United States General Accounting Office

GAO

Testimony

Before the Subcommittee on Energy and Environment,
Committee on Science
House of Representatives

For Release
on Delivery
Expected at 10:00 a.m. EST
Wednesday, December 6, 1995

SUPERFUND

Use of Innovative Technologies for Site Cleanups

Statement by
Lawrence J. Dyckman, Associate Director,
Environmental Protection Issues,
Resources, Community, and Economic
Development Division

GAO/T-RCED-96-45

Mr. Chairman and Members of the Subcommittee,

Thank you for the opportunity to participate in the Subcommittee's discussions of Superfund research and development activities, such as developing more efficient ways for cleaning up Superfund sites. The Subcommittee is reconsidering the scope and direction of these activities in view of the ongoing debate on Superfund's reauthorization. Reauthorization may bring major changes to Superfund in such areas as how sites are cleaned up and responsibility is divided between the federal and state governments. These changes, in turn, may call for modifications to Superfund's research and development effort. In past and ongoing work, we have assessed an important component of this effort--the Environmental Protection Agency's (EPA) attempts to promote the use of innovative technologies at Superfund sites.[1] We believe that the findings of our work are relevant to the Subcommittee's effort to guide the future direction of Superfund's research and development.

In response to your request, our testimony today focuses on three areas: (1) how often EPA uses innovative technologies at Superfund sites, (2) what factors limit the use of innovative technologies, and (3) how EPA's Superfund Innovative Technology Evaluation program encourages the development and use of innovative technologies at Superfund sites.

In summary, we found the following:

--EPA used innovative technologies in about 20 percent of its cleanup decisions made during 1994 at Superfund sites. (See app. I for a description of innovative technologies used at Superfund sites.) A recent EPA study also showed that the various parties that could be responsible for the cleanups, such as EPA, other federal agencies, or private parties, were as likely to select innovative technologies.[2]

--A number of barriers currently inhibit the further development and routine use of innovative technologies at Superfund sites. These barriers include the need to meet difficult regulatory standards, technical limitations, limited

---

[1]EPA considers a technology to be innovative if it has not been used in a full-scale application or if it is the first-time application of an existing technology to a new contaminant. More specifically, EPA defines innovative treatment technologies as those that lack the cost and performance data necessary to support their routine use.

[2]Feasibility Study Analysis, Volume 1: Findings and Analysis, prepared for the Technology Innovation Office by Environmental Management Support, Inc. (Silver Spring, Md., Apr. 21, 1995).

cost and performance data, and the lack of incentives to invest in the development of innovative technologies.

--EPA's primary program for encouraging the development and use of innovative technologies at Superfund sites is the Superfund Innovative Technology Evaluation (SITE) program. EPA's SITE program is intended to remove the barriers that innovative technologies face. Located within EPA's Office of Research and Development, the SITE program is a major part of EPA's research into innovative cleanup methods for Superfund sites. SITE's primary functions include testing unproven technologies at Superfund sites and publishing information on the performance of new technologies.

BACKGROUND

Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), which created the Superfund program, EPA assesses hazardous waste sites and places the most seriously contaminated ones on its National Priorities List (NPL). CERCLA makes certain parties, including those who contaminated the sites, responsible for cleaning them up, but it also established a trust fund to pay for cleanups when the parties cannot or will not pay. Since CERCLA's enactment in 1980, EPA has placed nearly 1,300 sites on the NPL.

The Superfund Amendments and Reauthorization Act of 1986 (SARA) required EPA to establish a research and development program for innovative treatment technologies. EPA's Superfund research and development is focused on four main research topics: (1) improving Superfund risk assessments; (2) making other site studies more accurate, faster, and less expensive; (3) performing research into cleanup technologies; and (4) providing better technical support.

In addition to its research and development efforts, EPA makes other efforts to increase the use of innovative technologies at Superfund sites. For example, the Technology Innovation Office acts as a clearinghouse for information on innovative cleanup technologies. Furthermore, EPA has also issued guidance that encourages its regional offices to consider innovative technologies for cleaning up Superfund sites.

EPA'S USE OF INNOVATIVE TECHNOLOGIES

EPA selected an innovative technology in about 20 percent of all the cleanup decisions made in 1994--up from 6 percent in 1986. The most commonly used of these new technologies are soil vapor extraction, which flushes contaminants into the air for further treatment, and bioremediation, which uses microorganisms to break down the contaminants into less harmful forms. Nine years ago, innovative technologies were rarely used at Superfund

sites; since then, they have been selected over 290 times. (See app. II for a table of innovative technologies by fiscal year.)

A recent EPA study also showed that the various parties that could be responsible for the cleanups, such as EPA, other federal agencies, or private parties, were as likely to select innovative technologies. However, no matter which organization is leading the cleanup effort, a number of barriers exist to the wide-spread use of innovative technologies at Superfund sites.

BARRIERS TO THE USE OF INNOVATIVE TECHNOLOGIES

Several factors, often inherent in any unproven technology, have inhibited the further development and widespread use of innovative technologies at Superfund sites. These factors include (1) regulatory standards, (2) technical limitations of innovative technologies (3) lack of sufficient cost and performance data, and (4) lack of incentives for private industry to invest in innovative technologies.

Regulatory Standards

Innovative technologies have difficulty in meeting the regulatory cleanup standards at many Superfund sites. For example, for the treatment of Polychlorinated Biphenyls (PCBs), EPA sets standards, derived from its toxic substances regulations, that are based in part on the performance of incinerators. Innovative technologies generally have been unable to meet these standards at PCB-contaminated Superfund sites. Recognizing this barrier, EPA recently proposed amendments to its toxic substances regulations to allow more flexibility in the cleanup standards for PCBs. Specifically, the proposal would allow, in addition to performance-based standards, other types of standards, including health-based ones, that may be potentially easier for innovative technologies to meet.

The House and Senate reauthorization proposals for Superfund, which are currently being considered would reduce the number of federal and state requirements potentially applicable to Superfund cleanups. If these proposals passed, innovative technologies would in some cases need to meet fewer cleanup standards.

Technical Barriers

Innovative technologies are, by definition, at their early stages of development and may only be applicable to certain site conditions or specific types of contamination. For example, these technologies are generally not yet suited for cleaning up sites with highly toxic contaminants (such as PCBs or dioxin), large amounts of contaminated materials, high concentrations of a contaminant, or multiple contaminants. In addition, their

performance can vary depending on the physical and chemical characteristics of the contaminated material, such as moisture levels, clay and silt content, and the presence of other chemical substances. On the other hand, more traditional cleanup technologies, such as incineration, are generally effective over a wide range of conditions.

Limited Cost and Performance Information

Innovative technologies have generally not gone through full-scale application at Superfund sites. Therefore, data on their cost, performance, and suitability under various site conditions are generally not available. EPA officials believe that technologies must be used multiple times under a variety of conditions before their cost and performance data become reliable and acceptable for cleanup decision-making purposes.

Because the information necessary to make cleanup decisions is not readily available, EPA and private industry officials responsible for cleaning up Superfund sites have been reluctant to choose unproven innovative technologies. To overcome this reluctance, EPA entered into a cooperative agreement with Clean Sites[3] in 1992 to demonstrate full-scale applications of innovative technologies at several federal facilities. The goal of the agreement is to demonstrate innovative technologies at real sites in order to generate actual performance data. Seven demonstrations are currently under way; however, data are not yet available on their outcome.

Lack of Incentives to Invest in Innovative Technologies

Uncertainty about both the market for site cleanups for certain types of contamination and future regulatory cleanup standards also create a disincentive for private industry to invest in innovative technologies. For example, the production of PCBs stopped in 1977, and the number of sites known to be contaminated with dioxin is relatively small. Also, House and Senate reauthorization bills would eliminate the current law's preference for permanent cleanup remedies, that is, remedies that eliminate contaminants rather than merely containing them on-site. Since innovative technologies often are intended to provide permanent remedies, this change could add additional uncertainty about the strength of the future market for new technologies. Furthermore, because the promulgation of a new environmental standard often takes many years, investors often choose to wait rather than invest in innovative technologies. They worry that if they invest money in a new technology, by the time the new standards come into effect, the technology might be

---

[3]Clean Sites is a nonprofit corporation whose mission is to improve the cleanup of hazardous waste sites.

obsolete.

EPA'S SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION PROGRAM

Under the SITE program, EPA enters into cooperative agreements with private technology developers who, after refining their technologies on a small scale, may demonstrate them, with support from EPA, at Superfund sites. In fiscal year 1995, SITE spent about $12 million to demonstrate 11 technologies. SITE's budget for demonstrations represented about 20 percent of Superfund's entire research and development budget and about 50 percent of EPA's budget for Superfund cleanup technology research.

SITE has four components. The Demonstration Program publishes data on the cost, performance, reliability, and applicability of selected innovative technologies after field demonstrations are conducted. The Emerging Technologies Program provides financial assistance to developers of new technologies undergoing laboratory tests. The Monitoring and Measurement Technologies Program tests new technologies to assess the nature and extent of contamination at sites. The Technology Transfer Program disseminates information derived from the other three SITE components to interested parties.

SITE solicits technologies for inclusion in the program through annual requests for proposals. The criteria that SITE uses to select technologies for demonstration include the technology's potential for reducing contamination, the technical viability of the technology, and the technology developer's potential for commercializing the technology. We said in our testimony of April 1993,[4] that SITE did not target its solicitations in an attempt to address any specific technology needs. However, in our current review we noted that the January 1995 SITE solicitation for proposals generally did advise technology developers of EPA's particular interest in innovative technologies for cleaning up specific types of contaminants.

Superfund officials involved in cleaning up sites told us that SITE's demonstrations often focus on the science of the innovative technologies and thus provide only limited information describing potential implementation problems at actual Superfund sites. For example, the EPA site manager at Times Beach (Missouri) told us that SITE had initially been extremely positive about the scientific potential for using one of its demonstrated technologies at Times Beach. However, after learning the specific site characteristics, such as the large volume and types of contaminated material, SITE officials

---

[4]Superfund: EPA Needs to Better Focus Cleanup Technology Development (GAO/T-RCED-93-34, Apr. 28, 1993).

conceded that the technology was inappropriate.

Superfund program officials told us that they began to work with SITE in 1993 to make its information more useful. As a result, additional information has been added to SITE's technology demonstration reports. However, SITE program officials told us that time and resource constraints will always limit the amount of information they can provide.

- - - - -

In summary, we believe that EPA has made progress over the years in using innovative technology at Superfund sites. However, these technologies are still used at only a relatively small portion of the sites. Greater use of new technologies, which can reduce the cost of cleanups, has been prevented by various factors such as regulatory standards, the absence of track records for these technologies, and uncertainties about future regulatory standards. Even after the Congress reauthorizes Superfund, it is likely that these challenges to the development and use of new technologies will continue.

Mr. Chairman, this concludes our prepared statement. We will be glad to respond to any questions that you or members of the Subcommittee may have.

TYPES OF INNOVATIVE TECHNOLOGIES USED BY EPA

Dechlorination results in the removal or replacement of chlorine atoms bonded to hazardous compounds. EPA has selected dechlorination to treat polychlorinated biphenyls (PCBs), dioxins, pesticides, and semivolatile organic compounds (SVOC).

Ex-situ bioremediation is a technology that uses microorganisms to degrade organic contaminants on excavated soil, sludge, and solid wastes. The microorganisms use the contaminants for food, thus breaking them down; the end products are typically carbon dioxide and water. Ex-situ bioremediation includes slurry-phase bioremediation, in which the soils are mixed with water to form a slurry, and solid-phase bioremediation, in which the soils are placed in a tank or building and cultivated with water and nutrients. EPA has selected bioremediation to treat volatile organic compounds (VOC), SVOCs, and polycyclic aromatic hydrocarbons (PAH).

In-situ bioremediation involves pumping nutrients, an oxygen source, and sometimes microbes into the soil or aquifer under pressure through wells or spreading them on the surface for infiltration to the contaminated material. The microorganisms present in the soil then degrade the contaminants as in ex-situ bioremediation.

In-situ flushing introduces large volumes of water, at times supplemented with treatment compounds, into the soil, waste, or groundwater to flush hazardous contaminants from a site. This technology assumes that injected water can be effectively isolated within an aquifer and recovered. EPA has selected this technology to treat VOCs, metals, SVOCs, and PAHs.

In-situ vitrification treats contaminated soil in place at temperatures of approximately 3,000 degrees Fahrenheit. Metals are encapsulated in a glass-like structure of melted silicate compounds. Organic wastes may be treated by combustion. EPA has selected the remedy to treat metals, pesticides, VOCs, and SVOCs.

Soil vapor extraction removes volatile organic constituents from the soil by using vapor extraction wells, sometimes combined with air injection wells, to strip and flush the contaminants into the air stream for further treatment. Vacuum extraction has been selected to treat halogenated and nonhalogenated VOCs, benzene, toluene, ethylbenzene, xylene, and SVOCs.

Soil washing physically removes contaminants from soil particles through mechanical action and washing with water (sometimes using additives). The agitation of the soil particles allows the

smaller-diameter, more highly contaminated fine particles to separate from the larger soil particles, thus reducing the volume of material that needs subsequent treatment. EPA has selected this remedy to treat metals, PAHs, dioxins, pesticides, and SVOCs.

Solvent extraction is a process that operates on the principle that organic contaminants can be separately dissolved and removed from the waste in a solvent. The solvent used varies depending on the waste to be treated. EPA has selected this remedy to treat PCBs, VOCs, PAHs, dioxins, and SVOCs.

Thermal desorption is a process that heats waste in a controlled environment to cause organic compounds to volatilize from the waste. The operating temperature is less than 1,000 degrees Fahrenheit. The volatilized contaminants will usually require further control or treatment. The contaminants most often treated with thermal desorption include VOCs, PCBs, SVOCs, pesticides, and metals.

NUMBER OF CLEANUP ACTIONS (REMEDIAL AND REMOVAL) FOR WHICH EACH TYPE OF INNOVATIVE TECHNOLOGY WAS SELECTED, BY FISCAL YEAR

	Fiscal year of record of decision									
Technology[a]	1986	1987	1988	1989	1990	1991	1992	1993	1994	Total
Ex-situ bioremediation	1	0	4	7	4	4	8	6	5	39
In-situ bioremediation	0	1	2	0	3	3	4	7	5	25
Dechlorination	0	0	0	0	1	2	0	0	0	3
In-situ flushing	1	0	1	3	1	3	4	2	3	18
In-situ vitrification	0	0	0	0	0	1	0	0	0	1
Soil washing	0	0	2	2	6	1	1	0	0	12
Solvent extraction	0	0	0	3	0	1	0	1	1	6
Thermal desorption	1	3	4	2	8	10	5	10	7	50
Soil vapor extraction	2	1	7	22	17	33	18	22	11	133
Other technologies	0	0	0	0	0	1	2	0	1	4
Total	**5**	**5**	**20**	**39**	**40**	**59**	**42**	**48**	**33**	**291**

Note: While in absolute numbers the cleanup actions for which an innovative technology was selected declined after 1991, they have increased as percentage of total treatment technologies since 1986.

[a]For technology definitions, see app. I.

(160333)

Ordering Information

The first copy of each GAO report and testimony is free. Additional copies are $2 each. Orders should be sent to the following address, accompanied by a check or money order made out to the Superintendent of Documents, when necessary. VISA and MasterCard credit cards are accepted, also. Orders for 100 or more copies to be mailed to a single address are discounted 25 percent.

Orders by mail:

U.S. General Accounting Office
P.O. Box 6015
Gaithersburg, MD 20884-6015

or visit:

Room 1100
700 4th St. NW (corner of 4th and G Sts. NW)
U.S. General Accounting Office
Washington, DC

Orders may also be placed by calling (202) 512-6000 or by using fax number (301) 258-4066, or TDD (301) 413-0006.

Each day, GAO issues a list of newly available reports and testimony. To receive facsimile copies of the daily list or any list from the past 30 days, please call (202) 512-6000 using a touchtone phone. A recorded menu will provide information on how to obtain these lists.

For information on how to access GAO reports on the INTERNET, send an e-mail message with "info" in the body to:

info@www.gao.gov

United States
General Accounting Office
Washington, D.C. 20548-0001

Bulk Rate
Postage & Fees Paid
GAO
Permit No. G100

Official Business
Penalty for Private Use $300

Address Correction Requested