NAS recommendation for additional research in behavioral science seems to have been addressed initially at a preliminary level, more work in this area should be considered.*

*And page 38: ORD should ask the question, "are there any lessons learned from the Katrina experience that could help inform the Agency on this issue?"*

*And page 39: Research is recommended on the social and behavioral dynamics of command of complex, catastrophic incidents as a means to improve success in future events*

**Response:** The HS Research Program agrees with the BOSC that more research is needed in the behavioral science area including learning from previous disasters. EPA recognizes its role in crisis and risk communication regarding chemical, biological and radiological risk from environmental contamination. The initial work in this area was started in LTG1 and received significant support from the end-users. Building on this research, LTG1 is funding a project in risk communication mental modeling namely, "Crisis communication needs for the public during water security emergencies." Additionally, the program plans to investigate risk communication issues surrounding the concept of "how clean is clean." The program will continue to evaluate its niche in behavioral science research.

5. *It is recommended that the NHSRC more formally establish a program to develop and periodically evaluate the priorities for evaluating research goals and for determining product delivery within research programs. Implementation of a mechanism to gauge the degree to which these priorities are heard and addressed in research activities is encouraged as part of this recommendation.*

**Response:** The HS Research Program thanks the BOSC for their recommendation and agrees with the points they raise. The program is following the BOSC's examination of decision analysis tools for prioritization and will study the feasibility of the BOSC's recommendations. NHSRC has already implemented a number of initiatives to improve its long term research planning approach, research prioritization mechanisms and the means by which the program can gauge stakeholder response to the program and its products. The following are HS Research Program responses to specific highlighted issues:

Establish a formal program to develop priorities and research goals – for LTG1, the HS Research Program meets regularly with its primary client the Office of Water (OW) to realign the research to the changing priorities of its client, the regions, states and the water utilities. Managers and staff of LTG1 participate regularly in many of the Water Sector associated meetings, e.g., the Government Coordinating Council and the Sector Coordinating Council meetings as well as the Critical Infrastructure Protection Advisory Committee (CIPAC) meetings that provide recommendations on research needs. Thus, the HS Research Program is continuously informed of the stakeholders' needs and can realign its research with changing needs and priorities.

The process is also informed by changes in threat assessments that are continuously updated by the Department of Homeland Security and the intelligence communities.

Similarly for LTG2, the program coordinates with Agency stakeholders and with other federal partners to set priorities. The U.S. EPA initiated the Taskforce on Research to Inform and Optimize (TRIO) chemical, biological, and radiological (CBR) terrorist agent response across multiple offices within the Agency. The TRIO group consists of members from NHSRC, Office of Solid Waste and Emergency Response (OSWER), Office of Pesticide Programs, and the regional U.S. EPA offices (e.g., On-Scene Coordinators (OSCs) and Removal Managers). The TRIO group recommendations and the updates to threat assessments by DHS continuously inform and help prioritize and refine research for LTG2. The program communicates and coordinates priorities with DHS and DoD chemical and biological research programs through the Technical Coordination Working Group.

Determining product delivery within research programs – The HS Research Program agrees with the BOSC's recommendation to establish a more formal process to ensure product delivery to all stakeholders and end-users. In addition to posting the product on the NHSRC web site and the informal exchanges among the technical staff in NHSRC and the Program Offices, the program is developing fact sheets, technical reports, and technology transfer documents. The program is also developing a more formal process to deliver the products to its customers. This includes preparing a cover memo that presents salient points, highlights the usefulness of the product to the customer, its impact on security, and how the product can help the users in supporting their missions. The program continues to play an active role in presenting the most up-to-date results at national and international technical conferences and workshops.

Implementation of a mechanism to gauge responsiveness to program – The HS Research Program is implementing a number of ways to improve communications with the clients and to survey their responses to the effectiveness of the products. The HS Research Program agrees with the BOSC that the surveys are an important component of the communication loop. Because the program is relatively young, the survey that was conducted in the spring of 2008 was the first to assess the impact of the HS research on the end-users. NHSRC plans to significantly improve the survey for the next round. Lessons learned from the first survey also demonstrated more informative results can be gleaned by separating the two long term goals, given the difference in the subject matter and the end-users. Additionally, the HS Research Program continues researching innovative approaches (and measures) and better means to assess the usefulness (and outcomes) of the results of the program from the perspective of the stakeholders and end-users.

- 6. It is recommended that the NHSRC develop a specific goal to include development of well-defined digital "clearinghouses" of technical information that are easy to search and cover each of the major topics (prevention, detection, mitigation, etc.).*

*And page 31: The Subcommittee believes that this area needs improvement and recommends some type of electronic database or clearinghouse so that information is more accessible to end users, even in a series of versions that can be updated as necessary*

**Response:** The HS Research Program agrees that it is very important for the end-users to have access to the program products. ORD's primary product catalog is its [Science Inventory](#), a searchable clearinghouse. Additionally, the NHSRC web site is continuously updated with new tools, instruction manuals, conference presentations, reports, peer-reviewed journal articles, fact sheets and other products. NHSRC also uses existing venues to effectively reach the end-users. For example, LTG1 products for safeguarding drinking water and wastewater are shared with the water community through a secure website, the [WaterISAC](#). The WaterISAC serves as a clearinghouse for sensitive products, threat alerts and rapid communication with the water community. Similarly for LTG2, NHSRC is working with OSWER to incorporate the information from the program products into their decontamination portal, used as a clearinghouse to support their on-scene coordinators (OSCs), decontamination teams and removal managers.

7. *It is recommended that the NHSRC take a more integrative, systems-oriented approach when evaluating key research objectives to ensure that the correct question(s) are being addressed in the context of real risk assessment and management.*

**Response:** The HS Research Program agrees that a system-oriented approach is a good approach for effective planning for the research in both LTG1 and LTG2. A risk assessment / risk management approach is used for the strategic planning in the Homeland Security Multi-Year Plan (MYP). This is reflected in the chronology presented in the MYP:

- Protect against an attack
- Monitor, detect and confirm attacks
- Minimize exposure of the public to the contamination
- Characterize the nature and extent of contamination
- Assess the risk to human health
- Clean up the site

The intent of the program is to address all the above components simultaneously.

Research priorities identified by the clients and end-users, yearly budget and staff availability determine plan implementation. For water security, the HS Research Program continues the detection research to support contamination warning systems but has increased its focus on response and recovery research per stakeholder guidance. For LTG2, research needs for large-scale decontamination is a priority. The program is working with OSWER and other end-users to evaluate remediation using a systems approach (e.g., wide area decontamination methods and human health

issues). Threat assessments and intelligence information help prioritize the research in the system continuum. Such an approach was also followed in the [Water Security Research and Technical Support Action Plan](#).

8. *It is recommended that greater explanation be provided in the MYP for the current priority of NHSRC research efforts and how these priorities may change over the duration of the plan and realized budget.*

**Response:** The MYP is a dynamic document and is expected to be revised every 2-3 years. The goal of the HS Research Program is to describe a system-oriented analyses of research needs to support and address EPA's responsibilities in protecting water systems from attacks and detecting and recovering from successful attacks. In addition, the research serves to support decontamination of buildings and outdoor areas and support the development of a nationwide laboratory network. The appendices in the plan clarify the research priorities for a three-year window (based on the assumption of limited changes in client priorities and a stable budget). A description of how research priorities are affected by client needs and budget changes has been added to the MYP.

#### **RESPONSE TO LTG 1 DIRECTED RECOMMENDATIONS**

1. *Prior to implementation of the Real-time Monitoring System (RTMS) and Threat Ensemble Vulnerability Assessment (TEVA) to any more systems, a detailed sensitivity analysis of these technologies to determine the variance of the resulting decisions should be performed.*

**Response:** The HS Research Program agrees that examining the sensitivity of TEVA tools to determine variance is important. Examining sensitivity and uncertainty is being pursued through a multi-disciplinary effort with extramural support (academia and interagency agreements with national laboratories). For TEVA-SPOT: sensitivity to model input parameters (time of release, duration of release, timing of exposure, population model, and quantity of release) is being examined. Uncertainties associated with the estimation of impacts from contamination events are also being examined. In addition, work is planned to develop stochastic models that allow for probability distributions as input to the models. Software tools (EPANET-MCX) are being developed to allow for the input of probability distributions of all distribution system model parameters and a Monte Carlo sensitivity analysis to determine their effect on the estimation of impacts and sensor network design. Some of the results from these analyses have already been published in peer-reviewed journals.

2. *A review of the Blast Vulnerability Assessment (BVA) Tool's value should be undertaken, and the process used to conduct this review and analytically quantify the merits of further investment should be made transparent as a model for project lifecycle determinations.*

*And page 21: The value of the BVA Tool to the vast majority of water utilities should be assessed.*

**Response:** The additional planned research on the Blast Vulnerability Assessment (BVA) tool is a direct response to the water utilities' needs. The utilities remain concerned with the threat of the use of explosives of all sizes in and around water and wastewater systems including the use of explosives near critical assets and near the storage of hazardous chemicals. This tool allows the utility to better assess their protective measures and plan for better measures to harden their systems. The program agrees with the BOSC that the research on the current tool is close to maturity. Ongoing research is to develop some additional modules, such as an underground storage tank, in response to direct requests from the users. The tool is also beneficial to other sectors and may be used to further the research in other sectors. The tool life cycle will be examined following the current work.

- 3. A clearer presentation of milestones for the PALs development subgoal for water systems is desirable, and the NHSRC should undertake an analysis of what needs to be accomplished for a more timely release of useful information derived from this research (also relevant to LTG 2).*

**Response:** The HS Research Program agrees with the BOSC that Provisional Advisory Levels (PALs) are important exposure advisory values for decision-making during a remedial response. NHSRC is only able to schedule the development of additional PALs based on the priority of chemicals to EPA's Homeland Security mission and on available annual funding. Since PALs are not clearance values, they do not provide any information of practical importance to material developers in the area of decontamination and treatment. Although provisional, NHSRC is currently evaluating mechanisms by which PALs can be released to the user-community which may include state and local responders and homeland security partnering with foreign governments.

- 4. It is recommended that the Center examine the CARVER (an acronym for Criticality, Accessibility, Recoverability, Vulnerability, Effect, and Recognizability) methodology as a means of generating Probability of Attack (**Pa**) to improve Risk Assessment Methodology for Water Utilities (RAM-W).*

**Response:** The HS Research Program agrees on the importance of the CARVER methodology and plans to continue research to support the Office of Water. OW has the lead on updating the vulnerability assessment tools to make them compliant with the DHS Risk Analysis and Management Critical Asset Protection (RAMCAP) approach.

- 5. A comprehensive model verification process should be established to evaluate the predictive capabilities of the advanced TEVA model and other models, such as Multi-Species EPANET (MS-EPANET), need to be quantified and documented, and the*

*sensitivity of TEVA to predict the potential occurrence of an attack on the system needs to be evaluated in terms of the exact time and duration of a potential contaminant insertion.*

**Response:** The release of all TEVA tools is accompanied by manuals that contain examples of specific cases. All models are modular and the individual modules have been tested. The release of EPANET-MSX included a peer-reviewed journal article and a QA verification report verifying MSX output with a simple batch chlorine reactor experimental data. EPANET-MSX is available via the internet and continues to undergo testing and verification by the research community. EPANET-MSX provides the software capability to model complex reactions in distribution systems; however the user must provide the mathematical equations for these reactions and verify them.

As for the ability of TEVA to predict the potential occurrence of an attack, the TEVA research program is not concerned with predicting the location or time of an attack on a water system. Instead, the TEVA research program is focused on developing tools and models that allow the user to quantify the impacts from intentional contamination events and to use the information to optimally place sensor monitoring equipment. In addition, the TEVA research program is focused on developing tools to assist water utilities in preparing and responding to contamination events.

6. *A rapid assessment process needs to be put in place as the timeline from detection to public notification is slower than the contamination event progress; thus, effort should be placed on assessment methodologies following detection.*

**Response:** The HS Research Program agrees that the time from detection to public notification is critical and continues to provide the utilities with up to date tools to help them make informed decisions. Response to contamination events is an ongoing research focus of the TEVA Research Program. While TEVA-SPOT provides the ability to quantify the importance of response time in reducing the impacts of contamination events, research has also focused on mitigating the spread of contamination through valve closures, flushing operations, and the implementation of administrative orders.

7. *During a mass contamination event, prioritization of the cleanup process likely will be required and a cost-benefit analysis methodology, along with a database as a decision-making support tool, should be developed to assist water systems in this prioritization.*

**Response:** The HS Research Program agrees that during a mass contamination event, prioritization of the cleanup process will be required and that a decision-making support tool will help the utilities make informed decisions. The HS Research Program is working with the OW through its Decontamination CIPAC to prioritize the decontamination research agenda. As described during the BOSC review, this is an expanding research area for LTG1. Given the recommendations provided by the

CIPAC and the OW, NHSRC is preparing a white paper to present a five-year research strategy in the area of CBR decontamination for water, wastewater and infrastructure. The goal of the decontamination research program is to ultimately provide utilities with a number of treatment and decontamination options to make informed response decisions. The implementation of this research and cost-benefit analyses fall under the responsibility of the OW. The HS Research Program will assist the OW in providing the tools to support their work in this area and the tools that help inform the water utilities in making decisions.

## **RESPONSE TO LTG 2 DIRECTED RECOMMENDATIONS**

- 1. It is recommended that the NHSRC better understand and evaluate time limitations in research requests of EPA program offices and regional homeland security research needs, and address these limitations with the appropriate level of implementation, recognizing that in some instances an implemented 50 percent solution is better than no implementation of a 100 percent solution.*

*And page 30: It is recommended that the Center try to supply these materials as draft documents while further development is underway so that the procedures and directions for actions relating to the CBR events are more quickly available to the clients and response community.*

*And page 39: It is strongly recommended that the NHSRC pursue the release of interim deliverables in all research programs*

**Response:** The HS Research Program agrees that the timing for the delivery of products is crucial and has therefore used several mechanisms to release information before the research endeavor is complete. For example, the program has delivered products in draft form to its customers and uses such opportunities of collaborations with the end-users to field or beta test the tools and technologies, using the feedback to improve the products. An example of this approach in LTG2 is the Disposal Decision Support Tool. The framework was developed and provided to the end-users for testing and evaluation. Feedback from the customers was used to further develop and improve the tool, updating it yearly with the state of the science research. The modified tool is then provided to the customers for further testing. Ultimately, the tool will reside on the EPA web site and will be widely disseminated.

Additionally, the HS Research Program is very active in presenting the new products at national and international conferences, meetings and workshops. These presentations and conference proceedings are continuously provided to the end-users as interim products. One-on-one communications also allow the staff to support the use of these products by the end-users. The program is making a concerted effort to provide technology transfer documents to the customers in a format that is useful to the end-users.

While the program agrees that the tools are needed by the customers as soon as possible, NHSRC is responsible for the quality of its research and its products and so must balance prompt release of information with its quality. Clients wish for timely information and high quality science.

- 2. It is recommended that customer support surveys be broadened to include On-scene Coordinators (OSCs), the national decontamination team (NDT), and other state and local responders, and expanded to include follow-up assessment, recommendation disposition, and end-user response.*

**Response:** The HS Research Program agrees that the surveys are an important component of the communication-feedback loop and that they must include a representative demographic of all the program clients. The survey conducted by the program and presented to the BOSC included responses from OSCs, NDT staff and other clients of the program. The program is designed primarily to meet the needs of the EPA clients and, therefore, future surveys will not likely include state and local responders. State and local responders will benefit from the program's products; however, the program is designed, research conducted, and products developed and delivered for Agency clients.

- 3. The NHSRC should take a more active role in identifying field-ready technology, and initiate an evaluative board or review processes to allow for and facilitate civilian/public testing. Included in this recommendation is the need for draft information materials and preliminary tools to be developed early on so that procedures and directions for actions relating to CBR events are available more quickly to clients and the response community (also relevant to LTG 1).*

**Response:** The HS Research Program appreciates the BOSC's recommendation. The Technology Testing and Evaluation Program (TTEP), (an off-shoot of ORD's Environmental Technology Verification Program) was developed to provide information to the end-users about existing commercial technologies and their performance effectiveness based on their respective vendor specifications. For LTG2, TTEP has organized a stakeholder group to constantly survey existing and new technologies that can be found in the government and in the private sector. The group prioritizes the testing of these technologies based on field-readiness and customer needs. A similar stakeholder group provides the same expertise for water in LTG1. The TTEP program is designed to address all field-ready technology from protection and detection to response and recovery for all chemical, biological and radiological contaminants.

- 4. Threat assessment evaluation similar to that employed in LTG 1 should be used to ensure that realistic source terms for key threat agents are identified and used to effectively set research objectives and priorities.*

**Response:** The HS Research Program agrees with the BOSC that threat assessments are critical to helping set research objectives and goals. While not presented to the

BOSC in detail during the May 2008 meeting, an assessment of threat similar to that conducted for LTG1 was accomplished for the LTG2 program in 2002. The initial threat assessments for both LTG1 and LTG2 were accomplished prior to the stand-up of DHS. DHS now holds the responsibility to conduct threat assessments for intentional biological and chemical contamination. The HS Research Program receives briefings on updated assessments from DHS roughly annually and uses this information to help prioritize research activities.

5. *It is recommended that the NHSRC should focus its efforts on evaluating existing commercially available real-time or near real-time detection systems and/or making some modifications to enhance specific needs, rather than on the development of new sensors and analytical equipment, which is best left to the commercial sector (also relevant to LTG 1).*

**Response:** In general, the mission of HS Research Program does not include development of sensor and analytical measurement technology. As the BOSC recommends, the program evaluates the performance of commercially available technologies and has established a specific subprogram to carry out this effort: TTEP. In a few isolated cases, when clients need a specific technology developed and the program has the capability to address this need, the program has led technology development. However, again, this type of work is uncommon in the program.

6. *Development of PALs for additional media beyond water and air are recommended to assist consequence management. It also is recommended to pursue advances in microbial risk assessment in partnership with the Centers for Disease Control and Prevention (CDC).*

**Response:** The HS Research Program agrees that exposure advisory information should be available to inform and assist consequence management concerning environmental contamination involving a variety of media and a variety of exposure pathways. Whether the mechanism for that information stream involves PALs, specifically, or some other risk-based methodology (e.g., acute and subchronic Reference Doses) is currently under discussion within the Agency. The program also agrees that whatever mechanism is selected, the consideration of multiple exposure routes and cumulative risk should be paramount.

NHSRC agrees that a partnership with Centers for Disease Control and prevention (CDC) is vital for a successful Microbial Risk Assessment (MRA) research effort. NHSRC currently has a close working relationship with CDC in the area of MRA having established a Memorandum of Understanding to collaborate in areas such as analytical method development, decontamination, risk assessment and environmental persistence. PALs are currently developed for chemicals only. Perhaps as MRA approaches mature, PALs could be developed for microbial contamination as well.

7. *Additional research in technical mitigation and remediation measures appears to be lacking and it is recommended that some consideration be given to possible new efforts that can be pursued in this area, particularly as it relates to environmental setting and media.*

*And page 37: The NHSRC is encouraged to pursue other non-chemical approaches and options for outdoor bioremediation (such as Phage approaches).*

*And page 37: Outdoor larger-scale radiological decontamination may not be technically feasible and other mitigation options (e.g., chelation) may be necessary in lieu of standard decontamination approaches. The NHSRC is encouraged to consider other options as part of its overall research strategy.*

**Response:** The HS Research Program interprets this recommendation to mean that the subcommittee is recommending additional research in scientifically-based mitigation and remediation strategies. The BOSC provided specific recommendations for expansion and new areas (described in more detail in Section III.3 – sequestration coatings, expansion of outdoor bio-reaerosolization and lessons learned from catastrophic events). The program agrees that additional efforts in the area of science-based mitigation and remediation research are needed. The program recognizes that outdoor bio-reaerosolization is a critical area to address in wide area remediation. Over the past year, the program has dramatically increased efforts in mitigation and remediation research. This is especially true for large scale testing and demonstration in which application methods and cost information can be more appropriately obtained.

For large scale decontamination, the HS Research Program is working with OSWER and other end-users to identify and prioritize research using a systems-approach. The HS Research Program also coordinates with the DHS/DoD (Integrated Biological Restoration Demonstration (IBRD)) in which a systems approach is adopted by the interagency workgroup to identify clean-up strategies and research needs. Application methods and cost information, in addition to decontamination effectiveness approaches are essential for clean-up strategies and guidance development. The program continues to investigate all technically feasible options including sequestration coatings and chelation. Radiological research conducted by the program focused on large scale testing and allowed for technology efficacy testing and cost determination (included testing technologies such as chelators). In the biological and chemical areas, the research focused on effectiveness due to method limitations with respect to the scale of the testing.

The HS Research Program built a 900 cu. ft. test chamber to scale-up biological and chemical agent decontamination technology testing, and to test additional radiological agent clean-up approaches. The program is currently developing protocols for technology and procedural testing at this larger scale facility. This scale-up allows for technology testing where appropriate application methods can lead to representative cost information. Additionally, the program continues to develop and

test non-chemical approaches (e.g., phage approaches) for outdoor and indoor remediation.

8. *An examination and report on the environmental settings and media that are likely to be impacted by various threat scenarios and the basic research needed to address fate, residence, persistence, and alternative disinfection and decontamination practices are recommended.*

*And page 36: Parallel studies with one or two other active chemicals such as chlorine oxides, bromine oxides, ozone, hydrogen peroxide, hydroxyl radical, ionic liquids, possibly other chemicals, and reasonable kinetic analysis are some possible recommendations to consider.*

**Response:** The HS Research Program agrees with the BOSC on the importance of basic research in the area of consequence management for CBR contaminant fate, residence, persistence in infrastructure and outdoor environmental settings. As mentioned by the BOSC, the program, given its limited resources, has partnered with several national laboratories and federal agencies to leverage expertise and funds to build on ongoing work in the program. The research is moving forward with outdoor decontamination as a critical research area. In addition, the program is conducting research on parallel threat agents, biological, chemical and radiological, to evaluate fate and transport and disinfection studies for biological contaminants. The radiological research program is not as mature as the chemical and biological areas but is also evaluating fate and transport. The HS Research Program thanks the BOSC for the detailed recommendations on how to augment the remediation research.

## **RESPONSE TO OTHER RECOMMENDATIONS**

*Page 24: EPA also should continue to investigate ways in which false positives may be reduced or eliminated, either by using a data fusion approach, in which multiple indicators must all occur before tripping an alarm, or by incorporating uncertainty analysis into the design or placement of such sensors*

**Response:** A simulation test bed software tool (including water quality process models, real-time demand data and model framework to simulate network variability and chemical reaction dynamics) is being developed to evaluate the performance of event detection system algorithms, as well as the development of receiver operating characteristic (ROC) curves to determine realistic false positive and false negative rates. Data can only be obtained using simulated data, because true events do not naturally occur within real distribution systems at a frequency sufficient for statistical analysis of behavior. The simulation test bed seeks to extend current simulation models in terms of accurately representing water quality reaction dynamics, uncertainty, and variability affecting system behavior. In addition, NHSRC is funding the development of the CANARY event detection software tool. Various statistical and pattern recognition techniques are being evaluated to determine how

well such systems can perform and what the expected levels of false positives will be. CANARY has been tested in real-time at one large utility for almost two years.

*Page 27 and 31: Direct engagement by ORD of outside decision makers through workgroups that include a full range of local and state responders for cities of varying size is recommended.*

*Page 39: More direct engagement of state and local incident responders and decision makers is an essential step that the NHSRC should take in order to best identify their unique needs*

**Response:** The HS Research Program does not routinely engage state and local responders in planning its research program. The program's mission is to conduct research needed by EPA to carry out its homeland security responsibilities. EPA's OW and OSWER hold the vast majority of these responsibilities. Therefore, the research program is designed to meet the needs of these offices which continuously engage state and local responders. The offices then communicate prioritized research needs to the program.

*Page 33: Research aimed at coordinating indoor/outdoor modeling efforts that can potentially answer the question of whether to evacuate or shelter-in-place. Excellent models exist for outdoor and indoor modeling; however, these modeling capabilities have never been linked to allow for a 24/7 integrated response capability. Having such a capability would aid overall protective measures (providing guidance as to "evacuate or shelter-in-place" as well as more quickly and effectively allowing for implementation of containment options and could assist OSCs in an expedited way in characterization activities).*

**Response:** The clients of the HS Research Program have also requested research in this area. The program is planning to begin this research in FY10 in order to link the best-available indoor/outdoor models. The program agrees that this research can assist decision makers in case of a contamination event.

*Page 33: Development of protocols for establishing sampling playbooks for key infrastructure facilities that are based on statistical modeling and utilize site/area specific characteristics. This is considered as a preplanning tool.*

**Response:** The DHS is coordinating the development of sampling strategies (Validated Sampling Plan Working Group which includes DHS, DoD, CDC and EPA) for indoor and outdoor events. This area is DHS's responsibility and NHSRC participates to provide technical support.

*Page 35: Development of sequestration coatings and related research products that provide additional response options for consequence management are a valuable component of NHSRC research. Although some has been ongoing as part of Theme 3, additional options should be pursued for wide area events to minimize the potential*

*for reaerosolization in the case of radiological dispersion device (RDD) and/or biological weapon (BW) attacks (specifically with regard to spores such as anthrax). The continued dispersion of particulate-based agents represents a health threat that should be evaluated for mitigation options. Some options could include environmentally acceptable materials that would allow for entrainment, adsorption, and/or agglomeration with outdoor surfaces and soils. These materials might be similar to those used as soil amendments for stabilization and/or "dust bowl" stabilization treatments.*

**Response:** The HS Research Program is conducting research on mitigation techniques for particulate-based contaminants. Additionally, the program is evaluating sequestration coatings for radiological contaminants and developing performance standards for these coatings. In FY10, the program plans to test coatings designed to meet these standards for their performance (in the radiological area). The program is continuing its research for wide-area biological decontamination with biocidal-based technologies and other applications. The program is also investigating the importance of reaerosolization of spores and based on the results will make a decision on the usefulness of sequestration research in this area. Based on these results and the results of the performance testing for radiological contaminants, coatings will be evaluated for their usefulness in the biological area.

*Page 35: Expansion on research for outdoor bio-reaerosolization is needed. Although some work has been initiated to evaluate indoor aerosolization (Poster #7), additional research should be undertaken specifically to address whether outdoor bio-reaerosolization will occur, and if so, under what conditions. This understanding is key for determining whether to evacuate or shelter-in-place. Additionally, it is important in the overall characterization of a contaminated area and impacts the strategy for wide area outdoor decontamination. Indoor aerosolization research focusing on understanding issues such as function of particle size, electrostatic charge, and preparation (in the case of bio-agents) also should continue. Consideration should be given, however, to heavily coupling/leveraging ongoing work with that being done in Canada.*

**Response:** The HS Research Program agrees and thanks the BOSC for their recommendations. The program is conducting research in the area of outdoor bio-reaerosolization and agrees on the importance of this research for decontamination of outdoor areas. Additional research in this area has started and is planned for the next fiscal year.

*Page 36: Additionally, a review and summary of the lessons learned from multi-jurisdictional management of large and complex catastrophic events is a relatively short-term and valuable research effort that may help in the overall approach to risk mitigation. Of particular importance are those events that involve principal management by law enforcement or other officials who do not have environmental management training. Behavioral dynamics of complex situations can greatly impede proper and appropriate environmental management of an event (for instance, the*

*response to the World Trade Center disaster). Research to assist environmental responders to function effectively in these complex situations is recommended and may include effective communication techniques. A better understanding of potential risk communication and perception strategies may help in overall mitigation from a behavioral standpoint and should be further evaluated. It appears that EPA is starting to do some work in this area, but additional effort is needed.*

**Response:** The HS Research Program has initiated behavioral science research and is evaluating research needs to support risk and crisis communication. As part of this evaluation, the program will consider conducting lessons learned activities.

*Page 37: A large-scale outdoor decontamination approach needs to take into account an understanding of the hydrogeologic/site-specific characteristics of the area. These include resonance time, porosity, permeability, etc., and involve a different set of tests than currently have been undertaken by EPA. An experimental approach needs to be designed to include this type of testing in order to further research objectives and meet overall goals for the end user.*

**Response:** The HS Research Program agrees with the BOSC recommendation and has always had this approach as a goal in its decontamination research and will continue to do so.

*Page 37: A review of commercially available products also needs to include the application method(s) and a good understanding of the cost effectiveness of that approach. There are, for example, some products used in Europe (such as Virkon S) that may have applicability for this application. Many of these companies, however, are not necessarily interested in investing in biocide product development for the United States. The NHSRC is encouraged to conduct testing of its own under some of the conditions stated above to see if suitable products are available.*

**Response:** The HS Research Program has conducted testing of such technologies investigating of application methods and cost effectiveness (including Virkon), and will continue to test commercially available products. Additionally, given the limited market interest in the development of homeland security specific technologies, the program (1) evaluates the applicability of technologies developed in other fields such as for agriculture and hospitals, and (2) adapts other technologies to homeland security uses.

**Table 1. Summary of the BOSC's Recommendations and ORD's Response and Proposed Actions Associated with Review of the Homeland Security Research Program**

Recommendation / Page Number	Recommendation	ORD Response	ORD Actions (Timing)
<b>General</b>			
1	Expand support of extramural research including STAR, increase collaboration with other organizations.	In the short term, the program must focus on urgent, near-term research that is difficult to conduct extramurally. In the long term, the program would benefit from support of longer-term, extramural research. Collaboration with other agencies is already active, but could be expanded.	Will consider expanding the support of extramural research in the future. Will continue collaboration efforts with federal agencies and look for opportunities to expand. (Ongoing and future)
2	NHSRC should explore the use of an acquisition life cycle model for individual research program elements.	Agreed.	Acquisition life cycle models will be investigated for their feasibility. (FY10/FY11)
3	Clarify roles and responsibilities of the NPD.	Some, though not all NPD responsibilities are relevant to this program.	Continue to pursue relevant NPD-like responsibilities. (Ongoing)
4	Additional research needed in behavioral sciences	Agreed when applied to homeland security issues.	The program is expanding its efforts in this area.(Ongoing)
5a	Establish a program to develop and periodically evaluate the priorities for evaluating research goals.	Agree on the importance of planning and prioritization using a formal approach. The HS Research Program will follow BOSC's ongoing work on using decision analysis for prioritization. In the meantime, the program will continue to prioritize its research based on the existing mechanisms for LTG1 and LTG2 work and seek improvements.	Continue efforts to improve prioritization processes. (Ongoing)
5b	Establish a program for determining product delivery within research programs.	The HS Research Program is making program-wide efforts to improve the delivery of products to clients so that they are used to increase the capabilities of the clients.	Continue to develop improved product delivery strategies. (Ongoing)

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Recommendation / Page Number	Recommendation	ORD Response	ORD Actions (Timing)
5c	Implement a mechanism to gauge the degree to which these priorities are heard and addressed.	Agreed. The HS Research Program believes and actively pursues feedback from customers on the responsiveness of products. These feedback mechanisms are evolving as lessons learned are used to develop refined approaches.	Continue to develop and improve client feedback processes. (Ongoing)
6	Develop a "clearinghouse" of technical info produced by the program.	HS Research Program products are available in several locations, some aimed at specific end users, and some for the public including EPA's Science Inventory.	Ensure that program products are represented in existing "clearinghouses." (Ongoing)
7	Take a more integrative, systems-oriented approach when evaluating key research objectives.	The HS Research Program is designed and planned using a systems-oriented, "event chronology" approach.	Continue this approach. (Ongoing)
8	Provide greater explanation in the MYP for the current priorities and how these may change.	Agreed.	More definitive statements on strategic directions and their likely evolution have been added to the MYP. (Completed)
<b>Long Term Goal 1</b>			
1	Conduct sensitivity analyses on TEVA tools to determine variance in decisions.	Agreed. Sensitivity analyses have been conducted in the past and will continue as needed.	Continue sensitivity analyses. (Ongoing)
2	A review of the Blast Vulnerability Assessment (BVA) Tool's value should be undertaken.	Direct requests from program clients require the program to conduct additional work on the BVA tool. However, the program agrees that research on this tool is close to maturity. The tool development life cycle will be examined following the current development efforts.	Continue current efforts then examine the utility of additional work. (FY10/FY11)

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<b>Recommendation / Page Number</b>	<b>Recommendation</b>	<b>ORD Response</b>	<b>ORD Actions (Timing)</b>
3	Clearer milestones for PALs are needed and more timely release of results.	PALs are developed as rapidly as funding allows using a prioritized list of chemicals. Although provisional, NHSRC is currently evaluating mechanisms by which PALs can be released to the user-community.	Continue to develop PALs as quickly as resources allow while developing improved mechanisms to communicate results. (Ongoing)
4	Examine the CARVER methodology to improve Risk Assessment Methodology for Water Utilities (RAM-W).	The Office of Water has responsibility for this activity. The HS Research Program will support OW as needed.	Continue technical support as needed. (Ongoing)
5	A comprehensive model verification process should be established to evaluate the predictive capabilities of the advanced TEVA model.	TEVA modules are tested and their manuals include examples.	Continue existing software testing and documentation efforts. (Ongoing)
6	Effort should be placed on assessment methodologies following detection to decrease the time for public notification.	Agreed. Existing and developing TEVA tools will assist utilities with interpreting signals of detection (CANARY) and in developing real-time containment and mitigation strategies and make informed decisions.	Continue development of advanced TEVA tools. (Ongoing)
7	A cost-benefit analysis methodology, along with a database as a decision-making support tool, should be developed to assist water systems in this clean up prioritization.	The proposed approaches are risk management decision tools that are the responsibility of the Office of Water. OW has not requested technical support in these areas.	None now. Continue to actively plan decontamination research with the OW. (Ongoing)

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<b>Long Term Goal 2</b>			
1	Accelerate release products to meet the needs of the clients, recognizing that at times 50 percent solutions with implementation are better than no implementation with 100 percent solution.	Agreed. In both LTGs, the HS Research Program has provided draft products to the end-users and used their feedback to improve on the products. The testing by the users allows the program to produce products that are useful to the clients.	Continue to communicate urgent research results to clients as they are developed while maintaining high quality standards for the research and the resulting products. (Ongoing)
2	Customer support surveys should be broadened to include OSCs, NDT and other state and local responders.	The survey presented included OSCs and NDT as participants. The HS Research Program is designed to support EPA science needs. Thus, the most relevant feedback would come from EPA clients including EPA response personnel rather than state and local responders.	Continue survey activities and improve effectiveness to gauge the utility of the program to EPA clients. (Timing of next survey is not yet determined)
3	Identify and test field-ready technology to provide information to the end-users.	The program created TTEP to test technologies according to their vendor specifications. Priority technologies to be tested are selected by stakeholder groups in both LTGs.	Continue technology testing efforts. (Ongoing)
4	Threat assessment evaluation similar to that employed in LTG 1 should be used for LTG2 work.	Agreed. The HS Research Program conducted a threat assessment for buildings early in its tenure. Now, DHS has responsibility to conduct these assessments. EPA receives threat assessment information from DHS annually.	Continue to coordinate with DHS to receive up to date threat assessments and use this information to plan and prioritize the research program. (Ongoing)
5	Efforts should be focused on evaluating existing commercially available detection systems rather than on the development of new sensors and analytical equipment.	Agreed. The HS Research Program rarely invests in technology development and supports a program to conduct performance testing of commercially available technologies.	Continue to operate the TTEP. (Ongoing)

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<b>Recommendation / Page Number</b>	<b>Recommendation</b>	<b>ORD Response</b>	<b>ORD Actions (Timing)</b>
6	PALs should be developed for multiple media to assist consequence management. Pursue advances in microbial risk assessment (MRA) in partnership with CDC.	The HS Research Program agrees that exposure guidelines that account for multiple exposure routes and cumulative risk should be investigated. The program actively partners with CDC on a number of technical issues including MRA.	The program will work with the Agency as approaches to risk assessment evolve, while continuing to collaborate with CDC. (Ongoing)
7	Additional research in technical mitigation and remediation are needed, especially as it relates to environmental setting and media.	Agreed. The program is increasing its efforts in mitigation and remediation and recognizes the importance of research in bio-re-aerosolization.	Continue and expand on ongoing efforts. (Ongoing)
8	Examination and report on the environmental settings and media that are likely to be impacted by various threat scenarios and the basic research needed to address fate, residence, persistence, and alternative disinfection and decontamination practices.	Agree that such an examination would be useful.	The program will work with the BOSC to better understand and respond to this recommendation. (FY09 and FY10)
<b>Other Recommendations</b>			
Page 24	Investigate reducing false positives in the use of event detection systems.	Ongoing refinement of CANARY using various statistical and pattern recognition techniques will reduce false positives.	Continue software refinement. (Ongoing)
Page 27, 31 and 39	Engage state and local responders in identifying and prioritizing research.	OW and OSWER hold the responsibility for engaging state and local responders. Research needs from this community are communicated to the program by these program offices.	Continue working with program offices to understand research needs from the response community.
Page 33	Link indoor and outdoor models for 24/7 integrated response capability.	Agreed. Research to link best-available models will begin FY10. This work was also requested by OSWER.	Begin research. (FY10)

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<b>Recommendation / Page Number</b>	<b>Recommendation</b>	<b>ORD Response</b>	<b>ORD Actions (Timing)</b>
Page 33	Develop protocols for establishing sampling playbooks.	DHS coordinates the development of sampling strategies for indoor and outdoor events. The HS Research Program provides technical support.	Continue to provide technical support to DHS. (Ongoing)
Page 35	Evaluate mitigation options for particulate-based agents: develop sequestration coatings for consequence management; and minimize the potential for reaerosolization for RDD and biological attacks.	The program is conducting research on mitigation techniques for particulate-based contaminants, developing performance standards for sequestration coatings (rad), and investigating the importance of reaerosolization of spores while the program continues wide area biological decontamination research.	Continue this research approach as planned. (Ongoing)
Page 35	Expand research on outdoor bio-reaerosolization.	Agreed.	The program is expanding its work in this area. (FY10 onward)
Page 36	Review lessons learned from catastrophic events to help risk mitigation, risk communication and perception strategies, conduct research to assist responders to function effectively.	The HS Research Program has initiated behavioral science research and is evaluating research needs to support risk and crisis communication. As part of this evaluation, the program will consider conducting lessons learned activities.	Continue to develop the behavioral science research program and consider conducting lessons learned studies. (Ongoing)
Page 37	Include hydrogeologic site-specific characteristics in large scale outdoor decontamination experiments.	Agreed. These factors have and will continue to be important in the program's design of outdoor decontamination experiments.	Continue accounting for hydrogeological characteristics in outdoor decontamination research. (Ongoing)
Page 37	Conduct testing on the application methods and cost-effectiveness of commercially available decontamination products.	The HS Research Program is conducting such testing and includes adapting technologies developed in other fields outside homeland security.	Continue decontamination technology testing focusing on application methods and cost-effectiveness. (Ongoing)