SPECIAL FEATURE: REMEDIATION

CHALLENGES IN DISPOSING OF ANTHRAX WASTE

Ann M. Lesperance, Steve Stein, Jaki F. Upton, and Chris Toomey

Disasters often create large amounts of waste that must be managed as part of both immediate response and long-term recovery. While many federal, state, and local agencies have debris management plans, these plans often do not address chemical, biological, and radiological contamination. The Interagency Biological Restoration Demonstration's (IBRD) purpose was to holistically assess all aspects of an anthrax incident and assist in the development of a plan for long-term recovery. In the case of wide-area anthrax contamination and the follow-on response and recovery activities, a significant amount of material would require decontamination and disposal. Accordingly, IBRD facilitated the development of debris management plans to address contaminated waste through a series of interviews and workshops with local, state, and federal representatives. The outcome of these discussions was the identification of 3 primary topical areas that must be addressed: planning, unresolved research questions, and resolving regulatory issues.

DISASTERS OFTEN CREATE large amounts of waste that must be managed as part of both immediate response and long-term recovery. Research on this type of waste management is sparse, and case studies more often relate to natural disasters.^{1,2} While many federal, state, and local agencies have debris management plans, these plans often do not address chemical, biological, and radiological contamination resulting from a terrorist action. In the case of wide-area anthrax contamination, a vast array of material, including furniture, carpet, sludge, building material, common garbage, animal carcasses, and personal protective equipment, would likely require decontamination and disposal.

In October 2009, with support from the U.S. Environmental Protection Agency (EPA), the IBRD program coordinated a series of workshops to understand the current

state of preparedness for disposal of anthrax-contaminated materials; the capabilities and requirements needed to respond to and recover from an anthrax incident, and the limitations of that response; and the issues of and barriers to disposal of biological agent-contaminated waste. The goal of the workshops was to develop a prioritized list of issues that must be addressed to recover and restore operations after such a disaster.

The team held 3 separate facilitated workshops in the Seattle, Washington, area with representatives from (1) waste facility owners, haulers, and associations; (2) state and local agencies with a role in disaster waste disposal; and (3) federal agencies with a role in disaster waste disposal. This article summarizes the findings from those workshops and identifies priority issues for disposal of anthrax-contaminated waste.

Ann M. Lesperance is Deputy Director, Regional Programs, Northwest Regional Technology Center; Steve Stein is Director, Northwest Regional Technology Center; Jaki F. Upton is Security Policy Specialist; and Chris Toomey is Nonproliferation Scientist, Global Security Technology and Policy Group; all are at the Pacific Northwest National Laboratory, Seattle, Washington.

MATERIAL AND METHODS

The project team identified key waste facility owners, haulers, waste associations, and service providers to participate in the workshops along with relevant officials at the local, state, and federal levels. The participants represented the waste-disposal ecosystem, including transportation, disposal, treatment, and regulatory components. An effort was made to include representatives from all relevant organizations, companies, and agencies involved with the handling and disposal of all forms of waste in order to provide a comprehensive picture of waste management from the initial response phases through the recovery phase.

To prepare for the workshops, the team interviewed 53 stakeholders in those areas by phone in June and July of 2009. The EPA provided an initial list of interview contacts encompassing both the private and public sectors, which was expanded as other experts were identified during the interviews. Included were representatives from local, state, and federal government agencies as well as waste facility owners, haulers, waste associations, and service providers. The interviews included a review of the workshop objectives and sought to ascertain each organization's current level of preparedness and experience as well as to flag relevant concerns to be addressed in the context of the workshops and the final report.

The 3 workshops were conducted October 13 and 14, 2009. Each workshop focused on a specific stakeholder group. The workshops were designed to identify and prioritize major concerns of each group regarding the management of waste during and after a biological disaster, including the decontamination and restoration of property during the recovery phase, while also maintaining current levels of service. At the outset of each workshop, facilitators described a wide-area anthrax contamination scenario, and participants were asked to describe their major concerns and needs to support recovery and restoration efforts regarding the collection, disposal, and management of anthrax-contaminated waste. Facilitators recorded these concerns, and participants prioritized them at the end of the session through a voting process. Participants then discussed priority issues in greater detail.

RESULTS

Both the interview results and the workshop results showed a great deal of similarity in the groups' primary issues of concern.

Results of Interviews

Three primary issues were repeated by all 3 groups during the interview process. The first concern dealt with roles and responsibilities. Interviewees questioned the role each level of government would play in waste disposal following a biological incident. Many comments were related to which

agencies would be involved and in what capacity. The specific delegation of responsibility and the chains of command within and throughout the decision-making process were not clear to the interviewees.

The second issue dealt with waste characterization. As would be expressed in the workshops, organizational representatives were unclear as to the classification of anthrax-contaminated waste. Beyond the basic regulatory framework concerns, there were ancillary questions regarding how the waste, once categorized, would be handled in the context of the cleanup. Another key question was how to determine how clean is clean. Discussions were held on the importance of disinfecting and decontaminating as much of the affected materials as possible on site, prior to transporting the materials. There were also concerns about whether the waste could go to Subtitle C or D facilities and, irrespective of the final disposal site, what type of long-term monitoring would be required. It was understood that, since anthrax is a naturally occurring microbe, it is possible that landfills could contain anthrax regardless of the disposal of anthrax-contaminated waste.

The third issue involved planning and execution. Current plans do not include anthrax as a possibility and focus on response rather than recovery. There is a need to understand the current capacity to handle waste and the capability to generate an estimate of the volume of waste from an anthrax attack. However, there can be no valid plan without first establishing the standard level of risk to workers, equipment, and facilities if the attack were to happen under current conditions. Existing federal, state, and local agencies have not communicated their roles and responsibilities specific to anthrax. The sense was that this lack of role definition prevented agencies from determining the level of risk and identifying gaps in the response. Interviewees also felt that communication between agencies and the general public about risk has not been appropriate for an anthrax incident. For risk communication to be effective, the public would require further education.

Results of Workshops

Waste facility owners, haulers, associations, and service providers met on October 13, 2009, in Seattle, Washington. These individuals come from the private sector and a small cross-section of local public-sector waste management and regulatory authorities. The 12 participants represented the Washington Refuse and Recycling Association, Waste Management, Republic Services, Allied Waste—Roosevelt Regional Landfill, Stericycle, Cleanscapes, the Washington Association of Sewer and Water Districts, King County Department of Natural Resources, and King County Solid Waste. Priority issues included the following:

- *Planning:* The consensus was that a plan must be created and be ready for implementation if an attack occurred.

- The plan should include information on how anthrax behaves (survivability and viability) through the waste disposal process in both natural and landfill environments, methods for cleaning up to various standards, information on providing and monitoring prophylaxis and personal protective equipment, and identification of disposal capacity and site-specific treatment of contaminated waste.
- *Regulatory status of waste:* Participants recommended the use of government proclamations to clarify the regulatory status of the waste and to address who can and would be handling it through the disposal process while also providing the leverage to bring historically hesitant participants, such as railroads, to the table.
 - *How is "clean" verified?* Through the discussion, it was clear to the participants that the more material that can be decontaminated in place, the easier it will be to manage the waste. However, without being able to answer this fundamental question of verifying to standards, there is no feasible way to plan or conduct a risk assessment to begin an anthrax waste management planning process.
 - *Education and training:* Participants were very concerned that information about the behavior and effectiveness of treatment against anthrax was lacking in the public sphere. This information would be particularly important in retaining workers or convincing workers to return to assist in the cleanup process. Workers would need education on timeframe and materials so they could begin work. They would also need training to handle, collect, and dispose of the waste. The training program must be in place and ready to deploy as needed. The other education issue was related to the communities through which the waste would be transported and where it would ultimately be housed in the waste disposal process. These communities would need to be informed to streamline the disposal process.

Other issues that received votes from participants were related to preparations (the process for waste handling, collection, and disposal; the threshold for transitioning from emergency response to recovery; the strategy for consolidating waste); the need for risk communication; cleanup issues regarding current tariff structures and pre-existing contracts; and indemnification. Participants also wanted answers to the questions of whether contaminated waste can be combined with other waste and the fate of anthrax in publicly owned treatment works.

State and local participants met on October 14, 2009, in Seattle, Washington. The 6 participants represented the City of Seattle, King County, Snohomish County, and the state of Washington. They identified the following priority issues:

- *Regulatory classification:* Participants were unable to reach consensus on how to classify the contaminated waste. They were also concerned about how to classify (if at all) waste that had been decontaminated and needed disposal. The group reached consensus that these issues

should be studied rigorously because of the implications for command and control as well as the impacts on how the waste is handled, transported, and disposed.

- *Behavior of anthrax in a landfill:* Participants voiced a concern that, because of differences in decontamination processes, decontaminated waste might still contain spores. In addition, incineration of municipal solid waste, while mostly effective, must still be verified as clean, and the ash might still contain some trace amount of spores. Participants wanted to know how spores behave under standard landfill conditions, such as temperature, pressure, leachate treatment methods, and effects of gas flaring. The group identified understanding anthrax behavior as a research priority in developing proper waste disposal approaches.
- *Lessons learned:* Participants thought the many incidents involving cleanup after large-scale disasters and several incidents involving anthrax had valuable lessons that could be learned for planning purposes. Of primary interest was identifying where those efforts met bottlenecks, areas for process improvement, and any other positive or negative similarities in the cleanup execution. In moving forward, the group agreed that studying the cleanup issues from some recent incidents—September 11 and Hurricane Katrina; the anthrax letters found at the AMI building in Florida, the Hart Senate Office Building in Washington, DC, the New Jersey post office, and the ABC/NBC/CBS/New York post offices in New York City; and Idaho's bird flu cases—could provide some valuable lessons for devising a plan for waste management in an anthrax scenario. Various source reduction and waste disposal activities for past anthrax incidents have been documented.³
- *Treatment in place:* The final consensus priority was that as much material as possible should be decontaminated in place to minimize the amount of waste produced. Treating in place would require research into decontamination protocols, the availability of technology and its effectiveness, sampling and clearance methodologies, and estimated timeframes for completion based on standards of clean. Participants also brought up the possibility of encapsulating the spores as a method of minimizing the amount of waste produced. Related to the ability to re-use decontaminated materials was a discussion on physically reducing the size of waste before disposal through methods such as incineration.

Other issues that received votes from participants included transportation (monitoring and mitigation en route), education (basic information about anthrax as well as health and safety communication), roles (who is in charge?), disposal (continuous monitoring at the disposal site and long-term liability of disposed waste), and coordination among counties under common regulatory authority. A key research question was the type of packaging that would effectively prevent leakage.

Federal representatives met on October 14, 2009, in Seattle. The group was a small cross-section of the federal assistance that would be expected in the event of an anthrax attack. The 13 representatives included staff from EPA headquarters and the regional office, the U.S. Department of Agriculture, and the U.S. Department of Defense. They identified the following priority issues:

- *Template or decision framework:* The overall consensus priority was to create an informal template or decision framework that shows the key players, others involved, decision makers and their process, questions that need to be asked, and their timing. There was consensus that the inevitable fear and stigma of anything related to the event could be combated effectively with clearly defined procedures and decision-making frameworks. Another related issue that needed to be addressed was cross-state outreach. Lessons learned from September 11 were that significant efforts will be required to facilitate waste disposal in addition to identifying the disposal locations and necessary points of contact in advance. Participants agreed unanimously that if a template exists to tell them who has jurisdiction, who makes the decisions, and who to bring to the table and when, the overall response and recovery process will be more effective.
- *Research:* There was consensus on the need for more research, primarily on risk assessment. Participants needed to know from a waste management standpoint how clean is clean enough for different treatment and disposal approaches and whether there are flexible tolerances for levels of clean at any point in the process. Participants felt that, without assessing risk, the planning process cannot triage the waste, estimate tonnage of different classes of waste, or know how much and what type of material will be needed to manage that waste. Other primary research needs included the types of technology available and their effectiveness, and what can be developed and pushed out to first responders and cleanup crews to speed the decontamination process. Parallel to this focus is the need for more efficient sampling and clearance analysis regarding the waste itself. Participants compared the goal to asbestos sampling, in which samplers have a high confidence of a total extraction.
- *Waste treatment and disposal approach and regulations on decontamination agents:* The final consensus priority was a waste treatment and disposal approach that was triggered by the classification of the waste. Participants suggested the need for legal counsel to weigh in because of the disagreement as to how the waste would be characterized. (Note that once the classification decision is reached by the government, the owners, haulers, and operators felt that, with proper training, personal protective equipment, and standard operating procedures, their employees could dispose of the waste without any additional information.) Participants agreed that a study was needed to characterize the waste so that waste

management plans can include a risk assessment and clear steps for treatment and final disposal of the waste. Identifying the capacity of onsite treatment is necessary to allow the EPA on-scene coordinator to define the site boundaries for staging and treatment before material becomes waste and is subject to regulatory timelines and tracking requirements.

Other issues that received votes from participants include identifying the decision maker for final disposal site locations, determining who will take on the role of working political issues and negotiating, the need to provide operational information to publicly owned treatment works, worker safety, perception and stigma, and federal guidance on publicly owned treatment work policies on wastewater treatment.

DISCUSSION

From the interviews and workshops, 3 major issues were determined to be the highest priorities for future work. The first issue was planning. Developing the decision processes and chains of command that will be employed following a biological attack was the primary concern of both the interview groups and the workshop participants. A major component of this decision process is contingent on research, particularly on disposal technologies and the waste disposal approach. Beyond research, work is needed on the following aspects:

- A risk assessment that is periodically updated as research and guidance changes. In this context, risk assessment means an evaluation of the level of risk faced by those participating in the response and recovery processes, under a defined set of conditions with a specified level of resources. Participants saw the risk assessment as an evolving document that would quantify the level of risk at any given time and change as additional resources are identified and as research reveals more about the effectiveness of the decontamination and clearance processes.
- A template or decision framework so that all stakeholders know their roles and responsibilities in the response and recovery process. Such a template would provide needed guidance but would not be limited to specific tasks that may not be relevant.
- The response and recovery effort's message to stakeholder groups. Participants felt that appropriate information can be provided in an anthrax emergency only after stakeholders have been educated on the dangers of anthrax, the process and effectiveness of prophylaxis, steps that can be and are being taken, and the roles that each stakeholder has to play in the overall effort.

The second high-priority issue was the need to address key research questions to support waste management planning. Issues included:

- How clean is clean?
- How do you verify clean?
- How does anthrax behave in a landfill environment?
- What are the lessons learned from previous experiences with anthrax?
- What is the best available way to treat contaminated material in place, and what types of technologies are being investigated to make that process more efficient and effective?

The third high-priority issue was to clarify the regulatory status of contaminated waste and the materials used in the decontamination process to establish a clear waste treatment and disposal approach. Currently, no protocol exists for biologically contaminated waste, and arbitrarily placing anthrax into a preset category has significant legal and planning implications that need to be understood. It must be determined what new or modified regulatory approaches are needed to deal with this type of waste.

Based on the workshops, much still remains to be accomplished to effectively and safely dispose of anthrax-contaminated waste after a biological attack. In the area of planning, information from the workshops was used to develop a recovery framework for the region,⁴ as well as to develop and revise local waste management plans. EPA held similar workshops in other regions in the United States. The objective of the follow-on workshops was to recreate the original workshops held in Seattle to gather additional information that may be present in other regions and raise awareness regarding the issue of waste disposal in the event of a biological attack. The information collected from these workshops, and future workshops, may be useful in developing future policies and procedures related to anthrax-contaminated waste disposal.

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Address correspondence to:

Ann Lesperance
Pacific Northwest National Laboratory
Northwest Regional Technology Center
1100 Dexter Ave. North, Suite 400
Seattle, WA 98109

E-mail: ann.lesperance@pnl.gov