TECHNOLOGY NEEDS AND EMERGING TECHNOLOGIES

JOINT ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT ACTIVITIES

A Report by the Federal Working Group

In Response To
A Memorandum of Understanding
Between

The Western Governors' Association

and the
U.S. Department of Defense
U.S. Department of the Interior
U. S. Department of Energy
U.S. Environmental Protection Agency

October 1992

BIBLIOGRAPHIC INFORMATION

PB93-111Ø52

Report Nos: none

Title: Technology Needs and Emerging Technologies (Joint Environmental Restoration and Waste Management Activities).

Date: Oct 92

Performing Organization: Western Governors' Association, Denver, CO.

Sponsoring Organization: *Department of Defense, Washington, DC. *Department of the Interior, Washington, DC. *Department of Energy, Washington, DC. *Environmental Protection Agency, Washington, DC.

Supplementary Notes: Sponsored by Department of Defense, Washington, DC., Department of the Interior, Washington, DC., Department of Energy, Washington, DC., and Environmental Protection Agency, Washington, DC.

NTIS Field/Group Codes: 68C, 68D, 7ØF

Price: PC A1Ø/MF AØ3

Availability: Available from the National Technical Information Service, Springfield, VA. 22161

Number of Pages: 2Ø6p

Keywords: *Environmental surveys, *Waste management, Technology transfer, Cooperation, Classifying, International trade, Markets, Decision making, Cost reduction, Safety, Technology assessment, National government, Licenses, Cleanup.

Abstract: The report was prepared by an interagency Federal Working Group. It references detailed information produced by the agencies as of June 1992 on needs and technologies in environmental restoration and, to a lesser extent, in waste management and provides a very general overview of that material. It does not represent new or independent analysis of technology needs or of emerging technologies. The purpose of the MOU is 'to establish a more cooperative approach to development of technical solutions to the environmental restoration and waste management problems shared by States, commercial entities, and the Federal government.' All Federalsignatories are committed to cooperatively developing solutions to the Nation's cleanup problems. The cooperation must be both between and among the Federal signatories, and between the Federal signatories and the WGA. To provide more cogent analysis in future reports, common terminology for classifying technology needs and initiatives must first be devised by the agencies.

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EXECUTIVE SUMMARY

Background. "Technology Needs and Emerging Technologies" is one of three initial Federal responses to a Memorandum of Understanding (MOU) signed by the U.S. Departments of Defense, Interior, Energy, and the Environmental Protection Agency with the Western Governors' Association (WGA). This report was prepared by an interagency Federal Working Group. It references detailed information produced by the agencies as of June 1992 on needs and technologies in environmental restoration -- and, to a lesser extent, in waste management -- and provides a very general overview of that material. It does not represent new or independent analysis of technology needs or of emerging technologies.

- The purpose of the MOU is "to establish a more cooperative approach to development of technical solutions to the environmental restoration and waste management problems shared by States, commercial entities, and the Federal government."

- All Federal signatories are committed to cooperatively developing solutions to the Nation's cleanup problems. The cooperation must be both between and among the Federal signatories, and between the Federal signatories and the WGA.

- To provide more cogent analysis in future reports, common terminology for classifying technology needs and initiatives must first be devised by the agencies.

Agency Goals for Technology Development. The participating agencies share the goal of securing a cost-effective cleanup of contaminated Federal facilities and sites. The agencies also seek to help U.S. firms utilize new environmental restoration technologies in order to reduce their environmental compliance costs and to help develop domestic and international markets. All signatories recognize the need for rigorous attention to interagency cooperation and sharing of information, both among themselves and with the public. Such cooperation can help the agencies avoid duplication of effort, improve decision-making, and leverage resources. The execution of this agreement can also help demonstrate principles and practices which may be adopted nationally.

Common Agency Technology Needs and Challenges. Federal agencies involved in the cleanup have a clear interest in promoting the development of new and better technologies that will safely help speed up and reduce the costs of environmental restoration. They also understand that the large number of sites to be remediated provides a great domestic and international business opportunity for firms that develop or license new technology.

Five common themes emerge in discussing needs and challenges:

- Cost reduction, speed, and safety and ease of operation are important technology assessment criteria for all Federal signatories.

- Mixed (radioactive and hazardous chemical) wastes pose one of the greatest technical challenges because of the difficulty of segregating the components.

- Groundwater and other subsurface contamination pathways are often of more concern than surface or airborne pathways because they are harder to access.

- Preventing pollution is preferable to removing contamination.

- Significant barriers exist to the development, deployment, and transfer of new environmental restoration and waste management technologies.

Overcoming Barriers to Deployment of Emerging Technology. The Federal signatories generally agree in their assessments of the developmental status of particular technologies, and about the following steps that are necessary to assist technology development:

- All Federal signatories advocate the use of Federal facilities as central, permitted test sites to demonstrate technology systems applicable to remediation problems of broad National concern. The Federal Working Group anticipates that, with the concurrence of the WGA and the affected States, the first such demonstration under the auspices of this MOU will be underway during 1993.

- These demonstrations must become a collaborative enterprise among Federal agencies and laboratories, private laboratories and research institutes, State and local governmental bodies, academia, and private industry.

- This enterprise must be driven by private industry's response to domestic and international environmental marketplace needs, must include mechanisms for including the public as partners in the decision process, and must incorporate innovative means for facilitating technology transfer to the private sector, including small businesses.

- Unless private industry can make a profit using new technologies, they will not be implemented, and government's aims to reduce the taxpayer's environmental burden and secure economic advantages will fail.

Technology Development Funding and Regional Relevancy. Because of differences in the way environmental restoration and waste management research and development activities are categorized within each agency, it is difficult to develop an internally consistent aggregate value for current funding levels. Nonetheless, requested funding appears to be approaching three-quarters of a billion dollars in the FY 1993 President's Budget. The agencies are not as yet able to provide a State-by-State analysis of funding, but the location of Federal facilities suggests that a significant fraction is to be spent in the West.

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Chapter II - AGENCY MISSIONS AND REQUIREMENTS

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2-B 1,709 Federal facility sites are on the Federal Agency Hazardous Waste Compliance Docket. An additional 116 are on the Environmental Protection Agency's (EPA) National Priorities List and 120 are covered by Section 120 (Superfund) Federal Facility Agreements.

2-C EPA has established the Technology Innovation Office to increase the application of innovative treatment technologies to contaminated soil and groundwater by both government and industry.

3-B The Department of Defense's (DoD) Defense Environmental Restoration Program has identified 17,600 potential sites at 1,877 installations for cleanup actions. Only 90 of those sites are on EPA's National Priorities List.

3-C DoD's Project Reliance has been organized to develop strong Army-Navy-Air Force teams to perform environmental research.

4-B The Department of Interior (DOI) has 422 sites listed on the Federal Facilities Hazardous Waste Compliance Docket. Only three of these sites are on EPA's National Priorities list.

4-C DOI's "waste management initiative" focuses on preventing hazardous waste generation, reduction of wastes generated, management of waste materials, cleanup of contaminated areas, and restoration of injured natural resources. DOI's FY 1993 cleanup request is $79.6 million, representing more than an eight-fold increase from FY 1988.

5-B The Department of Energy (DOE) nuclear weapons complex has 3700 contaminated sites and some 500 surplus facilities awaiting decontamination and decommissioning; another 5200 sites and 5000 peripheral properties having soil contaminated with uranium mill tailings are also a DOE responsibility.

5-C DOE has created a "Stakeholders Forum" and other bodies to support and encourage participation from Federal and State officials, public interest groups, university consortiums, industry groups, major Department contractors, and others in review of DOE plans and programs for achieving compliance with environmental laws. DOE has requested $5.317 billion in funding for Environmental Restoration and Waste Management activities in FY 1993.

CHAPTER III - COMMON PROBLEMS AND AGENCY TECHNOLOGY NEEDS

Section

1-B Mixed wastes, or radioactive waste containing hazardous chemical components, pose the most intractable challenges to the cleanup effort. Groundwater and other sub-surface pathways for contamination spread are generally of more concern than surface or airborne pathways, due to lack of access for remediation.

2-A DoD's cleanup goal is to have remediation technologies in place, and cleanup underway or actually complete, by the year 2000. Project Reliance has identified several dozen specific technologies needed under the pillars of cleanup, compliance, pollution prevention and conservation stewardship. Specific services are addressing these technology needs in seven research and development areas.

2-B DOI bureaus are focusing individually on developing technology for mine-waste and inorganic contaminant problems (Bureau of Mines), assessing contamination of natural resources (Fish and Wildlife Service), underground storage tank and abandoned mine sites (National Park Service), contaminated landfills (Bureau of Land Management) and for improvements in cleanup pump-and-treat methods (Geological Survey).

2-C DOE has special concerns for mixed waste and radioactive waste streams. DOE is pursuing permanent disposal for these wastes. DOE is also focusing on developing technologies to help clean and decontaminate structures and equipment involved in decontamination and decommissioning activities.

CHAPTER IV - SUMMARY ASSESSMENT OF EMERGING TECHNOLOGY

Section

1-A EPA is working with private industry to carry environmental technology development beyond pilot and prototype development. DOI tends to focus on the early portions of the technology development process. DOE and DOD programs are more oriented toward technologies presently between the later parts of basic research and full scale development; technologies in these stages are defined as "emerging technologies" for purposes of this report.

1-B Financial barriers to private sector deployment of emerging technologies are recognized, including a fragmented market for soil and groundwater clean-up, and a lack of cost and performance data on various technologies.

1-C There is a trend away from selection of conventional technologies at Superfund sites for use with traditional hazardous wastes,

especially volatile organics. There has been little use of innovative technologies thus far on radioactive/mixed and heavy metal wastes.

1-D The EPA, DOD, and DOE "Experts Groups" have recognized that Federal facilities offer key advantages for demonstrations of innovative technological systems to remediate contaminated soil, groundwater, and sediments.

3-B Among numerous examples of Federal projects that are testing "emerging technologies" are those located at the National Defense Center for Environmental Excellence (pollution prevention and abatement technologies), The U.S. Geological Survey's National Water Quality Laboratory in Colorado (on-site waste reduction programs), Fallon Naval Air Station in Nevada (removal of jet fuel contamination from soil), and DOE's Ames Laboratory (remediation of heavy metals).

4-C Among interagency initiatives to supply information on remediation technologies to potential users, EPA, DOD, and DOE are cooperating with the American Academy of Environmental Engineers to prepare a series of monographs representing professional consensus on the status of sufficiently advanced innovative waste treatment technologies.

CHAPTER V - CURRENT AGENCY APPROACHES TO TECHNOLOGY DEVELOPMENT

Section

2-A In DOD, the Army is the lead service on technology support for dealing with installation restoration site investigation and characterization, explosives, heavy metals and other organic compounds. The Air force will address solvents and fuels, with the Navy exploring Navy-specific solvents and fuels problems.

2-B DOD has underway an active pollution prevention research effort to reduce the approximately 675,000 metric tons of hazardous waste generated each year.

2-C DOD is developing technologies to minimize the propagation and effects of operational noise on humans and wildlife.

2-D The Army is responsible for research and development related to protection of natural resources on military bases.

2-E Joint service programs are developing technologies that reduce the cost of compliance with the Clean Air Act and the Montreal Protocol on CFCs.

2-F The Navy is conducting global marine compliance research related to oily waste waters, plastics and hospital wastes, and toxic and hazardous materials.

3-A The Geological Survey is providing technical assistance to EPA and other agencies on site characterization and is working on the development of new technologies for the cleanup of contaminated ground water.

3-B The Bureau of Mines' Environmental Technology Research Program is developing technology to reduce the toxicity and volume of mining and mineral processing wastes, and to characterize and remediate a variety of hazardous wastes contaminated with heavy metals and other toxic constituents.

3-C The Bureau of Reclamation is focusing on desalting and treatment of surface or groundwater of impaired quality.

4-B DOE's Research, Development, Demonstration, Testing, and Evaluation (RDDT&E) Program focuses on groundwater and soils cleanup, waste retrieval and waste processing, waste minimization and waste avoidance, and RDDT&E innovation and support.

4-C DOE moves technology products into the field through integrated programs (IPs) and integrated demonstrations (IDs). Entire systems of technologies are evaluated in IDs with respect to performance, safety and cost effectiveness. In one integrated demonstration activity, the application of advanced technology to the problem of removing volatile organic compounds from the soil at DOE's Savannah River site has saved $125 million and a robotics development program at two DOE facilities has saved $15 million.

4-D DOE activities broadly supporting the RDDT&E Program include Analytical Services, Robotics, Decision Support, the Environmental and Molecular Science Laboratory, and Technology Integration and Environmental Education Development.

4-E DOE is preparing a Programmatic Environmental Impact Statement (PEIS) for the overall environmental restoration and waste management program as a means of bringing public views into its decision processes.

4-F DOE is producing a research and development investment strategy for innovative technologies that will combine the R&D capabilities of the DOE laboratories and universities and the skills of industry.

5-A EPA is working through its regional offices to explore the use of Federal facilities for both site-specific technology demonstrations, and as test locations for evaluation of more widely applicable technologies.

5-B EPA's Office of Research and Development (ORD) is conducting R&D to address: Hazardous Wastes, Superfund, Leaking Underground Storage Tanks, and Oil Spills.

5-C The Demonstration and Emerging Technology components of EPA's Superfund Innovative Technology Evaluation (SITE) Program assist private developers in commercializing alternative technologies for site remediation.

5-C EPA's Technology Innovation Office is completing a study to assist technology developers in assessing cleanup markets for Superfund, hazardous waste and underground storage tanks.

6-A The signatories recognize the National Technology Information Service as a possible central source for new information on environmental restoration and waste management technologies.

CHAPTER VI - CURRENT FUNDING AND REGIONAL RELEVANCY

Section

2-A Proposed FY 1993 DoD funding for environmental restoration and waste management research and development is $244 million.

2-B Proposed FY 1993 DOI funding for environmental restoration and waste management research, development and demonstration is $63 million.

2-C Proposed FY 1993 DOE funding for its major environmental restoration and waste management research, development and demonstration programs is $301 million. Of that figure, $126.1 million is specifically targeted in western states.

2-D Proposed FY 1993 EPA funding for environmental restoration and waste management research and development is $112 million.

CHAPTER VII - ONGOING PLANNING AND IMPLEMENTATION ACTIVITIES

Section

1-A The interagency Federal Remediation Technologies Roundtable is meeting to share information on new technologies and to transfer this information to other user communities.

2-B The Strategic Environmental Research and Development Program will help provide DoD, DOE, and EPA a source of funds that will allow them in cooperation with other Federal and State agencies, to conduct joint research, development, and demonstration projects relating to innovative technologies.

2-C Interagency technical cooperation in environmental restoration and waste management is already extensive. Examples include: the Geological Survey is working to characterize and cleanup past spills at 45 DoD installations as part of DoD's Installation Restoration Program; DOE and EPA are co-sponsoring a forum on innovative hazardous waste treatment technologies in San Francisco, November 17-19, 1992; EPA is also working with the Air Force to conduct demonstration of bioventing on jet fuel-contaminated soils at fifty sites on bases across the U.S.

3-A Although the Federal agencies expect to spend on the order of two hundred billion dollars during the next 30 years to restore sites, these Federal programs are dwarfed by the challenge of restoring America's contaminated industrial sites. Industrial environmental restoration produced $130 billion in business activity during 1990, and waste management produced $120 billion in business activity during 1991.

3-B The Federal agencies suggest, for consideration in cooperative technology demonstration projects with the WGA, the problem areas of: groundwater contamination; decontamination and decommissioning of contaminated facilities; ex situ technologies such as site characterization instrumentation, waste characterization equipment, and waste treatment concepts; and treatment technologies for mixed wastes, explosives, and chemical munitions which emphasize process control for air emissions and land disposal restrictions.

3-B The Federal agencies propose exploring with the WGA ways to transfer technology that encourage the growth of a healthy regional and national environmental industry having both technical capabilities and supporting infrastructure.

3-B The Federal agencies welcome expansion of Cooperative Research and Development Agreements and other methods of cooperation between Federal laboratories and industrial and academic partners in the Western states.

CHAPTER I
INTRODUCTION AND BACKGROUND

1. PURPOSE

The Western Governors' Association (WGA) and the Federal signatories of the Memorandum of Understanding (MOU) regarding environmental restoration and waste management (ER/WM) activities have recognized the necessity to establish a more cooperative approach to development of technical solutions to environmental restoration and waste management problems. Such cooperation will foster more cost-effective and timely technology development and will enhance long-range efforts to restore and protect the environment. This can build on examples of cooperation between the signatories which already exist, and can in turn serve as a model for further cooperation between the Federal government and other State and Territorial elected officials -- individually, regionally, or nationally -- on environmental restoration and waste management issues.

Several motivations for a concerted, cooperative technology development effort exist. First, in many instances, technologies to accomplish certain cleanup and waste management tasks are either nonexistent or ineffective. Second, the development and implementation of new technologies can significantly help to reduce the cost of the cleanup.[1] Third, development of such technologies, and the technically and managerially trained workforce to implement them, can help to secure regional and national economic advantages by making industry more competitive.

This report addresses ER/WM technology needs, and the capacity of emerging technologies to meet those needs, as they relate to Federal facilities in the Western States and nationally.

2. RELATIONSHIP TO OTHER REPORTS

Two companion reports also provide information from the Federal signatories on ER/WM issues. One of these assesses the effectiveness of the current regulatory process for selecting technological remedies for ER/WM problems at Federal and, where relevant, private sector sites. It also identifies regulatory barriers to the development (and deployment) of faster, cheaper, better, and/or safer technologies as remedies for these same problems.[2] The other report pertains to workforce planning, providing information on appropriate employment,

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[1] "Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production", page 67, Office of Technology Assessment, 1991.

[2] "Technology Selection Processes and Regulatory Barriers to Technology Development: Joint Environmental Restoration and Waste Management Activities", the Federal Working Group for Implementation of A Memorandum of Understanding between the Western Governors' Association and Various Federal Agencies (in preparation).

education, and retraining opportunities, and suggesting short-term skills training and retraining curricula related to environmental restoration.[3]

3. SCOPE

This report, like its companions, provides an initial response by the Federal participants. It does not include any material from, or reflect coordination with, any parallel WGA activity, but is intended to prepare the groundwork for a more cooperative approach to development of technical solutions to ER/WM problems shared by States, commercial entities, and the Federal government, as specified in the MOU.

The report represents the best available assessment of current needs, capabilities, opportunities, and resources. Unless otherwise specified, the data provided is current as of June, 1992.

The information provided in this report was drawn from a broad and non-standardized array of studies and analyses. These studies compose a mosaic from which initial judgments are possible regarding broad categories of technology. The Federal participants recognize, however, that there is a need to develop a common framework of information that would allow a more detailed discussion of technology needs and emerging technologies.

The focus of the report is generally national. Where the data permits, of course, specific information pertaining to Western Governors' Association concerns is included.

4. ORGANIZATION OF THE REPORT

The report is organized into seven chapters as follows:

- Chapter I contains background regarding the creation of this report and its purpose, scope, and organization;
- Chapter II contains a discussion of the different Federal departmental and agency missions, tasks, organizational structures, and responsibilities in areas of ER/WM which determine their needs for technologies and have led to their approaches to ER/WM technology research, development, and demonstration (RD&D);
- Chapter III contains a discussion of ER/WM problems common to Federal sites (i. e., multi-agency problems) and often to private sector sites regulated by the Federal government and/or the States,

[3] "Workforce Planning: Joint Environmental Restoration and Waste Management Activities", The Federal Working Group on Implementation of a Memorandum of Understanding between The Western Governors' Association and Various Federal Agencies, October, 1992.

along with a more specific discussion of individual agency technology needs;

- Chapter IV contains a summary assessment of relevant emerging technologies by each of the Federal participants and discusses the opportunities to accelerate technology deployment through using Federal facilities as demonstration sites;

- Chapter V contains a discussion of current agency approaches to secure and deploy faster, cheaper, better and/or safer ER/WM technologies through RD&D, and efforts to integrate reporting of information about needs (and solutions) across the Federal government;

- Chapter VI contains a summary of current Federal funding for RD&D in these technical areas within each of the signatory departments or agencies, with special emphasis given, where possible, to the relevance of this funding to the western states;

- Chapter VII contains a brief discussion of ongoing planning and implementation activities to leverage technical development programs through improved cooperation among the Federal participants themselves, and suggests areas of cooperation with the WGA and/or the private sector; and,

Appendices follow the chapters, with supporting, more detailed information, including bibliographic information on relevant documents too lengthy to be attached to this report.

5. BACKGROUND

A. Federal Laws Governing Environmental Restoration and Waste Management

In recent years, a series of Federal environmental laws applying to Federal facilities was passed in recognition of the need to clean up these damaged sites that dot the landscape. These key laws are cited repeatedly throughout the body of this report, and are discussed briefly here for simplification. A more complete discussion can be found in the companion report pertaining to the technology selection process and regulatory barriers. This report does not address the regulatory authority that States and Territories have over Federal facilities because these authorities differ from state to state, and from facility to facility.

The National Environmental Policy Act (NEPA)[4] of 1969 is the foundation of Federal environmental law. NEPA establishes goals for the protection, maintenance, and enhancement of the environment and establishes principles and processes for Federal agencies to consider in decision-making.

[4] National Environmental Policy Act of 1969, as amended, 42 United States Code 4321-4370a (1988).

NEPA encourages public participation in decision-making by requiring Federal agencies to report publicly on what is known about the impacts of proposed Federal actions and on potential alternative courses of action. NEPA's scope is far broader than environmental restoration and waste management topics, but can be considered as a model for the narrower, more technically oriented ER/WM laws which were subsequently enacted.

The Resource Conservation and Recovery Act (RCRA)[5] of 1976 established a comprehensive framework for overall hazardous waste management by generators, transporters, and owners/operators of treatment, storage, and disposal facilities. RCRA was significantly strengthened by the Hazardous and Solid Waste Amendments of 1984 (HSWA). These require investigation and remediation of various hazardous waste and solid waste management units located at facilities subject to RCRA and define a "corrective measures" process to govern this investigation and remediation. RCRA authorizes states to assume the lead role in hazardous waste regulation under U.S. Environmental Protection Agency supervision when a state can demonstrate that their regulatory structure is at least as stringent as the Federal program.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as "Superfund",[6] was enacted in 1980. CERCLA provides both funding and enforcement authority for remediation of hazardous waste sites. The Superfund Amendments and Reauthorization Act of 1986 (SARA)[7] included a program defining CERCLA's application to Federal facilities. Unlike RCRA, CERCLA is generally administered by EPA itself without delegation of authority to states. EPA's procedures for implementing CERCLA are contained in a National Contingency Plan (NCP), and the "remedial action process" governing CERCLA remediation is similar to, but different in important ways from, the corrective measures process governing RCRA.

CERCLA also requires that contaminated sites owned or operated by any Federal department, agency or instrumentality which may require remediation under CERCLA (or RCRA) be reported to EPA and placed on a Federal Agency Hazardous Waste Compliance Docket. This Docket is an information base available for public inspection at reasonable times. Sites from this Docket may also be added to the National Priorities List. The timing and methods of bringing these sites into compliance with environmental law may be negotiated among EPA, the owner/operator Federal agency and the affected State.

Other environmental laws may also have significant impacts, directly or indirectly, on the development and selection of particular technologies for

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[5] Resource Conservation and Recovery Act of 1976, as amended, 42 United States Code 6901-6992k (1988).

[6] Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 United States Code 9601-9675 (1988).

[7] Superfund Amendments and Reauthorization Act of 1986, Public Law No. 99-499, 100 Stat. 1613 (1986).

the remediation of particular sites or wastes. The Atomic Energy Act (AEA)[8] governs the management and security of nuclear materials and technologies for manipulating such materials. As such, it is an important consideration at all nuclear weapons complex facilities, which are under the authority of the U.S. Department of Energy. Remediation and waste management at many Federal facilities is directed at the protection or restoration of water resources; standards applicable to such resources are set forth in the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA).[9] Remedial actions must also comply with the Clean Air Act (CAA)[10] when those actions could potentially involve airborne emissions (e. g., as in incineration).

B. Memorandum of Understanding

In July 1991, a Memorandum of Understanding (MOU)[11] regarding Environmental Restoration and Waste Management in Western States was signed by the U.S. Departments of Defense, Interior, and Energy, the U.S. Environmental Protection Agency, and, representing twenty western State and Territorial Governors, the WGA. The purpose of the MOU is "to establish a more cooperative approach to develop technical solutions to environmental restoration and waste management problems shared by States, commercial entities, and the Federal government." The regional approach will serve as a demonstration of principles and practices which may be adopted nationally.

The objective of the MOU is "...to encourage cooperation ...in research, development, and demonstration of cost-effective ...technologies germane to Federal lands and facilities in western states and insular areas, and associated information exchange related to waste management." All signatories are committed to fostering the development of better, faster, safer, and more cost-effective site restoration and waste management technologies and methods.

The MOU calls for the development of an annual report to identify and prioritize regional waste management RD&D needs on Federal lands and facilities, and to assess existing commercial capabilities and technology development initiatives. The report will highlight current funding levels and the most urgent waste management problems at Federal sites and identify for demonstration the most promising new solutions.

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[8] This Act, passed in 1954 placed production and control of nuclear materials within a civilian agency, originally the Atomic Energy Commission (AEC). The Department of Energy, the Nuclear Regulatory Commission, and the Environmental Protection Agency now all have fields of responsibility and authority regarding radioactive materials. International treaties (related to nonproliferation, for example) may also apply.

[9] Federal Water Pollution Control Act, as amended, 33 United States Code, 1251-1387 (1988).

[10] Clean Air Act, as amended, 42 United States Code, 7401-7642 (1991).

[11] MOU is attached at Appendix A.

C. Implementation Planning

An Implementation Plan[12] was designed to create the mechanisms necessary to implement the MOU and to provide a rational basis to pursue regional cooperative efforts. This Plan envisioned that a Federal Working Group (FWG) would begin work separately from the WGA during the summer of 1992 while mechanisms were developed to enable further collaboration. During the period, the Federal Working Group would focus on five tasks:

- Identification of technology needs at Federal facilities in Western States;
- Identification/assessment of emerging technologies within the Federal and private sectors;
- Assessment of the effectiveness of technology selection processes;
- Identification of regulatory barriers to technology development; and,
- Workforce Planning.

The White House guides Federal implementation activities through the Office of Policy Development. The FWG consists of representatives of all of the signatory departments and agencies, with representation from the Office of Management and Budget in an *ex officio* capacity. The Department of Energy has been assigned responsibility for day-to-day coordination of FWG tasks.

The Implementation Plan also specifies that the FWG will consult with other ongoing Federal interagency forums for addressing ER/WM RD&D issues, such as the Federal Remediation Technologies Roundtable, the Interagency Experts Group on Federal Facilities, and other pertinent Federal advisory bodies.

The Implementation Plan proposes that the WGA will, during the same period, address the same technology, regulatory, and workforce issues that the FWG addresses from a state and commercial perspective. As of the date at which this report was written, several of the WGA Governors have formed a Waste Task Force, supported by a staff group, which will be the nexus for such activities within WGA. The WGA has also signed a waste protocol among all its members establishing contacts for waste matters and governing communications on waste management issues, including many of those related to the MOU.

D. Activities of Federal Working Group

A committee of the Federal Working Group was formed in May, 1992, to consider Workforce Planning. In July, 1992 two additional committees were

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[12] Implementation Plan is attached at Appendix B.

formed, one to address the Technology Needs and Emerging Technologies tasks as a single, related activity, and the other to address the Technology Selection Process and Regulatory Barriers tasks. This report was prepared by the committee on Technology Needs and Emerging Technologies.[13]

E. Longer Term Cooperation

The FWG members fully endorse the intent of the MOU and the general process of coordination it proposes. Until more specific information is available relative to the WGA organizational structure for implementation, however, the FWG can only discuss its intentions regarding longer term coordination in broad terms.

The series of annual reports to be prepared under the MOU will grow more detailed over time as cooperative mechanisms between the Federal government and the WGA are better defined and as cooperation among the Federal participants themselves continues to expand. While these initial reports primarily address waste management issues most closely related to environmental restoration, cooperation in the future may be broadened to address other waste management issues of concern to the States, commercial entities, and the Federal government. One measure of the success of this cooperation will be the extent to which the MOU efforts motivate or provide a model for states and commercial entities in other regions of the nation to similarly join with the Federal agencies in addressing environmental concerns of interest in their regions. Expansion of the cooperation envisioned in this MOU into a multi-regional or national process will be actively encouraged.

[13] Members of and participants supporting this committee are listed at Appendix C.

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CHAPTER II
AGENCY MISSIONS AND REQUIREMENTS

1. GENERAL

All Federal agencies are committed to working with the States and the public to ensure an effective cleanup of Federal facilities and sites. This common approach shapes all Federal remediation and environmental stewardship programs. However, responsibilities for environmental restoration and waste management differ from agency to agency, so that information pertaining to the technologies required by each and their assessments of emerging technologies are shaped by individual agency missions, organizational structures, and functions. What follows is a survey of these differing organizational perspectives and involvement.

2. U.S. ENVIRONMENTAL PROTECTION AGENCY

A. The Backdrop

The Environmental Protection Agency was created in 1970 to control and abate pollution in the areas of air, water, solid waste, pesticides, radiation, and toxic substances. It endeavors to do this systematically, by proper integration of a variety of research, monitoring, standard setting and enforcement activities. The EPA is equally dedicated to improving and preserving the global environment.

B. The Challenge

EPA's challenge is national in scope and deals with two broad issues in the areas of hazardous waste.

EPA's first challenge is to respond to environmental contamination caused by past mismanagement of hazardous waste. Two decades ago, there were more than 10,000 municipal waste dumps in the United States, and tens of thousands of other locations where industry dumped its waste. Many of these were near surface water or above aquifers. Very few had adequate controls to ensure contaminants in the waste did not seep into the soil or water. Today, landfills are more carefully controlled, and the disposal of a wide range of hazardous substances has been outlawed.

In 1980, the EPA's Superfund Program to implement CERCLA was launched and, with the States' help, over 34,000 potential waste sites have been evaluated. From among this group, the Agency has placed on a "National Priorities List" (NPL) about 1,200 that need Superfund action, and cleanup efforts have been started at most of these. In 1986, $8.5 billion was provided over five years to pay costs for overseeing work by those responsible for remediating waste sites and to pay costs not assumed by responsible parties for cleanup at sites in the General Superfund Section of the NPL. In October, 1990,

an additional $5.1 billion in funding was provided to extend through September 30, 1994. EPA expects to have completed cleanups at several hundred sites by the year 2000. Statistical information on the status of the Superfund Program, with special emphasis given to Federal facilities, is shown in the table below.

Superfund Statistical Information

Status of the Superfund Inventory (as of June, 1992):

Sites evaluated; no further Federal action required	22,367
Sites evaluated; placed on the National Priorities List	1,235
Sites inspected; awaiting decision	6,652
Sites assessed; awaiting inspection	3,381
Sites awaiting initial assessment	2,223

Status of Work at Priority Sites (as of June, 1992):

Cleanup completed[1]	100
Cleanup underway	367
Remedies selected or under design	294
Detailed studies underway	425
Immediate threat evaluated; awaiting study	74

Status of Federal Facilities in Superfund Inventory (as of October, 1991):

Federal facility sites on the Federal Agency Hazardous Waste Compliance Docket	1709
Federal facility sites on National Priorities List	116
Federal facility sites covered by Section 120 Federal Facility Agreements	120

EPA's second challenge is to reduce current and future hazardous waste streams. The United States generates an estimated 150 million metric tons of hazardous industrial wastes annually, while its citizens and businesses produce another 130 million tons of non-hazardous waste. These waste streams pose a variety of environmental problems from scenic blight by litter to public health hazards caused by toxic contamination of groundwater. EPA and the states regulate hazardous waste management activities of more than 4,400 treatment, storage, and disposal facilities, 20,000 transporters, and 240,000 generators under the RCRA authority described in Chapter I. There are 327 Federal treatment, storage, and disposal facilities, and over 5,000 Federal facilities that generate hazardous wastes. Many of the regulated Federal and non-Federal treatment, storage, and disposal facilities will require corrective action and closure. EPA and the States also regulate more than 1.8 million underground tanks under the Underground Storage Tank (UST) Program.

[1] Cleanup has been completed at 112 sites as of September 11, 1992.

C. The Approach

The EPA is structured with Assistant Administrators directing activities for Water, Solid Waste and Emergency Response, Enforcement, Air and Radiation, and Pesticides and Toxic Substances, in addition to those directing various areas of staff support. The Office of Solid Waste and Emergency Response (OSWER) is responsible for managing the nation's hazardous waste remediation programs. For several years, EPA has seen a need for the development of new technologies to deal with the complex array of contaminated sites. As the national program manager, OSWER has helped to promote innovative remediation alternatives through policy, research, workforce training, creation of an innovative technology advocate staff, and program implementation. Together with the Office of Research and Development (ORD), OSWER has promoted: basic research grants, demonstration programs, testing and evaluation centers, cooperative agreements, and information exchange networks.

In response to internal management recommendations to improve the operation of the Superfund Program, in June, 1990, OSWER created the Technology Innovation Office (TIO). The mission of the new Office is to increase the application of innovative treatment technologies to contaminated soil and groundwater by both government and industry. Through TIO, EPA works with the private and public sectors to advance research, development, and application of innovative treatment technologies. The TIO believes application of innovative technologies can be increased dramatically when unnecessary regulatory barriers are removed and when information about these technologies is widely disseminated. TIO's private sector "customers" can include anyone that develops, selects and/or purchases remediation technologies, such as consulting engineers, responsible parties at a site, or researchers. TIO's services are also available to other Federal agencies, to State and local governments, and to regional bodies such as the WGA.

The Office of Research and Development conducts its hazardous waste research and development in four general problem areas: Hazardous Wastes, Superfund, Leaking Underground Storage Tanks, and Oil Spills.

The Office of Federal Facilities Enforcement (OFFE) has special responsibilities at all Federal facilities. These policy and oversight responsibilities include coordination with EPA regions, waste clean-up, and implementation of compliance agreements. The top priority of the compliance agreements is to foster the development of innovative technologies.

In addition to these EPA headquarters organizations, ten regional EPA offices throughout the United States help carry on the bulk of the agency's field activities, working closely with State, tribal and local governments to ensure compliance and oversight.

In carrying out its functions, the Agency is committed to ensuring that:

- Federal laws are implemented and enforced effectively;

- U.S. policy, both foreign and domestic, fosters the integration of economic development and environmental protection to ensure economic growth over the long term;

- Public and private decisions affecting energy, transportation, agriculture, industry, international trade, and natural resources fully integrate considerations of environmental quality;

- National efforts to reduce environmental risk are based on the best available scientific information communicated clearly to the public;

- Everyone in society recognizes the value of preventing pollution before it is created;

- People have the information and incentives they need to make environmentally responsible choices in their daily lives; and,

- Schools and other community institutions promote environmental stewardship as a national ethic.

The economic aspects of proper disposal are evident: while it can cost more than $1,200 for safe disposal of a single drum of some hazardous wastes, that cost may rise by a factor of ten to a hundred if disposal of that same drum is first attempted improperly.

EPA's approach requires not only that action be taken to minimize the hazards of existing pollution, but that future pollution be reduced. Thus, the Agency promotes recycling and waste reduction as much as cleanup.

D. The Goal

The goal of the EPA is to protect and enhance human health, welfare, and the environment, and the productivity of natural resources on which all activity depends, today and for future generations, to the fullest extent under the laws enacted by the Congress.

3. U.S. DEPARTMENT OF DEFENSE

A. The Backdrop

DoD is responsible for the nation's military properties and installations located throughout the States, U.S. territories, and abroad. Many of these facilities are located in regions of interest to the Western Governors' Association. Nearly all facilities are the responsibility of one of the military

services[2] (i. e., the Army, the Navy, or the Air Force), and these services have their own independent missions, regulations, cultures, and organizational structures.

Land disposal of munitions at some sites dates back to the mobilization for World War One. Accelerated growth of DoD facilities, both in terms of total number and complexity of use, came with the expansion of the Defense establishment after World War Two. Nearly one-half century later, the environmental issues faced by the Department are dominated by the treatment, storage, and disposal of contaminants and hazardous wastes from industrial production and extensive training operations, most notably residues from fuels and explosives.

B. The Challenge

The Federal statutes described in Chapter I of this report, as well as State, and local environmental protection and public health laws, specify that the Department of Defense (DoD) must reduce or eliminate the environmental and health impacts resulting from current and past defense operations. Furthermore, the Office of the Secretary of Defense has directed that the Services serve as a model to the civilian community. Remediating toxic waste sites will be one of DoD's largest challenges over the next decade.

The number of sites included in the Defense Environmental Restoration Program (DERP) -- which covers the three Services, the Formerly Utilized Defense Sites Program (FUDS), and the Defense Logistics Agency (DLA) -- has increased steadily since the inception of the program in 1984. By the end of FY 1991, 17,600 potential sites at 1,877 installations had been identified. Consistent with the Department's "worst site first" cleanup policy, emphasis was originally placed on contamination levels most likely to affect public health. Efforts have also expanded to address smaller installations with lower contamination levels.

Only 90 sites are currently on the EPA's National Priorities List (NPL) representing the most serious cleanup challenges, and after rigorous identification effort, growth in total sites has now leveled off, and 6,737 sites have been removed from the DoD list, including those already remediated or at which a determination has been made that no further action is required.

Current cleanup cost estimates (environmental restoration only) reach approximately $25 billion over the next ten years, beginning with the investments made in FY 1991.[3]

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[2] The U.S. Marine Corps is a separate military service and has its own environmental programs which are, however, funded through the Department of the Navy. Department of Defense environmental planning documents frequently use the terms "military service" and "military department" interchangably, as in "Tri-Service Plan", and the same practice will be followed in this document.

[3] Information on environmental restoration costs and categorization of sites in this section is taken from testimony by the Deputy Assistant Secretary of Defense (Environment) before the Subcommittee on Readiness, Survivability, and Support of the Senate Armed Services Committee on May 12, 1992.

C. The Approach

Consistent with the direction of the President and the Secretary of Defense, DoD is working to incorporate an environmental ethic into all defense activities in order to sustain military capability for protecting our homeland and resources while enhancing both the quality of life and the environment.

The Deputy Assistant Secretary of Defense (Environment), under the Assistant Secretary of Defense (Production and Logistics), is responsible for developing policy and program guidance for the Defense Environmental Restoration Program and overseeing its execution. Each of the organizations under DERP administers its own environmental restoration, waste management, and natural and cultural resources management programs under the broad umbrella of the Defense program. The other Defense agencies, such as those dealing with communications, intelligence, mapping, and security assistance, have their own environmental programs, which are smaller because of the smaller amount of hazardous waste they generate.

Departmental policy is to enter into formal agreements for installations on the National Priorities List as early in the process as possible, well before the time required by law. Early involvement with the EPA and appropriate State authorities helps smooth resolution of conflicts arising from overlapping or conflicting jurisdictions and helps build public confidence in the cleanup process.

To facilitate State participation, the Department now reimburses the States for up to one percent of the total cleanup costs through the Defense and State Memoranda of Agreement (DSMOA) program. To expedite the environmental program, DoD now has agreements in place with 36 states. In FY 1991, it provided about $17 million to State environmental regulatory agencies to support their involvement in the Defense program.

DoD's environmental budget is growing rapidly. In FY 1991, the Department invested over $1 billion in cleanup work, a 77 percent increase over the previous year. The FY 1992 budget request for DERP was $1.562 billion, roughly half again as large as the previous year. Additional information on DoD's environmental restoration budgeting, including information on expenditures within individual States, can be found in the Workforce Planning companion report to this document.[4]

Because the competition is intense for Federal funding to meet a variety of national needs, DoD's approach to addressing its environmental responsibilities places a heavy emphasis on the development of innovative technical solutions which may reduce those costs or offer other improvements. A Tri-Service Working Group has adopted plans to fully use the research capabilities of each service, under Project Reliance, by developing strong tri-

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[4] "Workforce Planning: Joint Environmental Restoration and Waste Management Activities", The Federal Working Group on Implementation of a Memorandum of Understanding between The Western Governors' Association and Various Federal Agencies, October, 1992.

service teams to perform research using each service's unique capabilities to the fullest extent. Such specialization leads to an organization of the DoD approach around technical problem areas. Thus, the Environmental Quality Research and Development Programs coordinated by DoD and conducted by the Departments of the Air Force, Army, and Navy represent an integrated effort, based on Project Reliance.

The Army's Environmental Quality R&D program focuses on four areas. They are: Installation Restoration (except fuels and solvents); Pollution Prevention; Terrestrial and Aquatic Assessment; and, Base Support Operations. Since the late 1960's, the Air Force's research programs have addressed environmental impacts related to the use (and past mis-use) of solvents and fuels, atmospheric emissions from aircraft operations, and the assessment and mitigation of aircraft noise. These emphases are continued in the Air Force's Environmental Quality R&D Program. The Navy's Environmental Quality R&D program is designed to provide technology for global compliance by ships and vessels and their supporting shore installations, with primary emphasis on Navy-specific pollutants. Because actual implementation of technologies developed through DoD Environmental Quality R&D Programs will normally be carried out by civilian firms, technology transfer to the private sector is an integral part of these programs.

The executive agent for the DoD in the management and disposal of low level radioactive waste is the Department of the Army. The DoD, working in close cooperation with the EPA, will continue to apply good management and quality control measures in disposal of such wastes.

D. The Goal

DoD is committed to executing an effective and open environmental cleanup program at its bases and installations, including those scheduled for closure, and to ensuring that cleanup schedules are maintained.

4. U.S. DEPARTMENT OF INTERIOR

A. The Backdrop

The DOI is the largest landowner in the United States. DOI manages 440 million acres, or 20 percent of the nation's surface area; most of these lands are in the western states. The Department is a trustee of an additional 50 million acres of Indian trust lands. DOI also holds about 32 percent of the nation's total subsurface and mineral estates in trust for the public.

Beyond environmental responsibilities based on its landholdings, DOI has responsibilities for certain kinds of natural resources wherever they occur, including birds, fishes, and certain mammals. Because of its historic missions, DOI therefore has a wide range of technical and scientific expertise in environmental matters which makes its Bureaus and Offices valuable partners as advisors or problem solvers in many situations.

The DOI is made up of ten different Bureaus, each with its own missions, statutory mandates, and mechanisms for administering multiple land uses.[5] In general, the DOI is not a major generator of hazardous waste, but is frequently a recipient of hazardous waste from diverse public uses of DOI land, especially from abandoned mines, illegal dumping, and landfills on lands leased to counties and municipalities.

B. The Challenge

The DOI has two major responsibilities under current waste management laws. First, it manages and controls waste in compliance with the body of law and regulation applicable to DOI facilities and landholdings. Second, the Department works to restore natural resources which have been injured by releases of hazardous substances, outside of DOI lands as well as on them. This activity is undertaken through claims for natural resource monetary damages, or settlements in compensation for such injuries.

The DOI presently has 422 sites listed on the Federal Facilities Hazardous Waste Compliance Docket. Cleanup and restoration activities required at the majority of these sites are small. Although DOI at present has three sites on the EPA's National Priorities List, it is anticipated that there will be more added in future years because of changes in the system used to determine what sites pose sufficient hazard to warrant inclusion.

C. The Approach

The DOI is committed to the comprehensive management of wastes on its lands. The waste management initiative recently created by the Secretary of the Interior is based on five fundamental principles, which are discussed in the paragraphs below along with information on program coordination and budgets.

(1) Prevention of Hazardous Waste Generation

In order to reduce hazardous waste generation DOI is establishing a pollution prevention program for DOI lands and facilities; educating DOI managers and employees; implementing practices to prevent chemicals and materials from becoming hazardous wastes; implementing a land acquisition policy and procedure so as not to acquire an interest in real estate where hazardous substances are present and require expending DOI funds for cleanup; and providing guidance for DOI lessees and concessionaires.

(2) Reduction of Wastes Generated

To achieve this objective, DOI is developing waste reduction guidance; establishing Bureau-specific waste reduction, reuse, and recycling

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[5] An overview of the missions of these organizations appears at Appendix D.

goals; developing affirmative procurement programs for purchase of recycled/recoverable products; and using innovative and state-of-the-art technologies to achieve waste reduction objectives.

(3) Management of Waste Materials

DOI is undertaking a comprehensive, Department-wide inventory of hazardous waste locations at DOI facilities and on DOI-managed lands and is developing a tracking program and supporting database.

(4) Cleanup of Contaminated Areas

DOI is increasing the level of resources dedicated to site cleanup and aggressively pursuing potentially responsible parties (PRPs) for pollution on DOI lands.

(5) Restoration of Injured Natural Resources

DOI is ensuring that appropriate natural resource restoration measures become an integral part of the overall cleanup at DOI sites where there has been natural resource injury. The standards and procedures applied to resource restoration will be the same as those for non-DOI sites.

Building natural resource damage assessment and restoration planning into the overall scope of Department site project management will mean that cleanups of DOI sites not only incorporate restoration measures into cleanup where appropriate, but that cleanup methodologies themselves do not produce additional injury. Restoration planning includes opportunity for public input, and responsible parties will be held to high standards of restoration performance. A successful DOI natural restoration program at cleanup sites will hopefully provide models for Federal trustee approaches to private site cleanups, in cooperation with compliance enforcement agencies.

For those sites where it is the sole identifiable responsible party, DOI will assure that the evaluation of natural resources injuries and planning for restoration is integrated with site cleanup investigations to the maximum extent practicable, and it will work with the States to achieve early and efficient accomplishment of restoration objectives. In cases of DOI sites where other responsible parties may be identified, DOI seeks to cooperate and coordinate with States and any other PRPs involved, in site/spill removal with regard to natural resource damage assessment and restoration activities to the extent appropriate.

DOI is prepared to take appropriate action when resources under its trusteeship are injured (such as a marsh being damaged by an oil spill). The Department will help responsible parties and State or Federal cleanup officials integrate natural resource protection and restoration activities into site

cleanup activities. DOI uses the natural resources damage assessment process[6], in cooperation with States and other trustees, to determine if trustee resources under DOI jurisdiction have been injured. If so, it works to quantify such injury, and obtain funds or actions from the responsible party for restoration and compensation for the lost use of the resource.

The DOI has established a revolving fund to initiate natural resource damage assessments at selected high priority sites. The fund works as follows: parties that are fined in cases involving natural resources damages will also reimburse DOI and other involved natural resource trustees for their natural damage assessment costs; these funds will be used in turn to assist future natural resource damage assessments.

DOI works with the States, EPA, and the Coast Guard to cleanup natural resource damages caused by discharges of oil and releases of hazardous substances into the aquatic and other natural environments. DOI trains other Federal, State, and Tribal trustees in procedures for assessing natural resource damages resulting from a spill or site cleanup. DOI also assesses natural resource damages at sites where DOI has significant trustee interests, and works with willing responsible parties to develop and implement appropriate restoration measures.

(6) Program Coordination and Budgets

Each DOI Bureau budgets for and administers its own cleanup and compliance program. The Office of Environmental Affairs coordinates the Bureaus' hazardous materials programs and activities at sites. This Office is developing a tracking system for Bureau site activities and a ranking system to establish priorities for hazardous waste cleanup sites, and taking actions to improve the exchange of technical information and expertise across Bureaus.

The total FY 1992 DOI budget for the oversight, investigation, and cleanup of hazardous materials on DOI lands was $70.4 million. The FY 1993 request is $79.6 million[7]. The FY 1993 request represents more than an eight-fold increase over that for FY 1988 (of $8.97 million).

D. The Goal

As a compliment to DOI's public stewardship responsibilities in managing natural resources, the Department's goal is to pursue, in an environmentally responsible manner, environmental cleanup for Departmental lands and facilities and restoration for injuries to natural resources.

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[6] Authority for this process is contained in 43 Code of Federal Regulations 11.

[7] This request reflects anticipated changes in EPA's Hazard Ranking System; additional information on DOI hazardous materials budgets is contained in the Workforce Planning companion report to this document (see footnote 4).

5. U.S. DEPARTMENT OF ENERGY

A. The Backdrop

The Department of Energy, heir to the Atomic Energy Commission and the Energy Research and Development Administration, faces the largest environmental cleanup task in U.S. history. This task was generated by almost five decades of defense-related production activities throughout the country, many of which have taken place within the areas represented by the Western Governors' Association.[8] Recognition of the cleanup task was formalized in 1989 with the creation of the Office of Environmental Restoration and Waste Management (EM), now headed by an Assistant Secretary.

B. The Challenge

The challenge of restoring DOE sites, and managing wastes at those sites which will continue to generate such wastes in the forseeable future, encompasses not only technical difficulties, but the necessity to ensure that the nation receives maximal economic benefits for its remediation and waste management expenditures.

Remediation of the defense nuclear complex has been estimated at a cost of $150 billion over 30 years, and more recent analyses suggest the actual figures could be even higher. To do this massive job in the most cost-effective manner, DOE is seeking to use the best "cutting edge" technologies, consistent with compliance schedules. Not only can adoption of such technologies insure that remediation expenditures are no greater than actually necessary, but they can secure for the country international leadership in a growing environmental industry. In this way, the governments' efforts to deal with contamination at the nuclear weapons complex can generate related public economic benefits. Such benefits can come both through international sales of environmental goods and services, and through lower costs (and, hence, more competitive prices) for environmental compliance by other American industries competing in the world market.

The development of nuclear weapons involved creation of an entire manufacturing industry and technical infrastructure. Although many of the materials with which that manufacturing has been concerned are unprecedented, the processes for manufacturing those materials do have parallels in many other high technology industries of potential importance to the civilian sector of the economy, such as advanced metals processing and development, electronics, and computers. Consequently, many types, and much of the volume, of contaminants at DOE sites are not unique to nuclear weapons production facilities but rather are typical of many industrial processes that involve waste chemicals, organics, and heavy metals. Similarly, the basic research which undergirded the weapons effort spawned major research institutions -- the National laboratories -- whose science

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[8] Maps of the major DOE field facilities and environmental restoration sites are at Appendix E.

is on the cutting edge of industrial innovation, both in environmental and other industrial areas.

Thus, DOE is committed to working with the States and the private sector to ensure that the cleanup is "cheaper, faster, safer, and better" than it would otherwise be without a strong, focused effort.

The FWG recognizes, however, that the technical challenges of remediating DOE sites are particularly difficult where the sites embrace radioactive, and mixed (hazardous and radioactive) wastes. Among these challenges are:

- 3700 contaminated sites and some 500 surplus facilities awaiting decontamination and decommissioning;
- 5200 uranium mill tailing sites;
- About 5000 peripheral properties, such as houses, businesses, and open land, that have soil contaminated with uranium mill tailings;
- More than 1.4 million drums of buried or stored waste;
- 2.5 million cubic meters of low-level radioactive waste; and,
- More than 300,000 cubic meters of transuranic waste (generally that which has been contaminated with plutonium).

C. The Approach

The DOE commitment to the environment has multiple elements: to clean up the sites, to work openly with the public in so doing, and to insure that the knowledge and techniques learned in the process are available to the private sector to address analogous problems at non-DOE sites. This requires changing the way DOE, its field entities, and its contractors have historically been managed and operated. Overcoming a culture based on security and secrecy appropriate to nuclear weapons, and replacing it with a culture of openness and partnership is a primary emphasis.

As an example of this new openness, the Department created the Stakeholders Forum, which includes wide participation from Federal and State officials, public interest groups, university consortiums, major Department contractors, industry groups, and others. This group reviews DOE plans and programs for achieving compliance with Federal, State, and local environmental laws.

Another mechanism for action is the Federal Facility Environmental Restoration Policy (Keystone) Dialogue. EPA sponsors the activity, and DOE and DoD are participants. Keystone was originally chartered to assist DOE develop a process to list, by priority, environmental restoration tasks at Federal

facilities. Keystone has evolved into a means of addressing more concerns related to public participation in the cleanup process. The Keystone process is expected to result by the end of 1992 in detailed recommendations for enhancing public participation in the cleanup effort.

Another similar review group is the State and Tribal Government Working Group, set up three years ago to provide input into the Office of Environmental Restoration and Waste Management's "Five-Year Plan" planning process (discussed further below). The group meets quarterly and contains representation of more than a dozen individual States -- approximately half of which are Western States -- along with Tribal governments potentially effected by DOE facilities, the National Governors' Association, the National Association of Attorneys General, and the National Conference of State Legislatures.

More recently, in compliance with the Federal Advisory Committee Act,[9] the Department has established an Environmental Management Advisory Committee (EMAC) to provide additional advice. All of these standing groups, as well as public hearings, help to facilitate two-way communication between DOE and the public before major decisions are made on matters of environmental concern to citizens.

Because of the magnitude and complexity of its environmental restoration and waste management problems, DOE is preparing a Programmatic Environmental Impact Statement (PEIS) to help insure that its activities are resource efficient, environmentally sound, and in compliance with applicable laws, regulations, and standards. The analysis of ER/WM alternatives will be done using data for existing technologies. However, in evaluating those alternatives, DOE intends to consider the fact that there are emerging technologies that may change the conclusions drawn from that analysis.

DOE planning for its ER/WM activities is also published, and updated annually, in a series of Five-Year Plans.[10] These documents, supported by programmatic and installation-level detail, report on progress to date toward meeting compliance and cleanup goals. They also describe near-term plans and overall long-term strategy goals for mission accomplishment.

Accomplishing a comprehensive clean up over several decades requires the building of a sound foundation -- a supporting infrastructure to research, develop, test, demonstrate, and use the best technologies that science and engineering can offer. It requires the establishment of a professionally qualified workforce, educated and trained for specialized tasks within a demanding regulatory framework. It also requires an organizational structure to be responsive to the needs of the government, the public, and the law.

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[9] See Chapter VII, Section 4, for a brief discussion of this Act.

[10] Environmental Restoration and Waste Management: Five-Year Plan, Fiscal Years 1993-1997, U.S. Department of Energy, 1991.

Under the Assistant Secretary for Environmental Restoration and Waste Management are three Deputy Assistant Secretaries charged with managing, accounting for, and disposing of waste in a safe and environmentally sound manner. Their responsibilities comprise:

- **Waste Management**[11] -- managing, accounting for, and disposing of waste in a safe and environmentally sound manner;

- **Environmental Restoration** -- ensuring that risks to human health and safety and to the environment posed by the Department's past, present, and future operations at its sites are either eliminated or reduced to prescribed, safe levels; and,

- **Technology Development** -- establishing and maintaining a national program for applied research, development, demonstration, testing, and evaluation (RDDT&E) to resolve major environmental restoration and waste management issues by advancing technology beyond current capabilities to meet cleanup deadlines, to transfer such advances to the private sector, and to insure that the current and future workforce for cleanup is capable of doing the job.

The Department budget for Environmental Restoration and Waste Management has grown significantly in response to the cleanup challenge, increasing by almost 20 percent between FY 1991 and FY 1992, from $3,596.9 million to $4,283.1 million. The request for FY 1993 projects another 24 percent increase, to $5,316.7 million. Allocation of these budget figures to the Field is shown in the following table:

[11] In August 1992 the Department of Energy announced that it was establishing a new Office of Facility Transition within EM to oversee the transfer of surplus DOE facilities that will no longer be needed as a result of Presidential decisions to significantly reduce the nuclear weapons complex. The new Deputy Assistant Secretary directing this Office can be expected to assume certain responsibilities from the other Offices within EM, especially in areas related to decontamination and decommissioning, but the impact of this reorganization is not discussed in this report.

Environmental Restoration and Waste Management
(in millions of dollars)

	Appropriated FY 91	Appropriated FY 92	Requested FY 93
Albuquerque	422.4	513.0	645.3
Chicago	64.2	59.1	84.4
Fernald	261.2	211.5	307.9
Idaho	417.5	464.3	604.1
Nevada	23.4	40.9	55.9
Oak Ridge	364.8	514.3	683.0
Rocky Flats	162.5	176.8	277.5
Richland	804.0	1,050.8	1,328.0
San Francisco	58.6	107.5	119.5
Savannah River	602.8	521.5	640.7
Headquarters	415.5	623.4	570.6
Total	3,596.9	4,283.1	5,316.7

Some caution should be used in interpreting these numbers, however, because Field Offices may spend substantial portions of their budgets off-site, especially where a Field Office oversees major facilities in different states.

D. The Goal

DOE's initial and fundamental goal is to clean up its contaminated sites to achieve compliance with the law and work with the many involved publics and stakeholders in so doing. This minimal goal does not convey the Department's strong commitment to continue operations in an environmentally sound manner at those sites which remain under its jurisdiction, and to relinquish sites to others for other purposes in accordance with negotiated agreements. DOE also recognizes its commitment to ensure the nation receives economic benefits from technologies developed through the Department, as well as its commitment to those loyal workers whose efforts may not be needed as a result of either scaled down operations or full closure of a facility.

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CHAPTER III
COMMON PROBLEMS AND AGENCY TECHNOLOGY NEEDS

1. CROSS-CUTTING ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT PROBLEMS

Remediation of the nation's hazardous waste sites and minimization of future waste disposal problems is a daunting task. There are currently over 1200 sites designated for priority remediation under CERCLA, while thousands of other sites will require corrective action and closure under the RCRA, Underground Storage Tank, or other State programs. A significant portion of the responsibility for restoring these sites will be shouldered by Agencies of the Federal government in two very different ways: as regulators of Federal waste programs; and, as legally responsible parties at Federal facilities.

A. Issues for Regulators of Federal Waste Programs

There are also a large number of non-Federal hazardous waste sites in the West. Many of these sites have contamination problems commonly found on Federal sites, e. g., residues from wood preserving operations, metal plating, or textile production. Together, Federal and non-Federal sites present a significant challenge for clean-up in the next decades.

However, these facilities also represent a great opportunity for the further development of the waste management and waste remediation markets. The technology needs of the Federal facility owners will foster business for those who can develop or license the science and technology to clean-up the contamination in a manner that is cost effective and acceptable to the public.

The EPA, unlike other Federal agencies, does not normally "own" responsibility for hazardous waste sites, except in cases where no responsible party is identifiable. Rather, EPA regulates owners and operators of both Federal and private sites under CERCLA and RCRA. The EPA enters into the technology selection process primarily through its management of laws and regulations. Even if it may be thought of as having few ER/WM technology needs of its own, EPA has a clear mission interest in identifying better, faster, cheaper ways to protect human health and the environment through remediation of both public and private sector sites. In oversight of the nation's Federal hazardous waste programs, EPA seeks to promote the implementation of innovative technologies and prevent the expenditure of funds on less effective or more costly remedies. EPA seeks to further the use of innovative technologies in order to: better pursue its statutory and regulatory mandates; speed the availability of cost and performance data regarding newly developed treatment technologies to many constituencies facing mandates to clean sites; and, increase the likelihood that remediation costs can be lowered in the near term through the demonstration of a larger number of engineering options to solve site remediation problems.

National experience in implementing cleanup remedies is limited, and the nation faces large future obligations to restore contaminated sites. Thus, EPA recognizes that responsible parties' needs include technologies at every step

of the remediation process. The nation must find cheaper, faster, and better ways to conduct site investigations and monitoring, to remediate soils with ex-situ and in-situ techniques, and to address complex and intractable groundwater contamination problems. Through its laboratories, Hazardous Substance Research Centers, consortia, and other cooperative ventures with the private sector and other Federal agencies, EPA promotes the availability of innovative remediation technologies for use by any party responsible for remediation and waste management at sites.

B. Issues for Responsible Parties

Signatory Federal agencies, principally DOE, DoD, and DOI, are responsible for numerous facilities in the States and Territories represented in the Western Governors' Association. Included among these Federal facilities are facilities owned and operated for the benefit of the United States, authorized non-Federally operated facilities located on Federal lands but operated for the benefit of others, and unauthorized facilities, such as dumps and drug laboratories, which are illicitly operating on Federal lands.

Hazardous waste contamination at Federal facilities may result from such activities as: oil and gas production and transportation; mining and milling; authorized or illicit manufacturing; unauthorized disposal of hazardous wastes, both at sites authorized for municipal solid waste disposal and elsewhere; testing, loading, and packaging weapons; maintaining and repairing aircraft and vehicles; plating metal; and producing, processing, and recovering nuclear materials. Types of hazardous waste disposed of include: explosives; solvents and cleaning agents; ore processing chemicals; heavy metals; oil and gas well chemicals; paints; pesticides and pesticides wastes; and, various organic and inorganic chemical wastes. At DOE facilities, and at a few DoD or DOI sites, high- or low-level radioactive wastes and mixed (hazardous and radioactive) wastes are a significant problem. Past disposal practices at Federal facilities include: disposal in unlined pits, drainage ditches, holding ponds, drying beds, landfills or waste piles; discharge to surface waters or soils; and incineration.

(1) Factors Influencing Technology Needs Identification

Agencies responsible for their own specific set of sites must keep a number of factors in mind in determining what they believe to be their technology needs:

- A unique set of feasible technology options is potentially available for each site contamination problem, depending on how soon compliance is to be achieved; better technologies, if developed too late, will never be implemented, while insistance on compliance too soon may foreclose better solutions;
- Proper exploration and characterization of the site is critical to the effective selection of appropriate technologies and determination of risk; the development

of technologies to acquire better characterization information about sites may be as significant as the development of follow-on remedies.

- Site characterization and technology selection are an iterative process; technology believed applicable to a site may be seen as unsatisfactory as more site data becomes available, and public and regulatory acceptance of the potential risks of using an advanced technology (in order to gain its potential benefits) will be an important consideration in establishing a priority for development of a technology;

- Technology selection should contain an appreciation of the "system" considerations -- what one unit operation might do to the material that becomes a product for another unit operation, the effects of scale or materials flow, the variations associated with changes in process conditions within a unit process, etc. (for example, treatment systems should create waste forms which are suitable for disposal); and,

- The policy goals of the cleanup operation should be defined before the fact; assumptions about future societal expectations regarding the sites (land use, contamination levels below regulatory concern, future views of health risks and economic costs) may be unimportant in an immediate remedy selection decision, but are of great importance in directing long-term research and development.

(2) Common Themes

While there are needs unique to each agency, certain common themes emerge. Cost reduction, speed, and ease of operation (or other means of being compatable with workforce constraints) are important technology features for all of the agencies. Mixed wastes pose the most intractable challenges, though the volumes of such wastes are very much agency-dependent. Mixed waste is defined as radioactive waste containing hazardous chemical components as regulated under RCRA. Groundwater and other sub-surface pathways for contamination spread are generally of more concern than surface or airborne pathways, primarily because of the lack of access for remediation. All of the signatories increasingly recognize the importance of preventing pollution as preferable to removing contamination.

The technology needs of the principal individual responsible agencies (i. e., excluding the EPA) are described in the sections which follow. Needs have been described in a number of documents, most of them too lengthy to mention here. Further bibliographic information on agency technology needs is given at Appendix F.

2. INDIVIDUAL AGENCY TECHNOLOGY NEEDS

A. U.S. Department of Defense

The Tri-Service Environmental Quality Strategic Plan R&D Program has been developed to fill the needs/requirements developed in the DoD Project Reliance effort (which was described in Chapter II). Within the Program, the goals, objectives, and requirements have been divided under four "pillars" addressing environmental quality problems resulting from past practices, present compliance efforts, future compliance efforts, and cultural changes. The environmental quality problems treated in the plan are not limited to the ER/WM issues which are the focus of the MOU between the WGA and Federal agencies. The pillars are titled: **Cleanup; Compliance; Pollution Prevention; and Conservation Stewardship**. These pillars also provide a convenient way to organize discussion of DoD technology needs, at the cost of broadening the discussion beyond ER/WM topics alone.

Under **Cleanup**, the needs are:

- Improvements in site characterization and monitoring, including advancement of remote sensing, field sampling and analysis, and database development;
- Development of remediation technologies which can be applied quickly and at less cost and which protect human health and the environment; technologies should be targeted to remediation of sediments, soils, groundwater, structures, surface water, and sludges; and,
- Development of use-based, realistic risk assessment methodologies within the areas of effects data and fate transport models.

The goal is to have remediation technologies in place, or cleanup actually complete, by the year 2000.

Under **Compliance**, the needs are:

- Technology for the control, sampling, and monitoring of airborne emissions (primary pollutants, volatile organic compounds, toxics), as necessary to achieve compliance with the Clean Air Act;
- Technology for the control, sampling, and monitoring of waterborne emissions (toxics, conventional, stormwater), as necessary to achieve compliance with the Federal Water Pollution Control Act;
- Solid waste treatment technologies (incineration, thermal, biological, chemical, etc.); storage (underground storage tank management, container storage, conforming storage) and land

disposal technologies, particularly deep well injection; technologies to compile effects data; and, fate/transport models.

- Technologies to comply with other regulatory regimes, such as noise control.

Under **Pollution Prevention**, the needs are:

- Technologies to reduce hazardous waste and eliminate the need to purchase environmentally harmful materials;
- Environmentally sound technological systems and platforms for carrying out ongoing DoD missions;
- Means to reduce non-hazardous solid waste for land disposal, and achieve zero total plastics discharge from ships; and,
- Technologies to reduce greenhouse gas emissions.

The overall goal is to reduce use of hazardous materials and generation of wastes to as near zero as possible, and the Program contains schedules and milestones by which to measure progress toward that end.

Under the pillar of **Conservation/Stewardship**, DoD seeks to acquire fundamental knowledge about natural and cultural resources in order to apply sound environmental management to military activities. Consequently, technology needs for this pillar are very different from those of the other pillars, and focus heavily on information acquisition and management.

DoD has gone well beyond this brief categorization and created a listing of several dozen specific technologies needed under each pillar.[1] Project Reliance groups these needs into seven areas and assigning responsibility to specific services to conduct necessary research. The relationship between the four pillars and seven R&D areas is discussed in Chapter V.

B. U.S. Department of Interior

Overall, DOI technology needs stem primarily from problems faced by its resource management Bureaus. These technology needs include the development of:

- A methodology to easily locate waste deposit sites and a fast, inexpensive method of determining the wastes present in those sites;

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[1] These specific DoD requirements are listed at Appendix G.

- An inexpensive risk assessment methodology that allows a quick and economic-based assessment of a variety of risk scenarios;
- Inexpensive, effective remediation technologies for control of contamination migration;
- Inexpensive, efficient technologies for remediation of mixed waste; and,
- An improved methodology for assessing priorities among potential cleanup sites and for making a determination of which sites pose insufficient risks to warrant cleanup.

Characteristics of the site generally define the broad menu of technology needs. Site characterization, definition of cleanup objectives, evaluation and understanding of the cleanup process, and the ability to critique and adjust processes are vital to definition and/or development of appropriate technology. For example, many of the processes and techniques developed for mineral production are readily applicable to mineral-related waste management.

Many of the particular emphases in the above list are related to the large numbers of sites, in comparison to the other Federal signatories, with which DOI must deal. The Department must address unique problems in identifying and managing these sites because many are accessible by the public. Hence, in comparison to the other Federal signatories, the above list places greater emphasis on identification and characterization technologies, and priority setting methods, than on remediation technology development per se.

The Department-wide discussion of needs is supplemented with the perspectives of several individual Bureaus in the paragraphs which follow.

(1) Bureau of Mines

Although the Bureau of Mines considers itself to be a technology developer rather than a technology user, its "needs" can be seen as being identical to its own technology research interests. The Bureau is active in the development of technology for both mine-waste associated environmental problems and for the solution of the problems of other hazardous wastes, particularly inorganic contaminants. The Bureau is interested in the development of databases containing meaningful site inventory information. It is interested in developing cost-effective, permanent, non-capital-intensive treatment technologies and the potential for reuse of equipment for sequential cleanup of sites. It is also interested in site characterization technologies (and protocols).

(2) Fish and Wildlife Service

A number of the DoD Defense Environmental Restoration Program sites, particularly along the West Coast and in Alaska, have been transferred to the Fish and Wildlife Service. While this service has unique needs in regard to

assessing the effects of contamination on natural resources, the DERP sites can be expected to pose many of the technology needs already described in the DoD section of this Chapter. Primary Fish and Wildlife Service needs are technologies that can remediate metal, PCB, pesticide, explosives, asbestos, petroleum, and volatile organic contamination.

(3) National Park Service

Contamination at National Park Service (NPS) facilities has originated through a number of processes. Most involve the disposal of contaminants in improper locations, the release of hazardous chemicals from underground storage tanks, or the residual from abandoned mines. Other contaminated land holdings have become the responsibility of NPS through property transactions. One such site, Nuclear Lake, in New York, is known to have low level radioactive waste on-site.

In the Western States, the NPS is currently investigating a number of contaminated sites which have a complex array of improperly disposed wastes. The identified waste streams range from pesticides and old lead acid batteries, to PCB's, ash containing metal, petroleum, mining wastes and asbestos. All of these waste products pose difficult questions related to their disposal. NPS has not yet initiated any major cleanups at hazardous waste contaminated facilities in the Western States. The focus of the NPS work has been on the assessment and investigation of the identified sites, and, consequently, knowledge of future remediation technology needs is limited.

Nonetheless, the following problems are apparent:

- Efficient technological solutions for the cleanup of groundwater and soils contaminated by **Mining Related Waste** -- uranium, asbestos, manganese, and other metals -- are extremely limited, and NPS estimates as many as 1,000 of these sites exist nationwide;

- Current technologies for the remediation of soils and groundwater containing **Mixed Contaminants** are expensive and inefficient; those containing metals-waste complexes and low level radioactive waste (mill tailings) complexes are especially in need of new technology, although this category of waste can consist of almost any mixture imaginable; and,

- In the area of **Site Investigation Procedures**, there is a large need for "in the field", or near-real-time, procedures which will hasten interpretation of site investigations and reduce the cost associated with these actions.

(4) Bureau of Land Management

The Bureau of Land Management (BLM) conducts a continuing evaluation of its ongoing hazardous materials management activities. In addition, BLM professional staff continually review current literature and published research reports in a search for technology which could improve BLM's management of hazardous materials.

Areas of concern exist throughout the CERCLA and RCRA processes since few of the existing technologies are fully satisfactory for their proposed use because of technical limitations, regulatory imperatives, or cost.

High resolution imagery should be linked with a high definition satellite locational system to aid in **Discovery of Potential Sites**, allowing improved accuracy and greatly improved descriptions of a potential site, while reducing the amount of time and resources required for "ground verification". This would be possible if presently classified technology was to be made available. New screening technology is needed for the **Identification, Reporting and Listing of Potential Sites**. New **Preliminary Assessment Technology** is needed which can reasonably quantify the significant contaminants present without requiring extensive equipment or expertise. Speed and cost must justify replacement of the present system. Speed and cost improvements are required in **Site Inspection Technology**, especially that applicable to the ground water pathway. Commonly available **Remediation Technologies** to prevent contaminant migration in ground water and to restore the quality of ground water are less than satisfactory in terms of cost, acceptable confidence level, and time.

BLM has worked with BM and one of its own contractors to develop a suitable phased method for investigating closed landfills using various physical methods depending upon the characteristics of the area. At present, the method is most appropriate to the preliminary assessment and site inspection phases. Further efforts should be devoted to developing a quick, easy, and inexpensive method which will provide the data required to determine whether reporting the site is required. Ideally, this would be remote sensing technique linked to a satellite site identification system of the kind discussed above. If this is not feasible, a stand alone system would be acceptable, provided that it could be easily and quickly used by BLM field personnel.

(5) Geological Survey

The U.S. Geological Survey (USGS) determines applicable technology needs in environmental restoration activities through cooperation with other agencies. In its view, new technologies to characterize contamination more quickly and economically are needed. In the field of remediation, the USGS has several active projects in microbiology at both the field and laboratory scale, which are investigating much needed improvements in cleanup pump-and-treat methods.

C. U.S. Department of Energy

(1) Waste Management

Most of the material that DOE manages as waste can be categorized as one of three major types: radioactive, hazardous, or mixed. It is estimated that DOE and its management and operating contractors produce over 95 percent of the mixed waste in the U.S., as well as much of the high-level and transuranic wastes.[2] Consequently, compared to other Federal agencies, the DOE considers mixed waste to be of special concern, even though hazardous waste technologies are also needed.

Today, treatment or disposal options do not exist for over two-thirds of DOE's mixed waste. As a result, large volumes of transuranic, high-level, and low-level mixed waste are currently being stored at various DOE facilities awaiting development of effective treatment and safe disposal methods. Although these storage practices present no imminent health and safety threats, they present a unique waste problem. DOE has taken the position that temporary storage of waste, whether radioactive, hazardous, or mixed, is not a solution; permanent disposal is necessary. Disposal of these wastes will require advanced material handling techniques and new technologies and processes to separate mixed waste components, reduce their volume, and either destroy or immobilize them in new waste forms.

Another waste form which presents a (potential) problem is the very large volume of waste which will arise from decontamination and decommissioning (D&D) activities. Approximately 500 contaminated DOE facilities are currently scheduled for D&D, and this number could rise in the future as the national security situation further evolves. These include hot cells, reactors, underground storage tanks, and enrichment and processing facilities. The tanks present a particular near-term problem because they are poorly characterized and many are leaking. The large volumes of waste generated by D&D activities will further expand as the DOE weapons complex undergoes modernization and old facilities are retired; these wastes will require volume reduction, as well as treatment, packaging, storage, and transportation, prior to their ultimate disposal. New technologies are needed to clean and decontaminate hazardous and radioactive materials from structures and equipment so that DOE may complete its modernization and decommissioning plans. There is a significant cost savings that can be realized by successfully cleaning and recycling metals.

Directly related to the issue of volume reduction is the avoidance or minimization of waste. For years, waste management practices have been directed at reducing the volume of waste through evaporation, incineration, and compaction. This has had little impact on waste generators, whose goals have been to increase productivity, and did not recognize the environmental consequences of waste generation. As a result of legislative action (e.g., the

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[2] Civilian nuclear power plants also produce significant quantities of waste containing transuranic elements and emitting high levels of radiation. Issues of the management and storage of spent nuclear fuel and other power plant wastes are beyond the scope of the MOU.

Montreal Protocol on reduction of CFC's) the focus of waste management in DOE is now to eliminate waste at the source through material substitution or changes in hazardous waste producing processes. Waste avoidance/minimization requires the development of new technologies and methodologies to reduce or eliminate the generation of waste and new pretreatment techniques to minimize waste. Better separation and concentration processes must be developed to increase recycling. Non-toxic materials, particularly solvents, must be developed as substitutes for hazardous materials. In addition, methods must be developed for removing radionuclides from aqueous and organic degreasers. These technologies must be applicable to a broad range of manufacturing efforts involving: depleted uranium, plutonium, nonradioactive components, and electronics.

Waste management at ongoing operations is one of DOE's biggest challenges -- and one which requires continuing technical and budgetary attention to control the magnitude of future environmental impacts.[3]

(2) Environmental Restoration

The environmental restoration of inactive facilities poses another set of environmental challenges. For decades, environmental wastes and byproducts were placed in seepage basins, buried in landfills and trenches, put in underground storage tanks and concrete vaults, or injected in wells and geologic formations deep below the surface. Though considered state-of-the-art at the time of disposal, over time they have proven inadequate or faulty, resulting in the contamination of the surrounding soil column and groundwater. Environmental remediation of these contaminated media requires the development of innovative in-situ and ex-situ treatment technologies for the removal or destruction of contaminants to acceptable levels in both arid and non-arid soils. In-situ methods are preferred because they minimize public exposure and the volume of waste for disposal (i. e., by avoiding generating secondary waste streams which themselves require treatment and disposal). Nevertheless, in those cases where in-situ methods may not be feasible, other innovative technologies must be explored, including extraction, recovery, and processing alternatives that reduce or eliminate environmental and health risks.

By developing and improving technologies, EM will help expedite near-term remediation, reduce cleanup risks and uncertainties, lower cleanup costs, and avert the need for future cleanups. However, because EM is faced with a multibillion dollar challenge of effective environmental stewardship, DOE must meet this challenge in cooperation with other governmental, as well as academic, industrial, and international parties if it is to satisfy regulatory deadlines.[4]

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[3] A more detailed list of DOE waste management needs is given at Appendix H.

[4] More detailed information on DOE environmental restoration technology needs is contained in Item 3 of the bibliographic Appendix F, already cited.

(3) Site-Specific Research and Development

In addition to these comprehensive national technology development needs, EM also supports a number of research and development activities related to site-specific environmental restoration and waste management needs. The purpose of such activities is to optimize existing technologies or polish emerging technologies in order to reduce the uncertainties associated with application of these technologies to meet site requirements. For example, these activities include several remediation treatability studies providing site-specific data necessary to support remedial actions at DOE sites.

(4) Transportation

The DOE also maintains a transportation program within EM. This program has wide visibility, particularly in the Western States, because the nuclear materials being transported are of intense interest to the public. Policy issues related to the transport of radioactive materials are of extreme importance. However, the Federal Working Group is not emphasizing these issues within the technology development area at this time.

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CHAPTER IV
SUMMARY ASSESSMENT OF EMERGING TECHNOLOGY

1. GENERAL STATUS OF ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT TECHNOLOGY: THE NEED FOR DEMONSTRATIONS

As a member of the consulting engineering community noted at a recent symposium, "We've been building bridges and highways for 5,000 years and treating wastewater for 150 years, and we're still learning in each of those areas. We've been trying to clean up hazardous waste sites through applications of technology for a little more than 10 years." His point was that hazardous waste clean-up is a relatively young business. It is new from the standpoint of regulators, new from the standpoint of the engineering community, and new from the standpoint of developers of treatment technologies.

Despite advances in new technologies through Federal programs and similar efforts in the States, the fact remains that the development and widespread application of technologies for the clean-up of abandoned waste sites and contaminated land are inadequate. There is a long, bumpy road between the initial operation of a pilot plant and the commercialization of new technologies.[1]

A. Working Definition of "Emerging" Technology

Federal agencies operate under specific statutory requirements governing acquisition of research and development in connection with major technology systems, and many of the technologies being contemplated under the ER/WM programs of DOE, DoD, and DOI would qualify as major technology systems.

Technology development is executed according to three categories related to the maturity of the technology, as shown in Figure IV-1. The maturity of the technology, its complexity, cost, importance, etc. determines the information needed to manage an activity.

The Science and Technology Base category includes the study of fundamental scientific principles, applied research, and exploratory development. The Concept and Demonstrational Development category includes scaling up concepts, validating, and testing the performance of subsystems and components. The last category, Full Scale Development, includes full scale testing of systems on an operational level, or testing and evaluating the performance of integrated systems.

All Federal agencies conduct Science and Technology Base activities related to environmental restoration and waste management research and

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[1] This and the preceding paragraph are taken from the article "From Know-How to Can-Do: EPA Recognizes that the First Time a Technology is Tried, It May Not Work", Walter W. Kovalick, Jr., EPA Journal, July/August, 1991.

development. Their emphasis and approaches to other research categories differ among agencies, however.

EPA uses in-house research, grants, and cooperative agreements to develop its science and technology base. Cooperative arrangements with private industry help to carry environmental technology development beyond pilot and prototype development. EPA also depends on industry to diffuse its new and innovative technology into the general economy. Cooperative Research and Development Agreements[2] (CRADA's) are used to complete research and development on technology concepts, and to test and demonstrate technology products to ensure their economic viability.

Several of the DOI Bureaus are considered to be significant basic and applied research organizations, and the DOI approach to ER/WM technology development should generate examples of Advanced Development (within Concept and Demonstrational Development). However, the DOI tends to focus on earlier portions of the technology development process.

By contrast, the DOE and DoD programs do not focus on basic research, although both agencies have strong basic research capabilities. Instead, because of regulatory deadlines, their programs are more oriented toward emerging technologies in development stages bridging the gap between the later parts of Science and Technology Base and Full Scale Development. Within DOE, this corresponds to the phases of Applied Research through Demonstration, Testing and Evaluation. Within DoD, this corresponds to the phases of Exploratory Development through Engineering Development (6.2 through 6.4). Although the definition of an "emerging technology" is very much context-dependent,[3] these phases provide a working definition of the term for purposes of this report.

There is also a clear parallel between the acquisition categories used by the other Federal signatories, and the progression of treatability studies defined by EPA to implement CERCLA. This progression begins with Remedy Screening (proof-of-principle, qualitative, laboratory scale activities), proceeds through Remedy Selection (quantitative, bench scale verification activities involving medium waste volumes) and Remedy Design (pilot scale field tests for optimization and engineering scale-up involving larger volumes of waste), and ends with Remedy Action (full scale tests for validation of performance and cost analysis under site-specific conditions).

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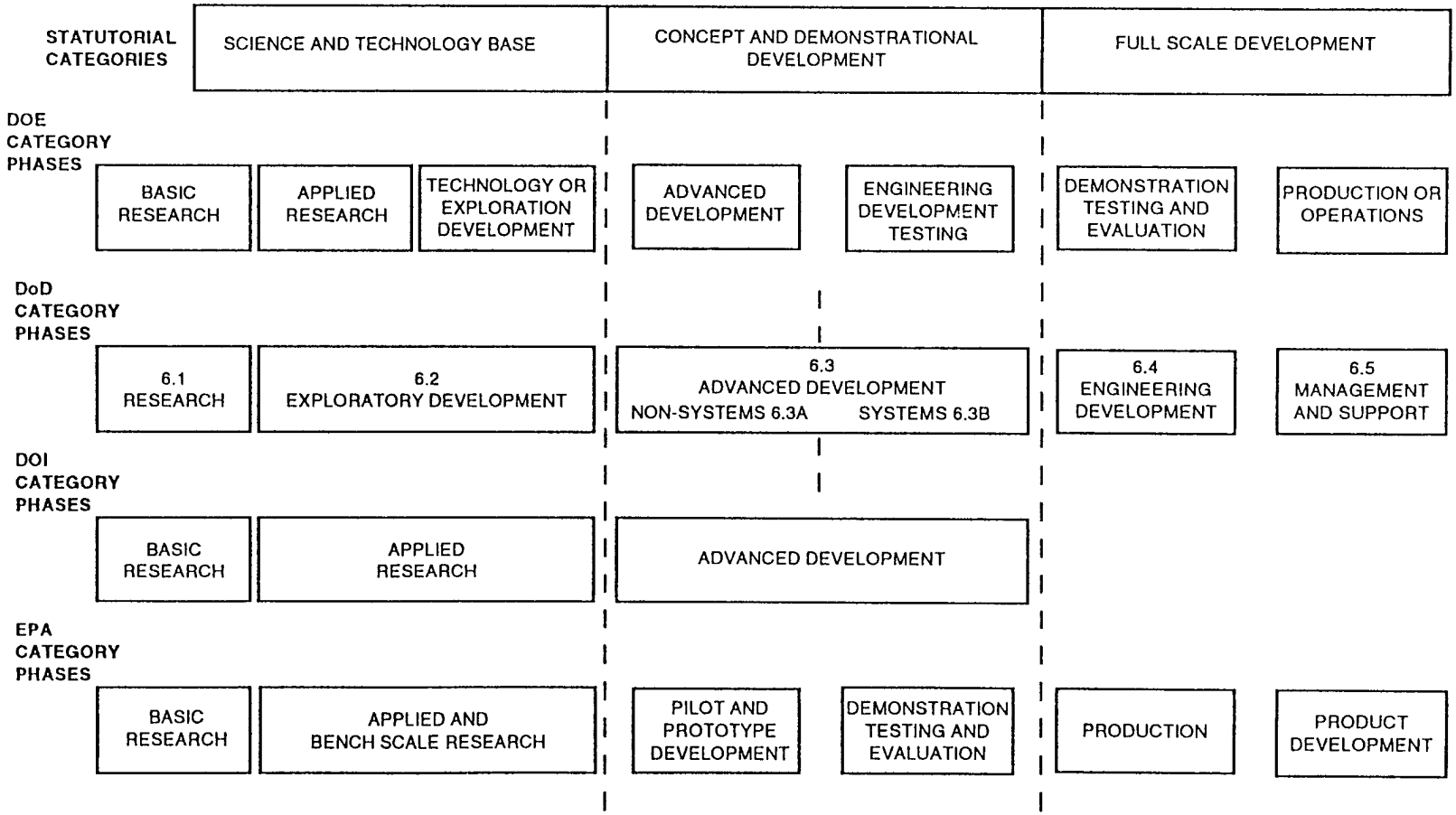
[2] Authority for CRADAs is contained in the Technology Transfer Act of 1986, Public Law 99-502.

[3] For example, EPA frequently uses "emerging" to refer to technology which is less mature than "innovative" technology, while other agencies tend to use the same terms more interchangably.

Figure IV-1

RESEARCH AND DEVELOPMENT OR ACQUISITION PHASES TYPICALLY USED FOR FEDERAL PROJECTS



B. Financial Barriers to Deployment of Emerging Technologies[4]

Basic research into solutions to environmental restoration and waste management problems is ongoing at numerous institutions in government, academia, and the private sector. Such research is relatively inexpensive compared to subsequent stages in moving toward technology deployment. Consequently, funding is relatively easy to obtain through grants or "start-up" company capital sources.

As a technology advances farther along the development track to the bench or pilot scale, and further to field demonstration, necessary investments rise rapidly. Developers of these new technologies face a fragmented market for soil and groundwater clean-up, driven largely by industry or Federal agency responses to regulatory programs. The variety of contaminants, soil types, hydrogeological settings, and other technical factors makes matching new ideas with definable market needs very difficult. In the remediation field most technical solutions must be custom designed to unique site circumstances. Complicating this scenario for technology developers are the perceived and real business risks of dealing with hazardous substances and liability concerns.[5] To hedge these financial risks, technology developers often seek funding from other sources, most commonly the potential end users in the private sector or the government.

However, private sector end users also have financial disincentives to invest in many cases. Investment returns in technology development are unlikely to be substantial for a user company unless the technology can find application at many sites beyond the company's own -- insubstantial especially in comparison to the alternative of acquiring the right to use a technology once someone else has paid the costs of development. Unless the new technology provides an appropriate fit to such a company's core businesses, and the company feels confident of its ability to manage a venture which can be competitive against more established environmental vendors, such investments may be regarded as highly speculative.[6] It is widely held that this type of speculative research venture is too risky for all but the most secure private enterprises to undertake without government support.

For their part, established environmental technology companies may run the risk of competing against their own existing technologies if they sponsor

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[4] Barriers to the deployment of emerging technologies is a major subject of the companion report, "Technology Selection Processes and Regulatory Barriers to Technology Development: Joint Environmental Restoration and Waste Management Activities", the Federal Working Group for Implementation of a Memorandum of Understanding between the Western Governors' Association and Various Federal Agencies, (in preparation).

[5] Much of the discussion in this paragraph is taken from the article "From Know-How to Can-Do: EPA Recognizes that the First Time a Technology is Tried, It May Not Work", cited in Footnote 1

[6] The EPA is having success in attracting interest from potential private sector users of innovative technologies in pooling resources to pay for evaluations of technologies as part of a proposed joint public-private effort (discussed in greater detail in Chapter VII) to be conducted at Federal sites, the first of which will be McClellan Air Force Base; innovative approaches to funding technology development, such as this one, may be increasingly important in the future.

development of more advanced methods; they also lack incentives unless they see new technologies being successfully developed by competitors.

Independent consultants (such as architect/engineers) may be paid to select technologies for users or to provide remediation services, but they are not paid to develop new technologies. The consulting engineers who design projects have no standard design documents to refer to; they lack cost and performance data with which they can assure their clients -- American industry and the government agencies having oversight responsibilities -- of the efficacy of these remedies. In many cases, they are firms whose experience base consists of decades of wastewater treatment plant design. It is only in the past five to seven years that they have turned their attention to waste site clean-up problems. Having to deal with hazardous substances, while still observing normal, conservative engineering practices, complicates the situation.[7]

Thus, very few companies are engaging on their own in bringing technologies which are maturing from basic research all the way into full scale deployment. Currently, almost all of the work at the latter technology development stages is occurring under partial or full government sponsorship.

C. Statistical Evidence of Barriers

Available statistical information also points to the need for further steps to bring emerging technologies into readiness for full deployment. In the context of these statistics,[8] "alternative" treatment technologies are defined to be alternatives to land disposal. Alternative treatment technologies are further subdivided into "established" and "innovative" technologies. Here, innovative technologies are technologies that have been applied to Superfund sites through a formal Record of Decision (ROD) process but which lack sufficient performance and cost data to enable their widespread use. The EPA has been working with other Federal agencies in assessing the application of "emerging" technologies to address environmental contamination at the site level. Technology development has been incorporated into cleanup and compliance agreements at both NPL and non-NPL Federal sites. Such technologies offer the potential of facilitating cleanups at other sites as their performance is better defined.

Through FY 1991, 42 percent of the 498 source control treatment technologies selected in RODs for National Priorities List sites were classified as innovative under this classification scheme. Furthermore, fiscal year 1991 was the first year that innovative technologies represented half of the treatment technologies selected at such sites. These innovative technologies included soil washing, solvent extraction, ex situ bioremediation, in situ bioremediation, in

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[7] This paragraph is taken from the article "From Know-How to Can-Do: EPA Recognizes that the First Time a Technology is Tried, It May Not Work", cited in Footnote 1.

[8] Information on the use of innovative technologies at NPL sites contained in this section comes from "Innovative Treatment Technologies: Semi-Annual Status Report (Third Edition)", EPA Office of Solid Waste and Emergency Response, EPA/540/2-91/001 #3, April, 1992.

situ flushing, soil vapor extraction, dechlorination, in situ vitrification, chemical treatment, and thermal desorption.

However, selection is not the same as successful implementation, or as widespread adoption. Although innovative remediation technologies have been increasingly selected, their actual application at the site, and the subsequent obtaining of performance data, largely remains for the future. It will not be known for several years how well these technologies have actually performed at their selected sites. As of February 1992, 76 percent of the selected innovative technologies were in the design stage, 20 percent in the construction/operational stage, and only 4 percent had run to completion.

A second notable problem shown by these statistics is a gap with respect to targeted problems. The innovative technologies currently in the ROD pipeline focus heavily on traditional hazardous wastes, especially volatile organics. That is, technology for dealing with organic waste problems is progressing toward "establishment" very rapidly. Unfortunately, two of the major contaminant problems for Federal sites are radioactive/mixed and heavy metal wastes. Through 1991, of the 498 innovative technologies being applied at NPL sites, none specifically targeted radioactive contaminants and only 16 targeted heavy metals.[9] These technical areas remain predominantly public sector or academic concerns.

D. Collaborative Demonstrations: An Acknowledged Federal Role

The accelerated development and application of innovative technologies for environmental purposes is recognized as a necessity for the improvement of environmental quality and the enhancement of economic productivity by all of the signatory Federal agencies. The Federal government has an opportunity to leverage its required technology development work into more economically beneficial activities through collaborative partnership with non-Federal parties. In particular, this opportunity exists in connection with demonstrations of innovative ER/WM technologies.

EPA, DoD, and DOE representatives have been addressing common problems in the remediation of Federal sites as Interagency Experts Groups.[10] One of their subgroups, which has the task of examining the use of advanced technologies, reports that "...successful demonstration of innovative technological systems to remediate contaminated soil, groundwater, and sediments is critical to overcoming resistance to such systems widespread use, and that, compared to private sites, Federal facilities offer key advantages for these

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[9] The EPA SITE Demonstration Program currently has only eight projects specifically targeting heavy metals and only four targeting radionuclides. The SITE Emerging Technology Program (the SITE element which sponsors the less mature research) does have numerous projects targeting heavy metals and radioactive wastes, as do programs within the other Federal agencies most directly concerned with such wastes. All of these activities are discussed in greater detail in Chapter V.

[10] Interagency Experts Groups are discussed in greater detail in Chapter VII.

demonstrations."[11] They further expanded on that conclusion with recommended areas for initiatives, including:

- Use Federal facilities as central, permitted test beds to demonstrate innovative technology systems applicable to remediation problems of broad national concern;
- Pursue early involvement and cooperation of industry and States in these demonstrations at Federal facilities to facilitate technology acceptance and transfer through rapid reductions in data uncertainty;
- Enhance this cooperative approach by coordinating development of technical solutions to environmental restoration and waste management problems shared by States, commercial firms, and the Federal government; and,
- Involve the public early, continuously, and effectively in site characterization as partners in the decision process to ensure public understanding and shared responsibility of risks and payoffs.[12]

The Federal Working Group believes these initiatives to be both important and timely.

2. AGENCY METHODS FOR ASSESSMENT

As might be expected from the discussion of agency missions and technology needs in previous chapters of this report, the agencies use very different methods to assess the status of emerging technologies, ranging from very informal and facility dependent approaches, to more formal, centralized methods.

A. Example of Informal Approach

The Bureau of Mines' first source of information, for example, is its own 80 years of research. The next source would be the Bureau's network of contacts in academia and other Federal labs and research programs. The next best source would probably be various professional meetings, particularly those related to extractive metallurgy and related earth science activities, followed by meetings related to the growing body of clean-up technology.

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[11] "Recommendations for Implementation, Applying Technologies to Cleanup Subgroup", Internal Report to the Executive Steering Committee, November, 1991.

[12] Ibid.

B. Example of Formal Approach

(1) Information Gathering

In contrast, the DOE EM Office of Technology Development (OTD) uses a more formal approach to gather information, based on priorities resulting from site and weapons complex-wide research and development requirements.

OTD "customers," i. e., Program and Project Managers from the Offices of Environmental Restoration (ER) and Waste Management (WM), are sources of the following needs/requirements information, as applicable:

- Waste Stream (Waste Site) Characteristics
- Priority Information
- Technology Constraints and Performance Requirements
- Administrative Information

Waste stream and site characteristics include location, physical, chemical, and biological characteristics, as well as other environmental characteristics, such as the geological setting. Priority information refers to such matters as environmental safety and health risk or agreed compliance schedules. Technology constraints and performance requirements consist of those regulatory and technical issues which must be resolved for the technology to be acceptable. Administrative information is concerned with legal, national security, or labor relations issues.

Not all information can be provided immediately, and success depends on continuing efforts at communication between OTD, ER, and WM to develop the requirements and information necessary to analyze technology options. An example of this type of effort is the recently completed ER Technology Needs Assessment Crosswalk Report.[13]

OTD recently cooperated with ER to identify technology development activities associated with the priority technology needs identified by ER regional programs. The report provides "validated information work sheets" on problem areas identified by ER and on each OTD technology development activity that supports the ER priority needs. The report also includes a keyword search program on computer disk to allow report users to quickly match problem areas to development activities. Work sheets include Program Manager/Principal Investigator identities and addresses in addition to schedule and technical information, in order to promote communications at the planning and working level. Annual updates and enhancements of the report are planned.

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[13] Technology Needs Assessment Crosswalk Report (Draft), U.S. Department of Energy, DOE/ID/12584-117, GJPO-109, August, 1992.

(2) Analysis Process

The analysis process used by DOE EM is a disciplined approach which relies heavily on technical peer review. When technologies are assessed, the process also considers the views of site management. Decision analysis involves analysis of proposed technologies from an overall systems perspective as they evolve from the research and development phase, through demonstration, testing, and evaluation. The process includes public participation and information sharing with effected parties. Policy factors may also be considered.

Since there may be several proposed solutions to a given problem, comparative analysis must be used, employing benefit, risk, and cost factors. The mix of emerging technologies ultimately pursued as potential solutions to a given problem depends on the problem (e. g., required solution date, consequences of technology failure, transferability to other problems, etc.), and not solely on the assessment of a given technology's status. The listing by priority of cleanup activities is a management function driven by constraining elements such as financial resources. However, health risk, as expressed through requirements for compliance, is the key evaluation factor, and technology activities necessary to achieve compliance are treated as non-discretionary spending in program budgeting. Other activities, such as technology transfer, avoidance of future costs, and development of infrastructure for the cleanup, regardless of their desirability, are not permitted to take a higher priority than compliance.

DOE plans periodic review of all its technology activities, which includes both technical and programmatic peer reviews. These reviews use information provided by the technology developers in a format that includes the appropriate decision factors.

3. EXAMPLES OF EMERGING TECHNOLOGIES

A. Basis for Example Selection

The inclusion of an environmental restoration or waste management issue in any discussion of agency needs in the previous Chapter of this report carries with it an implicit judgment by that agency that existing technologies are inadequate to meet the need, and that additional actions are necessary to bring any emerging technologies to a condition appropriate for implementation. All of the technologies being discussed in this Chapter, therefore, are "not ready" for implementation and are potential subjects for Federal and State cooperation. Indeed, certain environmental technologies which have been developed by the Federal government, such as the DOE horizontal drilling technology demonstrated at Savannah River, and the DoD cone penetrometer, are not discussed here because they are so far along in the development process.

However, selection or exclusion of a technology for this discussion should not imply that the Federal Working Group thereby is judging its suitability for joint Federal-State activity. Suggested areas of cooperation are

given in Chapter VII; here the intent is to give a "flavor" of the kind of technology options which are available as potential future solutions to Federal technology needs.

In its discussions, the Federal Working Group committee addressing technology needs has not encountered any examples of significant disagreements among the agencies regarding technology assessment. There is agreement, at least at the levels of broad categories of technology that this document addresses, as to whether a given technology is still in a basic research stage, or is ready for and needs to be demonstrated, etc. Consequently, the discussion in this Chapter is not organized by agency -- although problems of special concern to individual agencies are mentioned where appropriate -- but rather is intended to give a common view among those agencies dealing with a particular problem area.

B. Examples

Federal facility cleanups are currently being performed using a number of "conventional" types of technologies such as incineration, stabilization, and separation. The suitability of these technologies depend on the nature and extent of contamination as well as site-specific conditions such as the hydrogeology of the area of contamination. The application of such conventional techniques can often greatly simplify the magnitude or technical complexity of the problems remaining to be addressed at a site by more advanced methods, even if the conventional techniques cannot solve the problems directly.

Waste reduction at the source is also critical to controlling the magnitude of remediation problems at Federal sites. Substitutes or new processes to replace some hazardous materials may require extensive development times or simply may not be found. Where possible, waste recycling can be a viable method of reducing waste volumes for disposal when substitutes or processes to reduce waste production at the source do not exist. While this method is not appropriate for some waste streams, there are a number of sites, such as National Park Service sites, where this may prove beneficial. Potential waste products in this category include plastics, rubber, steel, and petroleum contaminated soil. Recycling may also have considerable benefit in dealing with the problems of radioactive contamination. By employing such materials in locations where further contamination would be expected, such as in the construction of any future weapons complex facilities, in high energy physics research facilities, or in materials or equipment destined for use in storage or disposal of nuclear waste itself, the contamination of "virgin" materials could be avoided and disposal volumes greatly reduced.

Technologies for radioactive decontamination and decommissioning currently involve high costs, large volumes of secondary waste generation, and great risk of exposure to workers. Government research is currently focused on detecting and quantifying contaminants, improving surface treatment processes and secondary waste collection, and reducing worker exposure (as well as learning to recycle and reuse more materials). One example of advanced DOE technology in this area is the use of microwaves to decontaminate cement. Microwave energy is used to generate high pressure steam from the water of hydration within the

cement. The steam causes the surface concrete to "spall" (fracture). It is anticipated that this will enable removal of only the contaminated concrete layer without forcing contamination further into the material, and will also facilitate collection and handling of the removed material.

The National Defense Center for Environmental Excellence will operate a "mini-factory" for the demonstration and validation of pollution prevention and abatement technologies. The initial processes to be examined may include: non-chromate conversion coating; self priming powder painting; zinc alloy plating; electroless nickel plating; high velocity oxygen fuel coating; electrodeposited painting; non-halogenated cleaning; and, ion-beam-assisted deposition coating.

The U.S. Geological Survey is currently investigating on-site waste reduction programs at its National Water Quality Laboratory (NWQL) in Denver, Colorado for wastes containing petroleum solvents and heavy metals, particularly mercury and chromium. A prototype system has been developed using an ion exchange column which may be disposed of as solid waste or recycled. Feasibility studies are underway regarding the reduction of waste solvents to carbon dioxide and water through use of ultraviolet light and peroxide.

The military services are examining a number of bioremediation approaches to problems of fuels and ordnance. Bioventing combines the capabilities of soil venting and enhanced in situ bioremediation to remove low volatility hydrocarbons from unsaturated soil and groundwater. It is being tested for the removal of soil contamination from jet fuel at Fallon Naval Air Station in Nevada. Anaerobic degradation of jet fuel in groundwater is being examined by the Air Force in laboratory column experiments aimed at enhancing the process through addition of proper nutrients. Bench scale studies near Puget Sound in Washington have shown that white rot fungus can degrade common military explosives within a former ordnance waste disposal area to carbon dioxide. The Army has pilot scale studies underway to optimize the use of composting for ordnance degradation, and is developing soil slurry reactor bioremediation technology for soils where composting may not be appropriate.

Technology for monitoring the success of remediation efforts in groundwater is also being developed, as is technology for rapid assessment of underground contamination of a site. The Air Force is developing protocols for using in situ monitoring devices or field sampling and analysis techniques for determining contaminant concentrations and proving when remediation is occurring. Prototype systems are being developed by the Army employing magnetic signature and ground penetrating radar to locate buried, unexploded ordnance. The DOE Ames Laboratory is working with the DOE Office of Environmental Restoration and Waste Management to develop a real-time sampling, screening, analysis, and quality assurance system to support remediation of heavy metals.

DOE researchers are also working on a system to monitor the effectiveness of environmental barriers designed to prevent migration of contaminants outside a given disposal area. The system uses chemically sensitive fiber optic sensors called optrodes. A bundle of sensors, each treated to react to a different chemical, is located in the sampling region. A change in the

light reflectivity of a particular sensor indicates the presence of a specific contaminant.

Commercial waste treatment/disposal systems and equipment typically cannot meet the performance requirements and wide range of constraints posed by the Navy's unique shipboard requirements in the areas of size and space, weight, reliability, maintainability, manning, shock and vibrations, "environmental" factors, electromagnetic compatibility, acoustics, noise, ship systems integration, ship's services, safety and health, and logistics support. Similarly, naval shoreside facilities are confronted with Navy-specific environmental problems which cannot be addressed by commercially available technology.

Supercritical water oxidation (SCWO) is a high temperature, high pressure technology being investigated jointly by the Navy and DOE, which may have applicability to the special needs of both agencies. SCWO technology originally attracted the interest of DOE as an energy conservation technology for recovering fuel from waste. More recently, it has been recognized as having potential as a disposal technology for certain liquid hazardous wastes and for the hazardous waste components of certain mixed wastes. Navy interests lie in use for ship sanitary and galley wastes and for hazardous waste from Navy industrial processes. A one-fourth scale unit is being planned for pilot testing. Key technical questions include corrosion and materials.

Technological options for treating mixed waste are currently inadequate and focus on stabilizing the waste (often in a dilute bulk form) for the purposes of long term storage/disposal. Alternative or innovative treatment technologies are clearly needed to satisfy the letter and the spirit of the statutory preference expressed in SARA for remedial actions "that employ treatment technologies that permanently and significantly reduce" the toxicity, mobility, or volume of the hazardous waste. The dominant established alternative treatment technology is incineration. This technology is useful for many traditional hazardous waste streams but has not been widely applied to mixed wastes.

Emerging technologies devoted to site evaluation have focused primarily on improving the determination of "technical feasibility" of proposed remediation solutions through better (especially faster) site characterization. This focus is understandable due to the high costs for completing individual projects. However, it is unfortunate that there has been less recognition of the size of the emerging market, particularly in the Western States, for improvements in earlier stages of the process (e. g., site identification).

The Bureau of Land Management was recently directed to develop and implement a method to inventory public lands so that all potential remediation sites would be identified and reported within the next several years. With over half a million potential sites estimated to exist on the 300 million acres of public lands -- including those associated with the oil and gas industry, the mining industry, and closed dumps -- this will be a staggering task using even state-of-the-art technology to locate suspect sites. For the most part, records are inadequate or non-existent. No available technology is adequate to the

demands of this task at a reasonable level of resource expenditure. The Bureau has already utilized the highest presently de-classified level of remote sensing technology in a pilot attempt to identify such sites, but results have been unsatisfactory insofar as selectivity, location, and type determination are concerned. Although many possible sites were located, remote sensing information obtained was usually inadequate to determine whether hazardous materials were present. Extensive ground verification would have been necessary to make a rational determination whether the sites should be listed as hazardous material sites.

4. SOURCES OF ADDITIONAL DESCRIPTIONS AND ASSESSMENTS

A. Importance of Decentralized Information Networks

The above examples are not represented as being comprehensive. A great deal more information is available within the Federal government concerning the status of emerging ER/WM technologies than can be assembled in this document. Perhaps the most detailed information resides in the experience of the engineers and scientists engaged in the day-to-day management of the site cleanups themselves. These technologists develop extensive networks of informal contacts with counterparts across government and beyond into the private sector and academia. These networks contain vast expertise, much of which is not easily centralized within any agency for transmittal outside the agency. Technology transfer between the Federal government, the States, and the private sector ought to be seen as encompassing such networks and enhancing the opportunities for decentralized, as well as centralized, exchange of information. Technology transfer can and should be a "contact sport", and not simply an exchange of documents.

B. Formal Federal Sources

A number of documented sources of Federal government information on emerging technologies are available for dissemination to organizations such as the Western Governors' Association, however. Numerous EPA, DOE, and DoD personnel and contractors assisted in providing information for a 1991 WGA study of innovative waste management technologies.[14] The staff of DOE's HAZWRAP Office in Oak Ridge, Tennessee, compiled information on 138 waste management technologies specifically for that report.

The Technology Innovation Office within the EPA Office of Solid Waste and Emergency Response has made such information dissemination a key part of its

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[14] "Federal/State Collaboration Study on Innovative Waste Management Technologies", prepared for The Western Governors' Association by RE/SPEC Inc., June, 1991.

mission. Products of this Office related to emerging technologies include brochures,[15] newsletters,[16] and longer reports.

The interagency Federal Remediation Technologies Roundtable,[17] chaired by the Technology Innovation Office, recently completed three documents to provide a better understanding of waste problems facing the Federal government and the technology development efforts underway. These three documents[18] are:

- Accessing Federal Data Bases for Contaminated Site Clean-Up Technologies;
- Bibliography of Federal Reports and Publications Describing Alternative and Innovative Treatment Technologies for Corrective Action and Site Remediation; and,
- Synopses of Federal Demonstrations of Innovative Site Remediation Technologies.

Much of the information on emerging technologies which is generated by the Federal government is available from the National Technical Information Service (NTIS) within the Department of Commerce.[19] NTIS makes a particular effort to provide coverage of EPA reports, many of which are relevant to both Federal and non-Federal sites.

C. Adapting Information to User Needs

One of the biggest problems associated with evaluating information on emerging technologies is the tendency of advocates to name and package these technologies (e. g., "The XYZ Soil Washing Process") as if they were stand-alone products, capable of operating at any scale without a front or back end, e.g., a materials handling system to feed the black box or a treatment system for associated waste side streams. This lack of a process perspective has resulted

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[15] A reproduction of the brochure "Selected Alternative and Innovative Treatment Technologies for Corrective Action and Site Remediation (A Bibliography of EPA Information Resources)", Spring Update, May, 1992, is given at Appendix I.

[16] A reproduction of the June, 1992, newsletter "Tech Trends: The Applied Technologies Journal for Superfund Removals and Remedial Actions and RCRA Corrective Actions" is given at Appendix J.

[17] The Federal Remediation Technologies Roundtable is discussed in greater detail in Chapter VII, Section 1.

[18] Brief abstracts of these three documents, along with similar abstracts for other Federal reports on emerging technologies, or on obtaining Federal information about emerging technologies, are given at Appendix K.

[19] Chapter V, Section 6 contains a discussion of the role of the Department of Commerce in integrating the reporting of environmental technology information from the Federal government.

in a great deal of confusion and disappointment on the part of potential users both at Federal and non-Federal sites.

Most of the traditionally-cited sources of information on emerging technologies for hazardous waste cleanup techniques are geared to technically sophisticated consumers. Most of the vendors do not, cannot, or will not provide sufficiently detailed information to allow well informed decision making unless those seeking help have good technical skills of their own to allow them to make critical judgments about the various claims. To the extent that government sources of information must also rely on vendors as their primary data source, they will also suffer from the same weakness.

There are several interagency initiatives[20] to make information provided by the Federal government on the use of innovative technologies in remediation more responsive to user (as opposed to vendor) concerns. There is an opportunity to use the Federal government's experience with emerging technologies to provide a source of unbiased assessments of the strengths and weaknesses of various technologies.[21]

Finally, the EPA, DoD, and DOE are cooperating with the American Academy of Environmental Engineers to prepare a series of monographs representing professional consensus on the status of sufficiently advanced innovative waste treatment technologies.[22] These monographs are scheduled for completion in the fall of 1993.

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[20] These initiatives, still at a very formative stage, are among those being carried out under the umbrella of the Interagency Experts Groups on Federal Facilities and the Federal Remediation Technologies Roundtable. These Groups are discussed in greater detail in Chapter VII, Section 1.

[21] Records of Decision (RODs) will, in many cases, also include judgments about the strengths and weaknesses of emerging technologies which can be taken as unbiased by potential users for subsequent remediation projects. Access to a database of RODs is discussed in Chapter V, Section 5.

[22] A Project Profile for this effort, WASTECH '92, is given at Appendix L.

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CHAPTER V
CURRENT AGENCY APPROACHES TO TECHNOLOGY DEVELOPMENT

1. GENERAL

As might be expected due to differing agency missions and organizational structures, the approaches to technology development taken by DoD, DOI, DOE and EPA differ in many ways. While the agencies' approaches are different, all increasingly recognize the need for rigorous attention to interagency cooperation and sharing of information. The natural outcome of this increased interagency communication will be more uniformity in technology development processes and information systems.

As the recognition has grown that the scope of Federal agency responsibilities in environmental restoration and waste management is immense, and as recognition has simultaneously grown that economic competitiveness is vitally important to U.S. national interests, the agencies have moved to leverage their efforts in environmental technology development through increased cooperation with industry, academia, and non-Federal governmental bodies. Key goals of this effort are reducing the burden on Federal taxpayers that restoration of Federal sites would otherwise impose, and securing competitive advantages in the international marketplace both for American firms requiring environmental technology (for whom environmental compliance is an element of production costs) and for American suppliers of environmental technology.

The agencies are also becoming increasingly sensitive to the need for active public participation in their technology development decision-making processes, and look upon the opportunity to explain their approaches as consistent with improving their decision-making. A discussion of individual agency approaches follows.

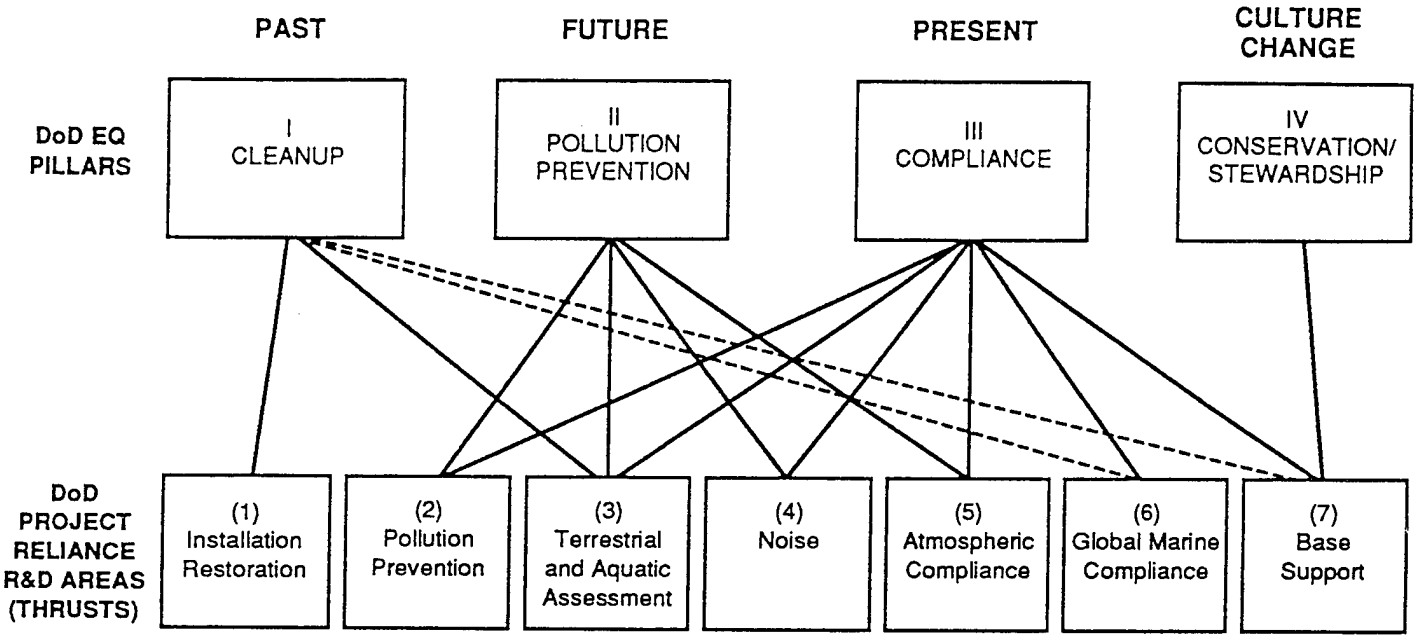
2. U.S. DEPARTMENT OF DEFENSE

The DoD environmental quality technology research and development approach under Project Reliance is designed to fully use the research capabilities of each service, as discussed in Chapter II. The four pillars of Cleanup, Compliance, Pollution Prevention, and Conservation/Stewardship -- with their corresponding emphases on past practices, present operations, future operations, and a culture change within DoD -- provided a convenient means to discuss Department technical needs in that Chapter, but do not provide such convenience in discussing the organizational approach taken by DoD to address those needs. Instead, the DoD approach is best addressed by problem area.

DoD has divided environmental quality issues into seven major problem or need areas. The relationship between the pillars and areas is illustrated in Figure V-1.

Figure V-1

RELATIONSHIPS BETWEEN DoD ENVIRONMENTAL QUALITY PILLARS AND R&D AREAS



In general, problem areas consist of a related set of research topics, or "thrusts"[1] which may comprise more than one of the pillars. The areas can be further subdivided to permit drawing clear organizational lines of responsibility for producing advances in each area or subdivision, thus matching the Project Reliance philosophy.[2] Although some of the areas bear little relationship to environmental restoration and waste management issues, all seven are discussed for the sake of completeness.

A. Installation Restoration

The purpose of the Installation Restoration Program is to clean up DoD facilities contaminated with hazardous materials as a result of past operations. The Installation Restoration Program is escalating, presently approaching a $1 billion annual DoD investment. This program provides the technology to reduce the cost of the cleanup of all DoD hazardous waste sites, especially those installations on the EPA National Priorities List, and it includes research and development in: site investigation and characterization; explosives, metals and other organic contamination treatment; and fuels and solvents site contamination treatment.

Under Project Reliance the Army is the lead service in site investigation and characterization. The Air Force and Navy will continue to rely on the Army to provide site characterization technologies and analytical methods for contaminant characterization. The Air Force will support the Army in developing site characterization technologies unique to fuels and solvents.

The Army is the single service manager for explosives and, as such, manages the life cycle of munitions development from explosives manufacture through disposal. The Army has significant experience and capabilities in development and evaluation of treatment technologies for heavy metals and for other organic compounds such as PCBs, pesticides, chemical agents, and other organics. The Air Force and Navy will rely on the Army for these technologies.

The Air Force has traditionally worked with solvents and fuels in its own installation restoration program and has built a strong research capability in this area. Project Reliance recognizes this Air Force capability, and the Army and Navy will rely on the Air Force's expertise to meet DoD requirements in this technology area. The Army and Navy will reprogram resources utilized in this area to other environmental quality research programs. The Navy will continue research on Navy-specific solvents and fuels problems through FY-94. The Navy efforts after FY-94 will be funded only as basic research.

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[1] In DoD documentation, these are often referred to as Tier 2 categories, or as sub-areas, or as "thrusts", but will be referred to here for simplicity as "areas" for research and development.

[2] Tri-Service Project Reliance Environmental Quality Area Summary, FY93-98 (Final Draft), 1992, U.S. Department of Defense.

B. Pollution Prevention

The objective of pollution prevention is to develop technologies which minimize or eliminate the hazardous waste generated by DoD. Currently, the services dispose of approximately 675,000 metric tons of hazardous waste each year. Within the past five years, certain disposal costs have increased tenfold (i.e. disposal of industrial sludges contaminated with heavy metals), and these costs will escalate even more dramatically as bans on landfill disposal become effective. Without technology innovation, disposal costs will restrict the accomplishment of other vital operating and maintenance functions.

Research in this problem area addresses wastes generated by weapons systems maintenance activities (such as cleaning and degreasing, metal plating and surface finishing, painting and coating, and paint stripping), and the manufacturing and reprocessing of explosives. Environmentally acceptable options for disposal of ordnance are also explored. The research program includes development of treatment technologies, process modifications, alternative operations, recycling, and chemical/material substitution. There are four major program subdivisions: explosives, manufacturing and demilitarization; aeronautical systems; nautical systems; and ground equipment systems.

Pollution prevention research conducted by DoD focuses on alternative, less hazardous materials and processes for new systems as well as for existing systems. Substitutes or new processes to replace some hazardous materials may require extensive development times or simply may not be found. In this case, development of technologies to recycle or treat hazardous materials will be pursued.

C. Noise Abatement

Operational capabilities are often lost because of problems associated with noise from armor, artillery training, and aircraft operation. Noise impacts have affected training capabilities at over 50 bases and ranges thus far. The primary sources of this noise are aircraft (fixed-wing and helicopter), weapons firing, and blasts/detonations. DoD is developing technologies to minimize the propagation and effects of operational noise on humans (troops and those in the surrounding communities) and wildlife. Research areas include: noise mitigation and propagation; wildlife and human response; community interaction; structural effects; and noise modeling, assessment and monitoring. The Noise Abatement area is subdivided into impulse noise and continuous wave noise.

DoD manages noise impact research through two major programs: the Air Installation Compatible Use Zone (AICUZ) Program and the Installation Compatible Use Zone (ICUZ) Program. Tri-service research in Noise Abatement supports and enhances the AICUZ and ICUZ programs. The Air Force continues to be primarily responsible for R&D in support of the AICUZ program. The Army continues to be primarily responsible for R&D in support of the ICUZ program. AICUZ or ICUZ studies are performed at virtually every Army, Navy, Air Force, and Marine

installation or base. The technology developed in this research area is used everywhere in DoD.

D. Base Support

In managing installations and federal lands utilized for training purposes, commanders must insure compliance with Federal and State environmental regulations, including those related to: protection of wetlands, wild and scenic rivers, and endangered/threatened species; soil protection; agricultural outleasing (forestry and grazing); and hunting, fishing, and other recreational uses. Improved, less costly technologies are needed to address installation operations issues and to design, rehabilitate, and better manage the use of training lands.

Research in this area is organized on topics of installation operations (on-base mission support), training area management/protection, and endangered/threatened species. Research activities in this area include biological and physical/structural erosion control technology for natural resources rehabilitation, the development of methods to inventory and monitor resource use, the establishment of thresholds for resource use, the development of methods to minimize operational impacts on training lands, and the minimization/elimination of base emissions into the environment.

The Army will be responsible for R&D in the Base Support area. The Air Force and Navy will rely on the Army to provide technologies, systems and procedures for environmental compliance, reducing the cost of achieving and maintaining compliance for military installations, and in the assessment, use, and protection of natural and cultural resources.

E. Atmospheric Compliance

The objective of Atmospheric Compliance research is to develop technologies, systems, and procedures that reduce the cost of compliance with environmental laws, treaties, and regulations while ensuring the completion of the DoD's military mission. Although the problems addressed are generally not unique to military activities, the potential impact (loss of mission capabilities) makes this research area crucial for DoD. Research is organized around characterization of pollutant behavior, criteria and hazardous air pollutant emissions, global impact pollutant emissions, and regulatory compliance tools.

Project Reliance has recommended joint programs while allowing for separate service funding and performance at separate service locations. This research emphasis is relatively new within DoD, developed in response to recent amendments to the Clean Air Act and the Montreal Protocol on CFC's.

F. Global Marine Compliance

The Global Marine Compliance area is Navy-unique and is designed to comply with all current and anticipated local, national, and international laws and treaties governing the marine environment. This includes all hotel, industrial, and propulsion plant emissions from ships operating in coastal, estuarine, and harbor waters of the continental United States, other states and territories, overseas bases, and foreign ports, as well as shipyards and other support facilities. Naval ships and support facilities have high visibility profiles and Navy personnel are required by Executive Order to excel in their duties to protect the environment.[3]

Naval research underway is related to oily waste waters, plastics and hospital wastes, and toxic and hazardous materials. Sub-categories of research include: offshore and marine; and ship emissions, fate and effects. The Army and Air Force will rely on the Navy to provide technologies, systems, and procedures for ship and small craft environmental compliance.

G. Terrestrial and Aquatic Assessment

Terrestrial and Aquatic Assessment is defined as the assessment of the hazard presented to the human and non-human environment from the production, use, and disposal of munitions-related wastes, industrial solvents, and military-unique fuels. Federal, State, and local authorities recognize that the data furnished by these assessments provides valid, biologically-based information about abatement, treatment, and cleanup levels.

To minimize the potential impacts of use of military relevant chemicals, their physical, chemical, microbiological fate, and ecological effects must be defined so technologies can be developed for their control and cleanup. Different media (water and soil) and divergent ecosystems must be addressed separately due to necessary differences in assessment technologies. Consequently, research is subdivided into installation restoration fate and effects, pollution prevention fate and effects, and salt water.

H. A Focus on Cooperation

Research in each of the seven problem areas is divided among the services' laboratories and research centers under Project Reliance in order to achieve the most efficient overall utilization of DoD resources. As can be seen from the discussion above, in some cases this leads to one service, or even one laboratory, becoming the primary location for a given type of environmental research. In other cases -- where a laboratory has a history of excellence in several areas, where a given area of research may apply to more than one of the

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[3] Letters, Chief of Naval Operations, March 13, 1989, and March 30, 1989. These letters promulgated the policies that, while maintaining military mission operational readiness, ships of the 21st Century will have a "pollution free profile", and Naval shore facilities will have "zero discharge" of hazardous waste.

pillars, or where the particular needs of a given service may bring an important perspective to the solution of an environmental problem being addressed by another service -- a laboratory may retain programs in several areas.

DoD laboratory capabilities are significantly enhanced by collaboration with the academic community. The DoD approach also places heavy emphasis on cooperation with private industry, which carries out much of the installation restoration work under contract. This cooperation includes a major emphasis on technology transfer, including "dual use" technologies applicable to both civilian and military needs.

3. U.S. DEPARTMENT OF INTERIOR

Just as differences between the missions and organizational structure of Federal agencies make it more difficult to describe an overall Federal approach to ER/WM technology development, differences between the missions and structure of Bureaus within DOI prevent ready description of any overall DOI approach. Several Bureaus have reported to the Federal Working Group that they have not as yet proceeded to address such technology development within their own programs. Others are engaging in technology development on a case-by-case and project-by-project basis, relying on their own pre-existing research structures, or private vendors, or cooperation with other agencies. Information at the Bureau level is as follows:

A. U.S. Geological Survey

The U.S. Geological Survey (USGS) approaches technology development through cooperation with other agencies. USGS assists DOE, DoD, and EPA in their environmental restoration programs. A principal USGS effort is in the field of site characterization where the Survey has significant expertise in assessing the extent, fate, and transport of contamination in both the vadose (unsaturated with water) and saturated soil zones. The USGS has provided technical assistance to EPA since 1983, in the area of site assessments related to the Superfund Program.

This assistance has included extensive training of field personnel and remediation studies in more than 28 States. Under the Federal-State Cooperative Program, USGS has conducted more than 60 investigations in more than 12 States involving one or more aspects of hazard identification, site assessment, pollutant transport and feasibility studies to meet statutory requirements. USGS support in these programs included the development of data base capabilities, geophysical surveys, test boring for sampling, chemical analysis of water and soils, contracting for hazardous waste chemical analysis, flow modeling, training of State personnel in hazardous waste sampling techniques, and advice on remediation alternatives.

USGS is participating on the Federal Remediation Technologies Roundtable,[4] including its initiative to find new technologies for the cleanup

[4] This interagency initiative is discussed in detail in Chapter VII, Section 1.

of contaminated ground water. Much of the research of USGS has relevance to these problems. In the field of remediation, USGS has several active projects in microbiology at the field and laboratory scale, which are investigating improvements in pump-and-treat methods which are universally acknowledged to be needed.

B. U.S. Bureau of Mines

The U.S. Bureau of Mines (USBM) is the Federal government's principle expert in the field of mining and extractive metallurgy. This body of technology has great applicability to problems related to cleanup of inorganic contamination. Under the Bureau's Environmental Technology Research Program, technology is developed to reduce the toxicity and volume of mining and mineral processing wastes, and to characterize and remediate a variety of hazardous wastes contaminated with heavy metals and other toxic constituents. This research has been directed at meeting the increasing number of requests by other organizations -- Federal, State, and private -- to apply USBM expertise to the identification, characterization, and extraction of hazardous wastes and other inorganic contaminants.

The USBM has been providing technical assistance to the DOI Bureaus of Land Management, of Reclamation, and of Indian Affairs, as well as to other government agencies, since 1987. For the Environmental Protection Agency, this assistance has varied from providing expert advice on proposed remediation plans to conducting complete Remedial Investigation / Feasibility Studies. Treatability studies have been conducted that included complete chemical, mineralogical, and geophysical characterization of given sites and contaminants, and evaluation of suitable remediation technologies with associated cost estimates. In one case, a generic process was developed that is capable of remediating lead contamination at battery breaker Superfund sites to levels below EPA's proposed standard of 500 ppm.

For the Bureau of Land Management, the Bureau of Reclamation, and the Forestry Service, the USBM has conducted studies to determine the location and extent of abandoned landfills, the environmental effects of excavation and relocation of mill tailings, and the detection, sampling, and analysis of groundwater contamination. The USBM has MOU's in place with these organizations in addition to the WGA agreement, and it is currently negotiating separate agreements with DOE and DoD. Memoranda of Agreement are in place with a number of States and with industry collaborators to assist in the development and demonstration of remediation technology.

The Generic Center Research Program is an important part of the Bureau of Mines approach to technology development. Research is concentrated in six generic mineral technology areas of broad applicibility across the minerals

industry. Each generic area has one lead academic institution that coordinates research and operates a reference center that disseminates results.[5]

C. Bureau of Reclamation

The Bureau of Reclamation has major expertise to offer in the area of desalting and treatment of water of impaired quality, whether surface or groundwater. Removal and/or destruction of toxic elements, heavy metals, volatile and nonvolatile organics can be addressed. In addition, the Bureau has developed a number of new processes for selenium removal, nitrate destruction, desalting pretreatment, and organic destruction.

4. U.S. DEPARTMENT OF ENERGY

A. Basis of Program

The DOE Office of Environmental Restoration and Waste Management (EM) ensures that reliable and accepted remediation and waste management technologies will be ready for implementation at DOE sites through an aggressive research, development, demonstration, testing, and evaluation (RDDT&E) program. The technology thereby made available will make DOE's environmental restoration and waste management operations faster, better, safer, and cheaper, and will help enhance U.S. industrial competitiveness. DOE's approach to technology development, and technology development's role in the Department's remediation and waste management effort, is contained in a series of Five-Year Plans that are issued annually.[6]

Technology development activities are conducted in support of the Department's mission and needs. Requirements are provided to researchers and developers which describe the problem in terms of technical performance, regulatory, cost, and schedule requirements. These requirements form the basis of what, when, and where the technologies are developed.

B. Major Application Areas

The RDDT&E program is organized into four major application areas that encompass the principal needs of environmental restoration and waste management operations: groundwater and soils cleanup, waste retrieval and waste processing, waste minimization and waste avoidance, and RDDT&E innovation and support.

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[5] Additional information on the Generic Center Research Program, along with other Bureau of Mines field facilities, is given at Appendix M.

[6] Environmental Restoration and Waste Management: Five-Year Plan, Fiscal Years 1993-1997, U.S. Department of Energy, 1991.

- The **groundwater and soils cleanup** activities are intended to: remove or reduce hazardous and/or toxic materials from contaminated groundwater, contaminated underground or surface soils; reduce radioactivity levels; and provide interim measures as necessary to retard migration of, or contain, hazardous and radioactive materials until suitable remediaton technologies can be developed, or until agreement can be reached on the applicable compliance requirements.

- The **waste processing and waste retrieval** activities are intended to: immobilize, treat (either in-situ or ex-situ), and/or remove contaminated material from a site or tank; process contaminated material into a suitable form for shipping and disposal; treat and dispose of waste arising from operations; and decontaminate and decommission materials, equipment, and facilities.

- The **waste minimization and waste avoidance** technical activities are intended to: reduce at the source, through solvent substitution, the toxicity and quantity of hazardous materials resulting from a process or operation; develop alternative metal forming processes that consume less stock and yield less waste; and, develop initiatives and methodologies to recycle all materials that are practical for reuse.

- The **RDDT&E support** activities are intended to determine the technical, regulatory, economic, and institutional feasibility of novel processes, devices and/or models by: supporting (through interagency agreements) the development, testing and evaluation of technologies of mutual interest to EM and other agencies; and, by developing initiatives (such as Program Research and Development Announcements and Cooperative Research and Development Agreements) to foster private industry participation in ER/WM technology development.

C. Integrated Demonstrations and Programs

To integrate these RDDT&E and other programs into a cohesive effort, EM established focused programs and demonstrations aimed at resolving the major environmental restoration and waste operation problems identified. These so-called integrated programs (IPs) and integrated demonstrations (IDs) are the two pillars of EM's programmatic infrastructure through which EM implements its aggressive RDDT&E program. They are the mechanisms to help move technology products from the universities, industries, government agencies, international agencies, and DOE laboratories and sites into the hands of technology users, including DOE field personnel and private sector technology vendors (who both do the actual remediation of DOE sites and provide similar services to other government agencies, private industry, and abroad).

An integrated demonstration provides an end-to-end system for solving similar environmental problems at similar sites. It applies multiple technologies and compares them as tools for a specific problem representing a generic environmental issue, such as groundwater and soil remediation. Entire systems of technologies are evaluated with respect to performance, safety and cost effectiveness. IDs are planned in sequences which address ever more difficult ER/WM problems, allowing the results of one ID to provide the foundation for successful resolution of the problems faced at other sites.

An integrated program, on the other hand, is a set of R&D activities dedicated to meeting the needs for technology solutions for a single problem category. Consequently, IPs are those cross-cutting activities, such as characterization and treatment, which will be key components of solutions to problems recurring throughout the nuclear weapons complex. They provide a mechanism for aggregating information so that it can be compared and transferred among DOE users and transferred to other Federal agencies, the industrial community, and academia.

Integrated demonstrations and programs are anticipated to produce significant cost savings to the taxpayer for environmental restoration and waste management. Savings are produced, first, because integration is inherently more cost-effective than conducting RDDT&E activities in non-integrated form. Second, and more important, the new technologies being developed are capable of providing significant cost savings as they are implemented at Federal sites. For example, application of advanced technology to the problem of removing volatile organic compounds from the soil at DOE's Savannah River Site has already saved $125 million compared to conventional pump and treat methods, and a robotics development program at DOE facilities in Ohio and Idaho has saved $15 million,[7] with many more savings anticipated as these technologies are applied at other sites.

D. Supporting Activities

In addition, to these direct RDDT&E activities there is a group of crosscutting activities that broadly supports the RDDT&E Program. These activities are organized in the following five infrastructure support groups: Analytical Services, Robotics, Decision Support, Environmental and Molecular Science Laboratory (EMSL), and Technology Integration and Environmental Education Development.[8]

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[7] Testimony of the Assistant Secretary for Environmental Restoration and Waste Management, U.S. Department of Energy, before the Subcommittee on Energy, Committee on Science, Space, and Technology, U.S. House of Representatives, February 6, 1992.

[8] The DOE also maintains a transportation program within EM which can be regarded as infrastructure supporting the entire cleanup effort. Policy issues related to the transport of radioactive materials are of extreme importance. However, the Federal Working Group is not emphasizing these issues within the technology development area at this time.

- **Analytical Services** involves the development of analytical capacity and protocols for the measurement of radioactive, hazardous, and mixed wastes for all EM programs.

- **Robotics** integrates the development of robotics technology needed to accomplish remote characterization of waste and waste sites and to support remediation of DOE sites containing radioactive, hazardous, and mixed waste.

- **Decision Support** provides the tools and methodologies to identify, assess, analyze, and control technical and other decisions associated with technology development program formulation and execution.

- The **Environmental and Molecular Science Laboratory (EMSL)** will develop the requisite interdisciplinary research programs, equipment and supporting facilities to meet the scientific environmental restoration and waste management challenges posed by DOE's environmental initiative.

- **Technology Integration and Environmental Education Development (TIEED)** establishes: an international technology transfer system (The International Technology Exchange Program)[9] that identifies foreign options for meeting technology needs in support of EM programs and facilitates transferring DOE technologies to foreign markets; a domestic technology transfer system that facillitates private sector participation in the IDs and IPs and delivery of successfully developed technologies to American industry; and, a system of educational and training programs to insure that a trained workforce will exist to apply successful technologies to DOE sites.

E. Public Participation

The Department is committed to encouraging public participation in all of its environmental activities, including technology development.[10]

Technology development is taken into account as appropriate in each decision process. For example, DOE is preparing a Programmatic Environmental

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[9] A recent reorganization has placed the International Technology Exchange Program (ITEP) in the same Office as the domestic technology transfer (technology integration) and environmental education functions, and they are discussed as a single entity in this section; much DOE documentation, particularly related to budgetary matters, shows ITEP as organizationally related to the other four infrastructure support areas listed in this section, while technology integration and environmental education are grouped as a separate "education" classification.

[10] The overall approach to DOE public participation in environmental decision-making is discussed in Chapter II, Section 5.C.

Impact Statement (PEIS) for the overall environmental restoration and waste management program as a means of bringing public insights into its decision processes. While the PEIS will not develop and analyze specific programmatic alternatives for technology development, it will describe the process to be used in selecting technologies for development, demonstration, and deployment, thereby opening that process to public comment. Furthermore, in evaluating environmental restoration and waste management alternatives using data for existing technologies, DOE will consider that emerging technologies may change the conclusions drawn from that analysis.

In addition, RDDT&E activities occuring at a site are incorporated in specific site public participation planning, and technology development personnel are represented on any working groups or task forces within the Office of Environmental Restoration and Waste Management concerned with public participation policies or procedures.

F. Strategic Business Plan and Investment Strategy[11]

The DOE approach to technology development continues to evolve. In February, 1992, the Office of Environmental Restoration and Waste Management convened a task force "to develop an R&D investment strategy that addresses both near- and long-term solutions to remediation and waste management problems in the DOE complex and application of these technologies to other national needs including international competitiveness through technology transfer."

The task force has produced a strategic business plan and operational model of an "enterprise" to maximize the benefits from the national investment in environmental restoration and waste management. Implementation is intended to catalyze interactions among DOE and other Federal agencies, the DOE laboratories, industry, universities, State governments, and other key stakeholders in the restoration of the environment and the long-term health of the U.S. economy. The synergy that is formed from this process will combine the research and development capabilities of the DOE laboratories and universities and the business and technology commercialization skills of industry.

5. U.S. ENVIRONMENTAL PROTECTION AGENCY

A. Policy Toward Demonstration Activities

The Federal government is striving to be a leader in innovative technology research, development, and implementation. There are a number of EPA activities underway in this area. A directive has been issued which encourages demonstration projects at Federal facilities in connection with Superfund, RCRA,

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[11] Discussion in this section is taken from the EM Strategic Task Force Strategic Business Plan (Predecisional Draft), U.S. Department of Energy EM Strategic Task Force, June 26, 1992.

and Underground Storage Tank activities.[12] In this regard EPA headquarters is exploring the use of Federal facilities for both site-specific technology demonstrations, and as test locations for evaluation of more widely applicable technologies. EPA Regions are encouraged to suggest innovative approaches and to be receptive to proposals for innovation from Federal facility managers, for example, by building timing and performance flexibility into compliance agreements in acknowledgement of current uncertainties associated with innovation.

The Office of Federal Facilities Enforcement (OFFE) will work with the Regions to identify locations for sponsoring potential test and evaluation activities. With assistance from the Technology Innovation Office, OFFE will develop necessary policies and guidance to ensure that support for innovation is congruent with other program and environmental activities.

B. Risk Management = Risk Assessment + Risk Reduction

The EPA has a comprehensive technology development program to prevent or solve environmental problems from hazardous materials and hazardous wastes. EPA's activities include research, development, demonstration, commercialization and technology transfer in both the headquarters Office of Research and Development (ORD) and Office of Solid Waste and Emergency Response (OSWER), and in the ten EPA Regional Offices. EPA's programs are structured around environmental media, i.e., air and radiation, hazardous substances and wastes, wastewater and water supply, and pesticides and toxic substances. The hazardous substances and wastes activities are directly applicable to this report.

The ORD conducts its hazardous waste research and development in four general problem areas: Hazardous Wastes, Superfund, Leaking Underground Storage Tanks, and Oil Spills. The most recent enabling legislation, the Oil Pollution Act of 1990, established an Interagency Coordinating Committee for research, technology development and demonstration among Federal agencies, in cooperation with industry, universities, research institutions, and State governments. Research, relevant to the WGA initiative, and to the effectiveness of bioremediation technologies is part of this effort.

ORD's research program is conducted through inhouse research efforts at EPA field research laboratories, through extramural grant and cooperative agreement projects with Universities (projects and Centers) and other not-for-profit institutions, through joint interagency agreements with other Federal Agencies, and through contracts with the private sector.

In the context of this report, it is important to recognize that environmental technology must have a broad definition, including not only the engineering-type "treatment" technologies, but also all types of methodologies

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[12] "Furthering the Use of Innovative Treatment Technologies in OSWER Programs", OSWER Directive 9380.0-17, Environmental Protection Agency Office of Solid Waste and Emergency Response, 1991.

from risk assessment and communication methods, monitoring characterization and techniques, to expert systems for improved decision making.

The process of risk management will help lead to new or improved technologies to prevent or solve environmental problems.

The EPA risk management approach yields three major activities. They are:

- Environmental Risk Assessment, which addresses the questions of what are the human health risks and what are the ecological risks;
- Environmental Risk Reduction, which involves reducing the environmental risk to acceptable levels through pollution prevention, day-to-day waste management and the cleanup of contaminated sites; and,
- Environmental Risk Management, which, in addition to the risk assessment and risk reduction activities, includes other factors, such as technology transfer, risk communication, socio-economic factors, etc., to ensure that the technology can be implemented.

(1) Environmental Risk Assessment

The **Environmental Risk Assessment** component of the EPA hazardous waste research program has two elements: human health risk assessment and ecological risk assessment. This research is designed to produce the methods and tools needed to determine the risk associated with the current waste management practices, with contaminated sites, and with the technologies used to reduce the risk to acceptable levels. Based on the identified risk, actions can be designed to prevent or reduce the risk to acceptable levels. Within the four problem areas described above, ORD conducts environmental risk assessment research in the following issues: ecological risk assessment, groundwater, human exposure, human health effects, and human risk assessment.

(2) Environmental Risk Reduction

The **Environmental Risk Reduction** component of the hazardous waste research program has three elements: pollution prevention, waste management and site cleanup. This research is designed to produce the technologies (hardware, software and methodologies) required to prevent or solve the unacceptable risk identified by the Environmental Risk Assessment component. Within the four problem ares described above, ORD conducts environmental risk reduction research in the following issues: pollution prevention, municipal solid waste, hazardous waste, surface cleanup, bioremediation, and innovative technologies.

(3) Environmental Risk Management

The **Environmental Risk Management** component is the area where research and other activities are synthesized with regulatory and socio-economic factors to ensure that the technology solutions developed under the Risk Assessment and Risk Reduction components can be practically implemented. The programmatic and regulatory side of EPA are the important players in this activity.

C. High Visibility Technology Development and Commercialization Projects

The following paragraphs describe some selected high visibility technology development projects underway in the Office of Research and Development that are relevant to the WGA initiative.

(1) Superfund Innovative Technology Evaluations

The U.S. EPA's Superfund Innovative Technology Evaluation (SITE) Program, now in its sixth year, encourages the development and implementation of (1) innovative treatment technologies for hazardous waste site remediation and (2) monitoring and measurement technologies for evaluating the nature and extent of hazardous waste site contamination.[13]

The SITE Program was established in response to the 1986 Superfund Amendment and Reauthorization Act (SARA), which recognized a need for an "alternative or innovative treatment technology research and demonstration program." Currently, the SITE Program is administered by the ORD's Risk Reduction Engineering Laboratory, headquartered in Cincinnati, Ohio.

The SITE Program includes the following component programs:

- A **Demonstration Program** conducts and evaluates demonstrations of promising innovative technologies to provide reliable performance, cost, and applicability information for future site characterization and cleanup decision-making;
- An **Emerging Technology Program** provides funding to developers to continue research efforts at the bench and pilot scale levels to promote the development of emerging technologies;
- A **Monitoring and Measurement Technologies Program** develops technologies that detect, monitor, and measure hazardous and toxic substances to provide better, and

[13] Additional information on the SITE Program is provided at Appendix N.

more cost effective methods for producing real-time data during site characterization and remediation; and,

- A **Technology Transfer Program** disseminates technical information on innovative technologies to remove impediments for their use.

The Demonstration and Emerging Technology Programs are designed to assist private developers in commercializing alternative technologies for site remediation. Under the Emerging Technologies Program, EPA provides technical and financial support to developers for bench and pilot scale testing and evaluation of innovative technology so that potential users can assess the technology's applicability for a particular site cleanup. Data collected during the field demonstration are used to assess the performance of the technology, the potential need for pre- and post- processing of the waste, applicable types of wastes and waste matrices, potential operating problems, and approximate capital and operating costs.

The Monitoring and Measurement Technologies Program is designed to accelerate the development, demonstration, and use of innovative monitoring and measurement, as well as characterization, technologies at Superfund sites. The Technology Transfer Program distributes technical information on innovative technologies participating in the SITE Program.

(2) Information Products Supporting Developers and Users

The EPA is very concerned with the transfer of information on innovative technologies. A major barrier to the acceptance of innovative remediation technologies is the lack of information, presented in a suitable format for potential user desisions, on the technologies' cost and performance. Several projects exist to address the availability of information on treatment technologies.

As indicated in Chapter IV, Section 4, the Technology Innovation Office produces a number of products containing information on emerging technologies, which should be of great interest to users. It has also published a guide for developers of innovative hazardous waste treatment technologies which identifies assistance programs, facilities and research centers which may be of assistance to them.[14] The Office is also completing a market study, available in the fall of 1992, to assist technology developers in assessing cleanup markets for Superfund, hazardous waste and underground storage tanks.

In addition, the EPA has developed the following computerized databases, publicly available except as noted, to address parts of the technology transfer problem.

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[14] "Innovative Hazardous Waste Treatment Technologies: A Developer's Guide to Support Services", EPA Office of Solid Waste and Emergency Response, EPA 540/2-91/012, June, 1991.

- The **Vendor Information System for Innovative Treatment Technologies (VISITT)**[15] contains information on vendors of innovative technologies to treat groundwater, soils, and sludges.

- The **Alternative Treatment Technology Information Center (ATTIC)** is a comprehensive bibliographic reference that integrates existing hazardous waste data into a unified, searchable resource.

- The **Clean-Up Information Bulletin Board (CLU-IN)** is a publicly accessible, on-line computer system that fosters technology transfer and facilitates communication among those involved in solid and hazardous waste clean-up.

- The **Records of Decision System (RODS)** was developed to track site clean-ups under the Superfund program and to justify the type of treatment chosen at each site, and it stores information on those technologies.[16]

(3) National Environmental Technology Applications Corporation

The National Environmental Technology Applications Corporation (NETAC) facilitates commercialization of promising environmental technologies. Created through a cooperative agreement between the U.S. Environmental Protection Agency and the University of Pittsburgh Trust, NETAC's services to government and industry include:

- technical and commercial assessments
- technology development assistance
- testing and demonstration
- market analysis and business development
- permitting and regulatory assistance
- patent, royalty, and licensing agreements
- identification of financial sources

NETAC matches EPA's financial support, dollar for dollar. Total joint funding has exceeded $10 million in the four year life of the project. NETAC is expected to be self-sustaining in 1993.

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[15] Additional information on VISITT is given at Appendix O.

[16] Although RODS is a limited access system requiring that special arrangements be made to access EPA computers through the National Data Processing Division, the National Technical Information Service maintains hard copies and abstracts.

(4) Environmental Research, Education and Policy Centers

The Office of Research and Development supports several university based environmental research centers that conduct basic and applied technology development. These Centers are designed not only to provide the new technology "knowledge," but also to work with the private sector to ensure that knowledge is transferred into marketable products and businesses.

(5) EPA Bioremediation Action Committee (BAC)

The Bioremediation Action Committee (BAC) is an affiliation of academia, government and industry representatives who share a common goal of working collectively to expand the responsible use of biotechnology for the prevention and remediation of environmental contamination. Chaired by EPA, the BAC serves as a forum for sharing information and for collaborative actions to address issues, and pursue opportunities that relate to the appropriate use of this technology.

The BAC is dedicated to advancing the responsible development and application of biotechnology for the prevention, control and remediation of environmental contaminants. It functions to develop common goals, coordinate joint actions to achieve those goals, and communicate progress of national efforts related to these goals. This is accomplished primarily through:

- identifying opportunities, appropriate applications, and/or limitations for environmental biotechnology;
- identifying scientific, institutional and regulatory limitations, barriers, and knowledge gaps and carrying out initiatives to address them;
- documenting uses and measuring progress in application of bioremediation;
- documenting effectiveness of biotechnology applications, and fostering use of quality control and sound science in measuring effectiveness; and,
- increasing public, corporate, and government awareness and understanding of the technology.

6. APPROACH TO INFORMATION INTEGRATION AND COMMON REPORTING FORMAT

Each of the signatory Federal agencies has developed its approach to environmental restoration and waste management R&D independently of the others. Approaches follow the unique mission requirements, operating philosophies, and organizational structures of each agency, discussed in Chapter II, and, therefore, are different from each other in important ways. Of particular relevance here, all of the approaches to acquire and transfer innovative ER/WM

technology rely heavily on technology development and acquisition structures that have evolved around the procedures each agency uses for overall management, and are now having to be adapted to the environmental arena.

As examples, the DoD has traditionally relied on each of the military services to solve research problems related to its own mission areas; Project Reliance initiatives are attempting to focus the skills of each service's laboratory system on appropriate "specialty" problems to the benefit of the entire DoD. The DOE has centralized the development of ER/WM technologies under one Deputy Assistant Secretary, replacing a structure in which individual National laboratories and site management and operating contractors each pursued programs of environmental research primarily according to the opportunities and issues for which they felt most concern. DOI continues to rely largely on the research components of its organization which predated recognition of the importance of ER/WM problems and is only beginning to systematize the search for innovative ER/WM solutions. Within EPA, the Office of Solid Waste and Emergency Response and the Office of Research and Development are taking initiatives, as part of a regulatory agency, to promote the demonstration and adoption of technical innovations within an entrepreneurial culture. Each agency is developing an approach which it believes will optimize the fulfillment of its own responsibilities.

The independent approach of each agency toward developing information and management systems often makes it difficult for the agencies to share information with each other and with non-Federal parties, such as the WGA. This difficulty is not limited to environmental research, but has been recognized as an issue regarding all Federal research, as Congress and the agencies themselves increasingly recognize the importance of tying such research to national economic competitiveness efforts.

A. NIST and the American Technology Preeminence Act

The recognition of the need to promote technology transfer has resulted in the American Technology Preeminence Act of 1991.[17] The purpose of this Act is to help United States industries to speed the development of new products and processes so as to maintain the economic competitiveness of the nation. Two sections of this Act affect the MOU's cooperative activities by strengthening the role of the National Technical Information Service in collecting and disseminating scientific and technical information.

Section 108, "Transfer of Federal Scientific and Technical Information," requires that Federal agencies submit to NTIS unclassified scientific, technical, and engineering information which results from Federally funded research and development activities. Section 506, "Report on Information Collection and Dissemination," directs a study to determine the feasibility of establishing a comprehensive inventory of Federal information products and services at NTIS.

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[17] American Technology Preeminence Act of 1991, Public Law 102-245, February 14, 1992.

These two provisions provide added encouragement to the MOU signatories to consider using NTIS as a locator and central source for new information on environmental restoration and waste management technologies.

B. Other Integrated Public Information Efforts

Already, NTIS's Federal Research in Progress Database (FEDRIP)[18] and the NTIS Bibliographic Database[19] are extensively searched for information about ongoing and completed environmental research, respectively.

The DOE, DOI, and EPA already contribute to FEDRIP. DoD does not because of ongoing security concerns not specifically related to environmental restoration and waste management topics.

Other efforts to integrate information provided to the public include many of those documents listed in the bibliographic Appendices (i. e., Appendices F and J) accompanying this report. The interagency Federal Remediation Technologies Roundtable has been a particularly fruitful source of such documents, as discussed in Chapter IV, Section 4. The DOE has also prepared a Directory of Federal Agencies and University Research Centers Conducting Research and Development in Environmental Restoration and Waste Management.[20]

C. A Common Reporting Format

DoD, DOE, DOI, and EPA recognize the need to develop a common method for communicating environmental restoration and waste management technology needs and research and development if they are to cooperate effectively with each other and with the WGA. Such a methodology would not be intended to replace management approaches used by the individual agencies, but would allow ready "translation" of terminology between agencies and aggregation of agency data for discussion with the WGA and other non-Federal bodies. Ideally, it should promote improved market identification by private businesses, educational and labor planning by regional, State, and local government bodies, and permit the Federal agencies to identify avenues for improving leveraging of technical and financial resources.

The Federal Working Group committee which is focusing on Technology Needs and Emerging Technologies is exploring an approach which takes advantage of the fact that all of the Agencies are developing for use some form of "wiring diagram" or "roadmap" to express the logical connections between technology

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[18] Copies of representative reports from Federal Research in Progress are provided at Appendix P.

[19] Information on the contents of, and gaining access to, the NTIS Bibliographic Database is given at Appendix Q.

[20] Directory of Federal Agencies and University Research Centers Conducting R&D in Environmental Restoration and Waste Management (Preliminary Draft), prepared for DOE's Office of Environmental Restoration and Waste Management by PAR Enterprises, Incorporated, and Robert G. Smith Applied Research Company, September, 1991.

needs, program goals, and individual technology projects and development schedules. Such connections lead naturally to an associated "taxonomy" for classifying problems. However, because the logical connections in the wiring diagram need not be unique (i. e., they reflect the preexisting mission and organizational structures of the sponsoring agency), the taxonomy natural to a particular agency is not usually consistent with that of the other signatory agencies. In practice, it is difficult for the agencies to currently match their wiring diagrams at any but the highest level of generality, or to aggregate information at more detailed levels of generality than given in this report.

In order to develop a system that is useful to the agencies and to the WGA, commercial companies, universities, and the public, a development process will be required which includes representatives of all the affected parties.

CHAPTER VI
CURRENT FUNDING AND REGIONAL RELEVANCY

1. GENERAL

The Federal signatories to the MOU with the Western Governors' Association recognize the vital role that technology development will play in accomplishing their collective goal of having effective and efficient environmental restoration and waste management programs. The Federal Agencies have supported significant growth in their technology development programs despite extensive pressures on overall agency budgets. Although it is difficult to categorize the budgets of the different agencies in a self-consistent way, aggregate FY 1993 funding requests to Congress for environmental technology development are on the order of $750 million.

Because of the number and size of land holdings and facilities managed by DoD, DOE, and DOI, and their distribution within the United States, it is apparent that a significant portion of those Departments' environmental restoration and waste management funds are allocated to, and expended in, areas of interest to WGA and its members. However, at this time, the Federal signatories are not able to collectively provide funding information on a State-by-State or regional basis. Since funds that are allocated to a particular office, laboratory, or remediation site in one State are not necessarily expended in that State alone, and since research and development expenditures are not categorized identically in the Federal agencies, any discussion of expenditure patterns becomes very complex, especially for agencies with large numbers of sites and/or decentralized research and development funding accounts. Notwithstanding the above comments, all the signatory agencies are reviewing how they can best provide the desired information.

2. CURRENT FEDERAL FUNDING FOR RESEARCH AND DEVELOPMENT AND ITS RELEVANCE TO THE WESTERN STATES

A. U.S. Department of Defense

A summary of national environmental restoration and waste management R&D funding for Department of Defense for fiscal years 1992 and 1993 is provided below:

ACTIVITIES	FY 1992 ($1000)	FY 1993 ($1000)	INCREASE ($1000)
Installation Restoration	$ 19,172	$ 29,449	$ 10,277
Pollution Prevention	11,197	17,056	5,859
Noise Abatement	4,597	5,696	1,099
Base Support	3,325	3,562	237
Atmospheric Compliance	739	2,045	1,306
Global Marine Compliance	0	3,295	3,295
Terrestrial and Aquatic Assessment	6,103	6,919	816
DERA R&D	0	50,000	50,000
Environmental Compliance	0	126,300	126,300
TOTALS	$ 45,133	$244,322	$199,189

Note: This table is based on Project Reliance, FY93 DERA R&D, and Environmental Compliance (Seperate from Reliance) Programs funding information only. Programs, such as SERDP, which provide additional projects and support will be considered at a later time.

B. U.S. Department of Interior

The fiscal year 1992 and 1993 Department of Interior budgets for RD&D are shown below:

ACTIVITIES	FY 1992 ($1000)	FY 1993 ($1000)	INCREASE ($1000)
Waste Retrieval and Waste Process	$ 9,848	$ 7,299	$ (2,549)
Waste Minimization and Waste Avoidance	29,728	22,046	(7,682)
Soils and Groundwater (See Note)	26,120	26,020	(100)
Infrastructure Support	8,357	7,400	(957)
TOTALS	$ 74,053	$ 62,765	$(11,288)

Note: $26 million funded to USGS by other Federal Agencies.

C. U.S. Department of Energy

(1) National Funding

DOE ER/WM RD&D activities are funded through the Office of Environmental Restoration and Waste Management (EM), most through the Office of Technology Development. Site-specific "Applications" funding is also provided through the EM Office of Environmental Restoration and the EM Office of Waste Management. Funding for FY 1992 and FY 1993 for such activities within these three EM Offices is summarized in the following Table:

ACTIVITIES	FY 1992 ($1000)	FY 1993 ($1000)	INCREASE ($1000)
Waste Retrieval & Waste Process	$ 51,900	$ 59,300	$ 7,400
Waste Minimization & Waste Avoidance	6,850	2,200	(4,650)
Soils & Groundwater	53,250	60,830	7,580
Innovation & Support	47,660	42,000	(5,660)
Infrastructure Support	29,265	43,600	14,335
Environmental and Molecular Sciences Laboratory (Engineering and Design only)	17,100	28,500	11,400
Environmental Restoration Applications	N/A	64,500	N/A
Waste Management Technology Applications	N/A	N/A	N/A
TOTALS	$ 206,025	$ 300,930	$ 30,405

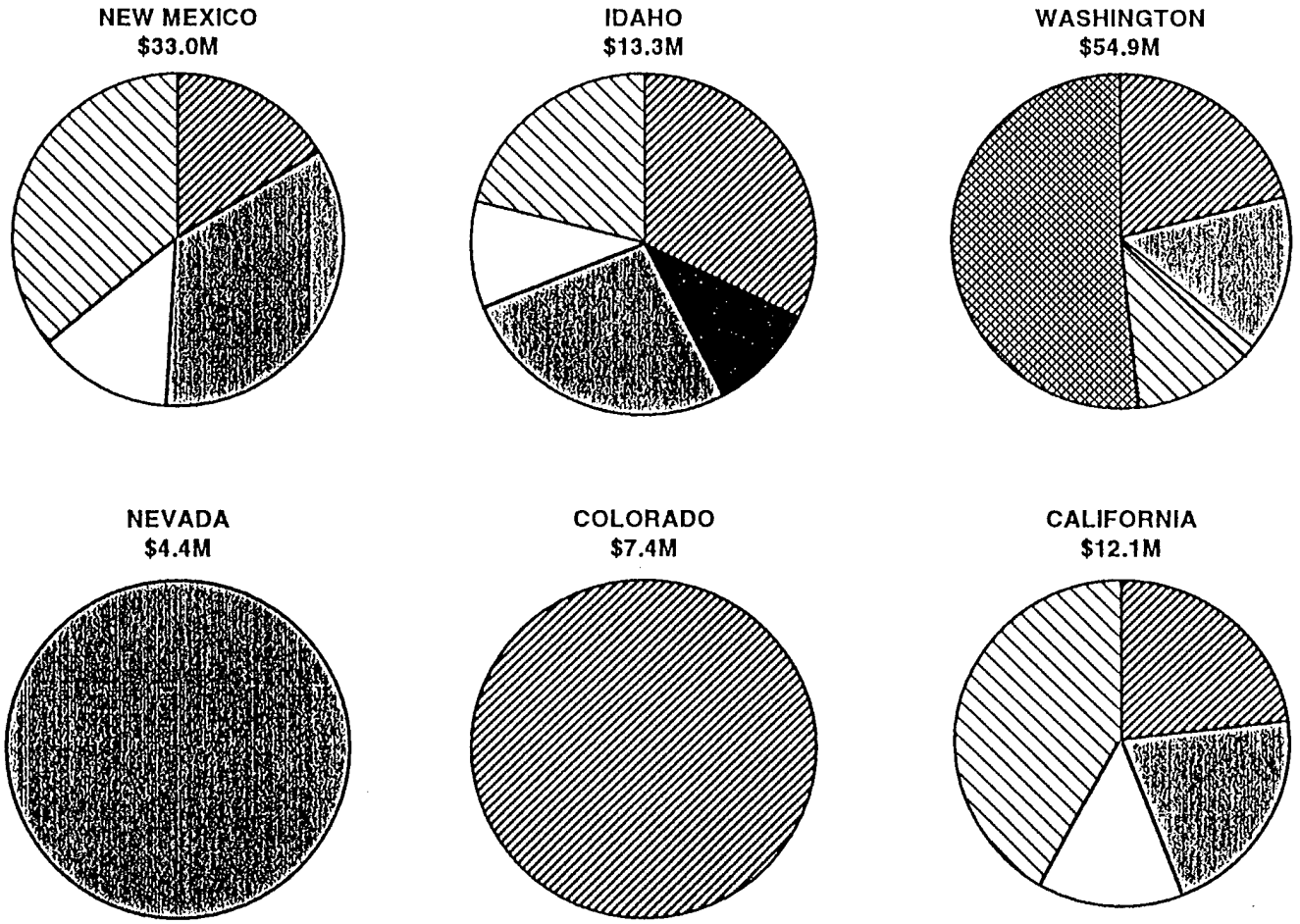
Note: RDDT&E budget requests include funding requests for RDDT&E and Infrastructure Development areas, but exclude funding request for Technology Integration and Education, Technology Transfer, and Transportation. Total for column labeled "Increase" excludes "Applications" categories, for which information is unavailable.

(2) Regional Funding

More than half of the FY 1993 RDDT&E funds of the EM Office of Technology Development, if approved by Congress, will be allocated to Field facilities in six western states, as shown in Figure VI-1. Additional funding will be expended by other Offices within EM, but a state-by-state breakdown cannot yet be provided. As discussed previously, these numbers should be used with caution.

Figure VI-1

FY 1993
REQUESTED DOE ER/WM RD&D ACTIVITIES FUNDING IN WESTERN STATES
(OFFICE OF TECHNOLOGY DEVELOPMENT ONLY)



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D. U.S. Environmental Protection Agency

As described in Chapter V, Section 5, EPA's activities relevant to the MOU with the Western Governors' Association are conducted by the Office of Research and Development (ORD), the Office of Solid Waste and Emergency Response, and the EPA regional offices. Only the resource levels for the ORD are available. These FY 1993 requested budget levels are listed in the table below.

Four of ORD's programs support hazardous waste research and development: Hazardous Waste, Superfund, Leaking Underground Storage Tanks, and Oil Spills. While ORD's research is national in scope, the vast majority of research and development spending, regardless of where it is spent, would be applicable to environmental problems within the Western States.

ACTIVITIES	FY 1993 ($1000)
Hazardous Waste	39,800
Superfund	68,900
Oil Spills	2,600
Leaking Underground Storage Tanks	800
TOTAL	112,000

Note: All numbers have been rounded to nearest $ 100,000.

CHAPTER VII
ONGOING PLANNING AND IMPLEMENTATION ACTIVITIES

1. INSTITUTIONAL FORUMS FOR FEDERAL INTERAGENCY COOPERATION

The Federal agencies participating in the WGA MOU have many institutional forums for cooperating in and coordinating their environmental restoration and waste management programs. Some of these are formal and governed by charters, interagency agreements, MOUs or similar mechanisms. Others operate on a more ad hoc basis. Still others operate without top agency management initiative, as Federal professional staff recognize common interests in problem solution and seek out opportunities to work together. The following paragraphs provide discussion of two of the key forums for institutional cooperation which can be used to further the purposes of the MOU signed with the Western Governors' Association; these forums are specifically mentioned in the Implementation Plan[1] which created the mechanisms by which the Federal signatories are seeking to fulfill their responsibilities under the MOU.

A. Federal Remediation Technologies Roundtable

One such forum is the Federal Remediation Technologies Roundtable. The Roundtable is an interagency workgroup that includes DoD, DOE, DOI, and the National Aeronautics and Space Administration (NASA). The Bureau of Mines, U.S. Geological Survey, and the Bureau of Reclamation all participate within DOI. The Department of Defense is represented not only by the Office of the Secretary of Defense, but the three services and the Corps of Engineers as well. DOE representation is drawn from various organizations within the Office of Environmental Restoration and Waste Management. EPA participation includes the Office of Federal Facilities Enforcement, Office of Research and Development, and the Technology Innovation Office, with the latter Office chairing the Roundtable.

This group provides a central forum to share the lessons that each agency is learning in developing new technologies and to transfer this information to other user communities. Roundtable meetings typically focus on specific topic areas with presentations by invited experts, and suggestions for specific projects (both informational and technical) to facilitate the cooperative development, evaluation and implementation of innovative treatment alternatives at Federal facilities. Several of these information products have been cited in the various Chapters and Appendices of this report.[2]

One significant private/public partnership project that was initially started through the Roundtable is the Clean Sites/McClellan Air Force Base Project which seeks to generate cost and performance data on innovative technologies. The EPA, Air Force, Cal-EPA, and several private firms are joining forces to demonstrate and evaluate hazardous waste site remediation technologies.

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[1] Implementation Plan is attached at Appendix B, previously cited.

[2] See, for example, Chapter IV, Section 4, and Appendix K, previously cited.

The private firms stand to benefit by gaining cost and performance data on technologies targeted for problems similar to their own without the risks (e. g., liability) associated with testing on their own property.

Another new subcommittee taskforce, which has recently organized and has representatives of all the signatory Federal agencies to this MOU, as well as from NASA, is exploring the feasibility of conducting a joint demonstration of an innovative treatment technology for contaminated groundwater. Still another subcommittee is identifying needs for evaluation of site characterization technologies which agencies can co-sponsor.

B. Interagency Experts Groups

At an ad hoc level, Interagency Experts Groups have been organized within DoD, DOE, and EPA to address environmental restoration and waste management. These groups are also called the Federal Facilities Environmental Strategy or Federal Facilities Environmental Improvement Initiative Working Groups.

A Steering Committee is composed of the principals (i. e., Assistant Secretary/Administrator rank), a coordinator supplied by EPA, and Working Group and Subgroup Leaders. Working Groups function in the areas of Compliance, Pollution Prevention, and Restoration. The Restoration Working Group is further divided into Subgroups on Accelerated Cleanup, Site Deletion (from the National Priorities List), Training, Applying Technology to Cleanup, and Waste Management. Members are normally managers responsible for programs on these topics within the agencies, and funding comes from normal program management sources. For this reason, activity is often dependent on intraagency availability of staff resources, and group initiatives often are carried out through enhancement to ongoing agency activities within the purview of the working group members themselves rather than through formal recommendation to the Steering Committee. The Department of the Interior is not yet involved in these Groups.

2. PLANS FOR ENHANCING COOPERATIVE FEDERAL TECHNICAL EFFORTS

A. Effects of MOU on Cooperation among Federal Agencies

The Federal Working Group also recognizes that the attempts to cooperate more closely with the Western Governors' Association is beneficial to enhanced cooperation among the Federal agencies themselves. New contacts are being formed, for example, between DOI, and the other three agencies. Parallel activities are being identified, and opportunities for further leveraging of activities are being pursued. The attempts to develop a common framework for identifying technical needs will be valuable for the agencies themselves, quite apart from the benefits that will also accrue to non-Federal entities, and may permit identification of additional opportunities for joint demonstrations both in the West and elsewhere.

B. Strategic Environmental Research and Development Program

The Strategic Environmental Research and Development Program (SERDP)[3] is another means of interagency cooperation. As described in the legislation, the purposes of the program are to: (1) address environmental issues of concern to DoD and DOE through support for basic and applied research and development of technologies; (2) identify and share research, technologies, and other information developed for national defense purposes that would be useful to governmental and private organizations involved in the development of technologies addressing environmental restoration, waste minimization, hazardous material substitution, and other environmental concerns; (3) furnish other governmental and private organizations with data and enhanced data collection and analysis capabilities for use in the conduct of environmental research; and (4) identify technologies developed by the private sector that are useful for DoD and DOE environmental restoration and waste management activities. In support of these objectives, the legislation directs DoD, DOE, and EPA, in cooperation with other Federal and State agencies, to conduct joint research, development, and demonstration projects relating to innovative technologies.

C. Other Examples of Technical Cooperation

There are already many examples of interagency cooperation on specific technical projects. Some were described in Section 1 of this Chapter; others were given in the discussion and assessment of emerging technologies in Chapter IV. A few more examples are offered here.

DOE, DoD, and EPA have formed an Interagency Cost Estimating Group (ICEG) for Hazardous, Toxic and Radiological Waste (HTRW) Remediation. Estimating costs for HTRW is technically difficult,[4] yet necessary in order to judge the appropriateness of cleanup proposals and plan funding. The purpose of the ICEG is to establish a network among member organizations for collecting and sharing HTRW remediation cost information[5] and related experience.

The U.S. Bureau of Mines (USBM) has increased its outreach efforts with other Federal agencies and has modified its research efforts to include more work directed at the broader issue of hazardous wastes than the Bureau's traditional minerals waste treatment activity. Agreements are in place between the USBM and EPA, the U.S. Forestry Service, parts of DoD, and a number of DOI agencies such as the Bureau of Indian Affairs, Bureau of Land Management, National Park Service, and the Office of Surface Mining. Additional agreements

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[3] SERDP was established by the FY 1991 Defense Authorization Bill (Public Law 101-510).

[4] A summary of available software models for environmental remediation cost estimating is contained in "Environmental Remediation Cost and Risk Estimating Software Summary", Annette Youngblood and Steven Booth, Los Alamos National Laboratory Report LA-UR-92-1932, June 1992.

[5] An example of this type of information is "A Compendium of Cost Data for Environmental Restoration Technologies, Methods, and Processes", Annette Youngblood and Carlos Ulibarri, Los Alamos National Laboratory Report LA-UR-91-2455, June 1991.

are being discussed with DOE and other agencies. Under these agreements, the USBM provides assistance ranging from technical advice through development and adaptation of technologies for site cleanup.

The Bureau of Land Management has cooperated with EPA in the development of remote sensing and environmental indicators to identify remediation sites in rural areas.

Requests by other Federal agencies for the U.S. Geological Survey (USGS) to provide its ground-water and surface-water geophysical, hydrogeologic, and water-quality capabilities to address their hazardous waste problems are increasing. Currently, the USGS is assisting the DoD, DOE, EPA and other Federal and State agencies in their hazardous waste programs. The USGS cooperates with the States and other Federal agencies in the assessment of contamination problems. For example, a bioventing project was initiated with New Jersey at a gasoline spill in Galloway Township, and a project to characterize and eventually cleanup trichloroethylene and other contaminants in the vicinity of Boise, Idaho, is under discussion with Idaho. The USGS also works on some 45 DoD installations as part of the Installation Restoration Program to characterize and cleanup past spills. The USGS, in cooperation with the EPA, has investigated bioremediation techniques at the Champion Mill site near Libby, Montana, to neutralize wood treating fluids and their constituents, including creosote and pentachlorophenol.

DOI wishes to take full advantage of the EPA Superfund Innovative Technology Evaluation (SITE) Program.

DOE and EPA are co-sponsors of the **"Fourth Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International"** to be held in San Francisco, November 17-19, 1992.

EPA is working with the Air Force to promote a bioventing initiative. The Air Force hopes to conduct demonstrations of bioventing on jet fuel contaminated soils at fifty sites on bases across the U.S. EPA is also "partnering" with the Air Force using their funds to refine a presumptive technology framework for the numerous common problems at Air Force bases. Using existing contaminant technology matrices, the Air Force and EPA plan to develop basic guidance on screening technologies for site problems at the base level.

The DOE Integrated Demonstrations and Integrated Programs actively seek participation of other Federal agencies as well as the private sector, other governmental, and academic institutions. The Office of Environmental Restoration and Waste Management and the Office of the Deputy Assistant Secretary of Defense (Environment) are discussing ways to more effectively leverage their technical efforts in future demonstrations, building on past cooperative efforts between DOE and DoD laboratories.

3. AREAS FOR COOPERATION WITH THE WGA AND/OR THE PRIVATE SECTOR

The MOU furthers opportunities for enhancing coordination between the WGA and the Federal agencies and builds the framework for creating effective

solutions to environmental restoration and waste management problems. Team building is an essential first step in this process. The FWG suggests topics of cooperation in this Section of the report, based on its best judgments of its own needs, but fully expects that the WGA will be able to expand on these topics.

A. Benefits Being Sought

Opportunities for cooperation between the Western Governors' Association, the private sector in the western states, and Federal agencies in restoring and enhancing natural resources for current and future generations of Americans should produce benefits of several types.

Cooperation should **maintain quality of life.** Waste management issues affect the public's perception of the environment in which their families live, work, play, and raise children. Each citizen's life is touched in some fashion, and actions taken today could have consequences reaching far in the future. In the Western context, these issues have a particular significance in preserving Tribal cultural resources, reflecting the sanctity of the land to Native Americans.

Cooperation should **improve socio-economic well-being.** At stake are the ability to create new jobs for the cleanup, protect current livelihoods threatened by contamination, and manage the dislocations resulting from the cutback of defense activities as the cleanup progresses.

Cooperation should **improve economic competitiveness.** Future economic well-being hinges on issues dealing with residual economic potential and industrial competitiveness. If properly developed, a home grown, high technology, environmental restoration industry has the potential not only for economic leadership in the United States but in emerging markets abroad in countries that badly need assistance. Applying the technologies of such an industry to other American industries' own environmental responsibilities can lower those industries' production costs and enhance their economic competitiveness as well.

Public concern is growing regarding the ability of the U.S. environmental industry to compete effectively when matched against the rapidly developing environmental industries of the European community and Japan.[6] The commitment of these foreign nations to become involved in the global environmental marketplace is clear, as evidenced by initiatives presented at the recent Environmental Summit in Rio de Janiero, where Japan pledged a total of $7 billion over the next few years to aid third-world nations in new environmental programs. Similarly, Germany pledged to double its environmental aid to third-world nations, and significantly increased pledges were also made by other Western European Nations. Bringing together all relevant U.S. resources in an organized way and becoming actively involved in the global environmental movement can help ensure that the American environmental industry will compete

[6] Discussion in this and the following paragraph is taken from the Preface of the EM Strategic Task Force Strategic Business Plan (Predecisional Draft), U.S. Department of Energy EM Strategic Task Force, June 26, 1992.

successfully with foreign industry in the rapidly enlarging global environmental marketplace. There is no time to wait; the window of opportunity for significant improvement in the U.S. position is closing rapidly.

Under current regulatory constraints, the Federal agencies participating in the MOU will spend on the order of two hundred billion dollars during the next 30 years to restore sites contaminated with radioactive or toxic wastes. However, these Federal environmental programs are dwarfed by the huge challenge of restoring America's contaminated industrial sites, an activity that generated $130 billion of business activity in 1990 alone. The need to restructure the Nation's Federal and industrial waste management systems produced an additional $120 billion of business activity in 1991. A clear opportunity now exists to use mechanisms of cooperation to leverage the Nation's Federal and industrial investments in domestic environmental restoration and waste management activities and to simultaneously provide for enhanced U.S. environmental industrial competitiveness in the global environmental marketplace.

B. Opportunities in Cooperative Demonstrations

The Federal Working Group believes that the most significant opportunity for effective cooperation with the Western Governors' Association lies in cooperating to conduct demonstrations of innovative environmental restoration and waste management technologies. Such cooperation can help to maintain quality of life, improve socio-economic well-being, and improve economic competitiveness. For example, an effective R&D program can materially reduce the economic costs of achieving a given degree of environmental protection. The DOE estimates that one advanced remediation technology developed by its research activities at the Savannah River Site, horizontal drilling, alone saved $125 million in cleanup costs compared to conventional "pump-and-treat" methods.[7]

In this context, the concept of "demonstration" should be considered in an inclusive sense, incorporating not only actual demonstration activities, but whatever set of associated research, development, testing, evaluation, regulatory, public participation, and technology transfer activities are necessary to provide a systems approach to a real problem which is common across several installations. **The FWG hopes that, with the concurrence of the WGA and the affected States, the first such demonstration will be underway during 1993.**

Key actions in conducting such a demonstration successfully would be expected to include:

- Define the common problem;
- Propose host site(s) for the demonstration;

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[7] Testimony of the Assistant Secretary for Environmental Restoration and Waste Management, U.S. Department of Energy, before the Subcommittee on Energy, Committee on Science, Space, and Technology, U.S. House of Representatives, February 6, 1992.

- Reach agreement with the state(s) and regional EPA Office(s);
- Select a demonstration manager;
- Develop a demonstration implementation plan;
- Reach agreement on the plan with all affected parties; and,
- Support technical achievements with effective technology transfer.

(1) Problem Definition

Demonstration topics should balance potential transferability to broad national problems with the urgent need for breakthroughs in areas that are technically difficult or to which the public has a special sense of urgency.

The signatory agencies would intend to partner with the Western Governors' Association in all aspects of planning for, and implementation of, these demonstrations, including the listing of demonstration problems and sites. Based on the discussion of technology needs and the assessments of emerging technologies given elsewhere in this document, however, the agencies can suggest several problem areas for consideration:

- Groundwater contamination;
- Decontamination and decommisioning of contaminated facilities;
- Ex situ technologies such as site characterization instrumentation, waste characterization equipment, and waste treatment concepts; and,
- Treatment technologies for mixed wastes, explosives, and chemical munitions which emphasize process control for air emissions and land disposal restrictions.

(2) Demonstration Sites

Demonstration sites should be chosen to build upon other demonstration projects already underway within the Federal government. This will help speed the use of innovative approaches to remediation within negotiated compliance schedules.

(3) Permitting

Securing permits to operate the demonstration facility as a centralized test bed for technologies will also be important, especially to private sector developers who otherwise find it difficult to obtain a location to test treatment concepts with actual hazardous materials under field conditions

at scales necessary to be convincing to potential users and investors. Care will need to be taken to recognize the differing perspectives between participants whose primary interest will be cleanup of the facility at which the demonstration is occurring, and participants whose primary interest will be in use of the technology at a variety of other sites. These perspectives can be accomodated during the demonstration planning process, provided that all affected parties have opportunity to participate in that planning.

(4) Demonstration Management

This situation is illustrative of a more general observation: in order for the demonstrations to succeed, all affected parties, especially those who regulate or manage the installations, must have a strong commitment to make the demonstrations succeed. Innovative technologies involve risks, which can cause reluctance to be first in trying a new technology concept. The senior managers at the installation and at the regulatory agency must be convinced of the potential benefits of the innovation and committed to manage the technology development process for the demonstration to succeed. Other affected parties must also see benefits for them, or their support will be lacking. Thus, intrinsic in this process will be selection of a motivated manager who is committed to technology development, while also mindful of the concerns of other parties and effective in working with them.

(5) Planning for Demonstration Implementation

It will be the demonstration manager's responsibility to devise technical protocols for the demonstration, to secure regulatory approval and necessary permits, to lead development of technology transfer and public participation plans, and to otherwise implement the activities necessary for demonstration success. In many respects, the development of technical protocols will be the simplest of these responsibilities, since it is a task that has been successfully accomplished in the many technology development and demonstration activities (both environmental and non-environmental) already carried out by the Federal government. The protocols will be problem-specific. For example, in several problems of interest to DOI, the ability to keep capital costs low by reusing equipment for sequential site cleanup will be an important evaluation criterion.

As already indicated, regulatory and permitting concerns can also be readily accomodated within the planning process. Of greater difficulty, however, are issues of public participation and technology transfer, which have not been dealt with in the Federal technology development process until recently, and about which much still can be learned.

(6) Public Participation

As elected officials on the "front lines" of dealing with public concerns about environmental restoration and waste management at Federal

facilities, Governors have unique interests in seeing that such concerns are fully represented in demonstration planning, and bring unique resources to that task. Working together, the Western Governors' Association and the Federal signatories can enhance two-way communication between the public and the Federal agencies to improve the planning process for demonstrations (as well as other aspects of the Federal facilities cleanup). More specifically, the parties to the MOU can:

- Insure that public debate over the demonstration and adoption of innovative technologies (including both policy and technical issues) is conducted using the best available knowledge about environmental and economic benefits and risks of all alternatives.

- Cooperatively explore ways to inform the public of constraints on environmental remediation efforts, since both parties' agreements are necessary to accomplish these challenging tasks.

- Continue to expand both Federal and State understanding of each other's respective interests with regard to binding Federal Facility Compliance Agreements in instances where no existing technologies are known for narrowly-focused remediation problems, especially where innovative technologies may pose technical breakthroughs for broad application.

- Identify ways to utilize the technical and financial resources available to both Federal and WGA members to solve environmental remediation problems in the most cost-effective manner.

- Work cooperatively to deal with the various Indian Nations within the geographic area of WGA member states to utilize their unique resources in this effort.

(7) Technology Transfer

In carrying out these demonstrations, the Federal signatories should explore with the WGA ways to transfer technology that encourage the growth of a healthy regional and national environmental industry, one having not only technical capabilities, but a supporting infrastructure including labor, management, public support, marketing expertise, equipment, etc. To achieve such effective technology transfer, the parties to the MOU will need to cooperate in identifying mechanisms for effective leveraging of Federal technology investments, and will need to define their separate roles, as well as the roles of non-governmental institutions, in the technology transfer efforts. Only recently have funds for technology transfer outside the Federal sector begun to receive higher priority in Federal agency budgets.

There are a number of existing Federal initiatives which can be part of these technology transfer efforts.

Passage of the Federal Technology Transfer Act of 1986 (FTTA) and the National Competitiveness Technology Transfer Act of 1989 (NCTTA) has removed some of the legal and institutional barriers that have prevented government and industry from collaborating in developing and marketing new technologies. These acts make possible Cooperative Research and Development Agreements (CRADAs) between Federal Laboratories, industrial firms, and academic institutions. Now, under some CRADAs, companies are given exclusive rights to market and commercialize new technologies that result from the collaboration. Most Federal laboratories, including Government-owned, contractor operated facilities, now have CRADA authority, and Federal research laboratories combine world class expertise with state-of-the-art equipment, often in fully permitted facilities. Each of the Federal agencies welcomes expansion of CRADA activities with partners in the Western states.

All Federal agencies with significant research budgets administer Small Business Innovation Research (SBIR) Programs. The purpose of these programs is to use small businesses to meet Federal R&D needs, stimulate technology innovation, and increase private sector commercialization of innovations derived from Federal research. Government funds are spent for research that supports agency mission requirements. However, the programs provide incentives for the conversion of this research into potential innovative commercial applications.

The Department of Energy EM Technology Integration Program (TIP) is examining a number of approaches to partnering with the private sector in the development of innovative environmental restoration technologies.[8] In cooperation with the EPA Office of Research and Development and NETAC, TIP is evaluating a Private Capital Model of collaboration. This interagency effort is to determine how private-sector funds can be invested in cost-sharing arrangements with government to accelerate developments of environmental technologies. The ultimate purpose is to clean up DOE defense sites. The project also aims to help firms develop cost-effective technologies and thus establish exportable product lines.

The unique part of this effort is the inclusion of the equity-capital community as an active member of the partnership. This has never been done before and could represent one of the most important breakthroughs in technology commercialization. The lack of investment capital has been one of the greater barriers to bringing a product to market.

In another TIP approach, the Ames Laboratory's Center for Advanced Technology Development is exploring issues involved in the maturation of a real-time analytical instrumentation system for site characterization,

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[8] The Technology Integration Program differs in an important way from other Federal technology transfer activities related to environmental restoration technology; its primary focus for the next few years will be on facilitating acquisition of private sector technology for use by the Department of Energy.

remediation process monitoring, and waste minimization. This Ames Derisking Model is being adapted from a DOE partnership with the Department of Commerce and should provide valuable insights about the differences between developing technology for use at Federal facilities and developing such technologies for use in the commercial sector.

Numerous other proposals are developing that follow a tripartite (Federal government, State government, private industry) approach to application and evaluation of technologies. For example, a concept paper has been developed that proposes the establishment of a Center for Site Characterization. This Center would bring Federal agencies and private industry together to develop site characterization tools for hazardous waste site cleanups. Through CRADAs the Center would work with industry to stimulate the development and commercialization of technologies and would strive to improve the market position of domestically developed technologies in international markets.

The signatory agencies could also include cooperation with WGA and private industry on a variety of projects that focus on technology development internationally. The DOE International Technology Exchange Program is already planning and participating in overseas demonstrations as a means of obtaining foreign technologies for cleanup of Federal facilities and promoting export opportunities for U.S. techniques. There may also be great opportunities to do soil and groundwater remediation research and demonstrations overseas -- enhanced by the pressing environmental needs of the former Eastern Bloc, or facillitated by the North American Free Trade Agreement -- that currently cannot be done here due to Federal or state regulatory barriers. All of the Federal signatory agencies would be interested in promoting and demonstrating technologies developed by the private sector, advancing the state of the science internationally while promoting and exporting the environmental technological expertise of American companies.

The efforts already underway to develop a common categorization for environmental restoration and waste management technology needs among the Federal agencies[9] will result in more effective communication of Federal technology needs and business opportunities to the private sector, also advancing the technology transfer goals of the demonstration projects.

The Federal signatories would also have interest in exploring efforts to work with state universities, especially those in the West, to mutually develop innovative technologies to meet environmental technology remediation needs (as well as to develop broader education programs to provide the cadre of trained technical and scientific management personnel imperative to meet future environmental challenges).

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[9] These efforts are discussed in greater detail in Chapter V, Section 6.

C. Other Cooperative Opportunities

The DOI also has separate problems which may not lend themselves to demonstrations as such, but in which the agency would welcome collaboration with the Western States. One such area would be development of meaningful databases containing site inventory information. Armed with a useful structure like this, both the public and private sector can begin to get a much better picture of "markets" and begin to make wiser decisions about assignment of resources than is possible with the current, almost anecdotal collection of information.

The USGS also welcomes the opportunity to expand cooperation with WGA States in the field of environmental restoration through its existing channels in the Federal-State Cooperative Program in water resources.

4. SEIZING THE OPPORTUNITY

In summary, Federal, State, Tribal, and local officials, together with leaders from business and communities, and the public at large, have a singular opportunity to work in tandem toward solving some of the major environmental restoration and waste management challenges affecting the lives of all Americans.

By tapping into the creativity of its citizens, by drawing on the strengths of each involved community, by engaging in public discussions to reach consensus on priorities, and by focusing finite resources on the issues of greatest significance, the nation can make major gains toward improving quality of life, enhancing socio-economic well-being, and advancing industrial competitiveness.

Additional, formal meetings between the WGA and the Federal participants are anticipated following the submission of this report and its companions and their discussion at a fall WGA Waste Task Force meeting. The meetings themselves should permit free exploration of the differences in Territorial, State, and Federal perspectives on issues of relevance to the MOU, as well as exploration of such different perspectives among the Federal signatories themselves. Such an open approach will encourage the development of innovative policy and technical solutions to MOU issues.

The Federal Advisory Committee Act (FACA), which governs all contact between the FWG and WGA counterparts, must be followed in determining the mechanisms which evolve for cooperation over the five-year period of the MOU. Agreement in principle has been reached that senior personnel should be designated by the signatories to serve as a Federal Advisory Committee within the context of FACA, with a balanced membership established between the WGA and the Federal agencies. Joint or independent staff support, under the general supervision of the Advisory Committee, could then be provided to this effort by the various signatories.

The process of cooperation being established between the WGA and the Federal signatories can provide a significant national model. Expansion to other parties can increase the potential for benefits. For example, additional Federal agencies, such as the Department of Commerce, the Department of Transportation,

the National Aeronautics and Space Administration, and others, have technical or policy expertise which can contribute to the success of this effort.

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LIST OF APPENDICES

MEMORANDUM OF UNDERSTANDING
AMONG THE
U.S. DEPARTMENT OF DEFENSE,
U.S. DEPARTMENT OF INTERIOR,
U.S. DEPARTMENT OF ENERGY,
U.S. ENVIRONMENTAL PROTECTION AGENCY, AND
THE WESTERN GOVERNORS' ASSOCIATION
REGARDING ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT

I. Purpose

The purpose of this Memorandum of Understanding (MOU) is to establish a more cooperative approach to development of technical solutions to environmental restoration and waste management problems shared by States, commercial entities, and the Federal government. The regional approach will serve as a demonstration of principles and practices which may be adopted nationally.

II. Objective

To encourage cooperation among the U.S. Department of Defense (DOD), U.S. Department of the Interior (DOI), U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and the Western Governors' Association (WGA) in research, development, and demonstration (RD&D) of cost effective waste management technologies germane to Federal lands and facilities in western states and insular areas, and associated information exchange related to waste management.

III. Background

Hazardous and radioactive waste sites pose unique management, treatment, and disposal problems that must be addressed to ensure protection of public health, welfare, and environment.

The Nation's waste clean-up effort will last at least a generation; its costs promise to be unprecedented. Various complex waste management and environmental restoration problems exist in the West. The signatories to this agreement are committed to a long-term, cost-effective effort to: clean up and restore contaminated Federal lands and sites in Western States; safely dispose of the associated waste; develop methods of minimizing or avoiding the generation of future waste; and share information relating to emerging waste technologies. Cooperative strategies for research, development, and demonstration are required to promote development of new technologies and to assess their effectiveness so that they may be permitted and implemented.

Selection of projects for State and Federal waste management research and development funding should be based on wide competition and broad participation. Wider competition and broader participation among technologies and participants will encourage more responsive and rapid deployment of waste management technologies. It will also promote more rapid commercialization yielding further benefits to the region and the nation.

The signatories seek a regionally integrated cooperative approach to identifying solutions to problems. The proposed approach for this MOU will bring together the signatories or their designated representatives to share information on emerging waste management technologies and describe needs for new technologies so that scarce RD&D funds are targeted to the right problems at Federal lands and sites to the extent permitted by law.

The signatories are committed to fostering the development of better, faster, safer and more cost effective site restoration and waste management technologies and methods.

IV. Authorities

Nothing in this MOU alters the responsibilities or statutory authorities of DOD, DOI, DOE, EPA, WGA, or individual States and insular areas. This MOU does not supersede existing agreements among any of the signatories.

V. Responsibilities

The signatories agree to prepare an annual report to identify and list by priority regional waste management RD&D needs on federal lands and facilities and assess existing commercial capabilities and technology development initiatives. The report will include an identification and assessment of emerging Federal waste management and cleanup technologies, regulatory issues related to implementation, and the effectiveness of technology selection processes. The report will highlight current funding levels and the most pressing waste management problems at Federal sites and identify for demonstration the most promising new solutions.

The report will be completed and submitted to the signatories no later than February of each year for use as a resource in the formulation of the nation's waste cleanup effort.

The signatories agree that this MOU is intended to be a prelude to a National program for identifying and implementing needed new, effective, cost effective technologies for development and deployment.

VI. Authentication

This MOU becomes effective upon its signature by all parties. The MOU will continue in effect for five (5) years or until modified by mutual consent. Participation by any signatory member may be terminated at the request of any signatory within ninety (90) days prior notice.

Asst. Secretary of Defense — 7/22/91 Date

Secretary of Interior — Date

Secretary of Energy — 7/22/91 Date

Administrator of Environmental Protection Agency — 7/22/91 Date

Chairman of the Western Governors' Association — 7/22/91 Date

Vice Chairman of the Western Governors' Association — 7/22/91 Date

Draft 4-92

IMPLEMENTATION PLAN
JOINT ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT ACTIVITIES IN WESTERN STATES

APRIL 1992

Introduction:

In July, 1991, a Memorandum of Understanding (MOU) Regarding Environmental Restoration and Waste Management in Western States was promulgated among the U.S. Departments of Defense, Interior, and Energy, the U.S. Environmental Protection Agency, and, representing twenty western state and territorial governors, the Western Governors' Association (WGA). The intent of the MOU is to "establish a more cooperative approach to development of necessary technology to apply to environmental restoration and waste management problems shared by States, commercial entities, and the Federal government." The MOU calls for development of an annual report to "identify and list by priority regional waste management research, development and demonstration needs on Federal lands and facilities and assess existing commercial capabilities and technology development initiatives." The report is to "highlight current funding levels and the most pressing waste management problems at Federal sites and identify for demonstration the most promising new solutions."

This implementation plan is intended to create the mechanisms necessary to implement the MOU and provide a rational basis to pursue regional cooperative efforts. Future annual reports will provide information on activities and demonstrations being carried out under the auspices of the MOU.

Proposed Approach:

First working independently, and then jointly, the Federal agencies and WGA will initiate five tasks in FY 1992:

1. Identification of technology needs at Federal facilities in Western States;

2. Identification/assessment of emerging technologies within the Federal and private sectors;

3. Assessment of the effectiveness of technology selection processes;

4. Identification of regulatory barriers to technology development; and

5. Workforce Planning.

Draft 4-92

Structure of Federal-WGA Work Activities

It is important that MOU work move forward as quickly as possible so that data can be gathered, and possible technology development projects and regulatory reform proposals be examined, discussed and proposed. In order to initiate the MOU, it is proposed that a Federal working group composed of the signatory parties and the Office of Management and Budget as an ex-officio member be formed to prepare reports on the five identified tasks. This Federal working group will be coordinated by the U.S. Department of Energy. The Federal working group may split into committees in order to develop reports on the five identified tasks. It is also proposed that in parallel, the WGA form a working group to also prepare reports on four of the identified tasks. Once these reports are prepared, it is proposed that the Federal-State MOU signatories meet in the September-October time period to recommend a number of technology demonstrations to address the highest priority technology needs as identified by the signatory organizations.

1. Identification of Technology Needs at Federal Facilities in Western States. The Federal working group will prepare a report that will identify generic environmental restoration and waste management technology needs common to Federal sites, facilities, and lands in Western States. The Federal working group will consult with the Federal Remediation Roundtable, the Interagency Experts Group on Federal Facilities and other pertinent Federal advisory bodies. The Federal working group will create a standard reporting format to pull together existing information on possible technology solutions to the identified waste management problems. The Federal working group will also prepare a list of existing funding for research, development, and demonstration activities germane to regional environmental cleanup activities. These efforts will be completed by the end of June.

Concurrent with the above effort, the WGA working group will create and maintain a data base to utilize information about technology solutions in collaboration with the Federal working group.

2. Identification/Assessment of Emerging Technologies Within the Federal and Private Sectors. The Federal working group will identify and assess emerging technologies currently available or being developed for the Federal Sector. The Federal working group will draw upon the work of the Federal Remediation Roundtable, the Interagency Experts Group on Federal Facilities and other pertinent advisory bodies. This effort will be completed by the end of June.

Concurrent with the above effort, the WGA working group will prepare a report to identify existing commercial capabilities and technology development initiatives that may be applicable to cooperative environmental restoration activities.

3. Assessment of the Effectiveness of Technology Selection Processes. The Federal working group will prepare a report on how the Federal government currently selects technologies for use in the cleanup of Federal facilities and sites. This report will consider the potential of technologies to solve site cleanup problems, taking in account such factors as economic viability, regulatory compliance, technical merit and community acceptance. The report will be completed by the end of July.

4. Identification of Regulatory Barriers to Technology Development. The Federal working group will prepare a report identifying potential barriers to technology development and implementation at the Federal level. Potential barriers to technology development and implementation might include Federal environmental laws and regulations and site specific and other legally enforceable compliance agreements (i.e. permits, Federal Facility Agreements, etc.) This report will propose reforms to the regulatory system within the Federal governmental structure. The Federal working group will complete this report by the end of July.

Concurrent with the above effort the WGA working group will prepare a report to identify all potential barriers to technology development and implementation imposed by State laws and regulations. The report will propose reforms to the regulatory system within the States' specific governmental structure.

5. Workforce Planning. The Federal working group will report on information derived from Federal facilities and national laboratories and on information derived from non-proprietary sections of specific competitive grants on employment and educational opportunities related to the cleanup of Federal facilities and sites. The Federal working group will report on information about available worker retraining opportunities at those production facilities that are being decontaminated and decommissioned. The Federal working group will utilize the experience of the signatory agencies to help suggest short-term skills training and retraining curricula related to the environmental restoration of facilities for use by regional colleges and universities.

Concurrent with the above effort the WGA working group will survey cleanup contractors to help develop short-term skills training and retraining curricula related to the environmental restoration of facilities for use by regional universities and colleges. The WGA report will provide technical advice to governors and higher education officials who share an interest that the cleanup of sites in Western States is accomplished effectively and efficiently. The WGA report will hopefully assist in the preparation of State action plans to develop a skilled environmental remediation workforce. This report will be completed by the end of July.

Technology Demonstrations

As previously noted, the Federal-State MOU signatories will meet in September-October to review the recommendations provided by the Federal and WGA working groups on the five work tasks and to prepare recommendations for technology demonstrations at selected host sites that address the highest priority needs as identified by the signatory organizations. Selected host sites should have cleanup problems representative of other regional sites. The signatories will also meet to propose regulatory reforms to eliminate barriers to technology development and implementation at Federal facilities and sites.

Funding

The MOU is intended to provide a mechanism to integrate environmental cleanup research, development, and demonstration activities among the signatory organizations in order to maximize the application of scarce funds and target technologies at the most pressing problems. The Federal-State MOU provides that the Federal signatory agencies and the participating State governments will work together to ensure that generic technical solutions are made as widely available as possible.

It is understood that the actions and recommendations of the Federal-State MOU signatories are advisory in nature. Any obligation of Federal funds must be made by the appropriate Federal agency and adhere to Federal budgeting and procurement laws and processes.

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Committee on Technology Needs and Emerging Technologies
Administration-Western Governors' Association MOU

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An Overview of the Missions of Department of the Interior Bureaus

The Bureau of Indian Affairs recognizes and preserves the inherent rights of Tribal self-government, strengthens tribal capacity for self-government, provides resources for tribal government programs, protects the rights of Indian peoples when dealing with other government entities and the private sector, and fulfills and executes its part of the Federal Government's responsibility for trust resources and property.

The Bureau of Land Management owns and manages approximately 343 million acres of public lands. Management is based on the principles of multiple use and sustained yield -- a combination of uses that balances the needs of future generations for renewable and non-renewable resources, including recreation, range, timber, minerals, soil, water and air, fish and wildlife, and natural, scientific, and cultural values.

The Bureau of Reclamation manages over 4 million acres of public lands located around dams and water projects. The Bureau's mission is to reclaim the arid lands of the western United States for farming by providing a secure, year-round supply of water for irrigation. The Bureau is also responsible for a wide range of water resource efforts, including hydroelectric power generation, municipal and industrial water supplies, flood control, outdoor recreation, enhancement of fish and wildlife habitat, and research.

The Bureau of Mines helps ensure that the nation has an adequate and dependable supply of fuel and non-fuel minerals to meet its defense and economic needs by conducting research aimed at maximizing resource recovery and use and minimizing the environmental, health, and safety costs of mineral extraction and processing; acquiring and analyzing domestic and international minerals data; and engaging in activities to advance minerals and materials science.

The Fish and Wildlife Service owns and manages approximately 85 million acres of public lands primarily for protection of animal habitats. The mission of the Fish and Wildlife Service is to conserve, protect, and enhance fish, wildlife, and their habitats for the continuing benefit to the American people.

The Geological Survey conducts the systematic and scientific classification of the public lands and examines the geological structure, mineral resources, and products of the national domain.

The Minerals Management Service provides responsible stewardship of America's offshore resources and collects and accounts for revenues generated from mineral leases on Federal and Indian Lands.

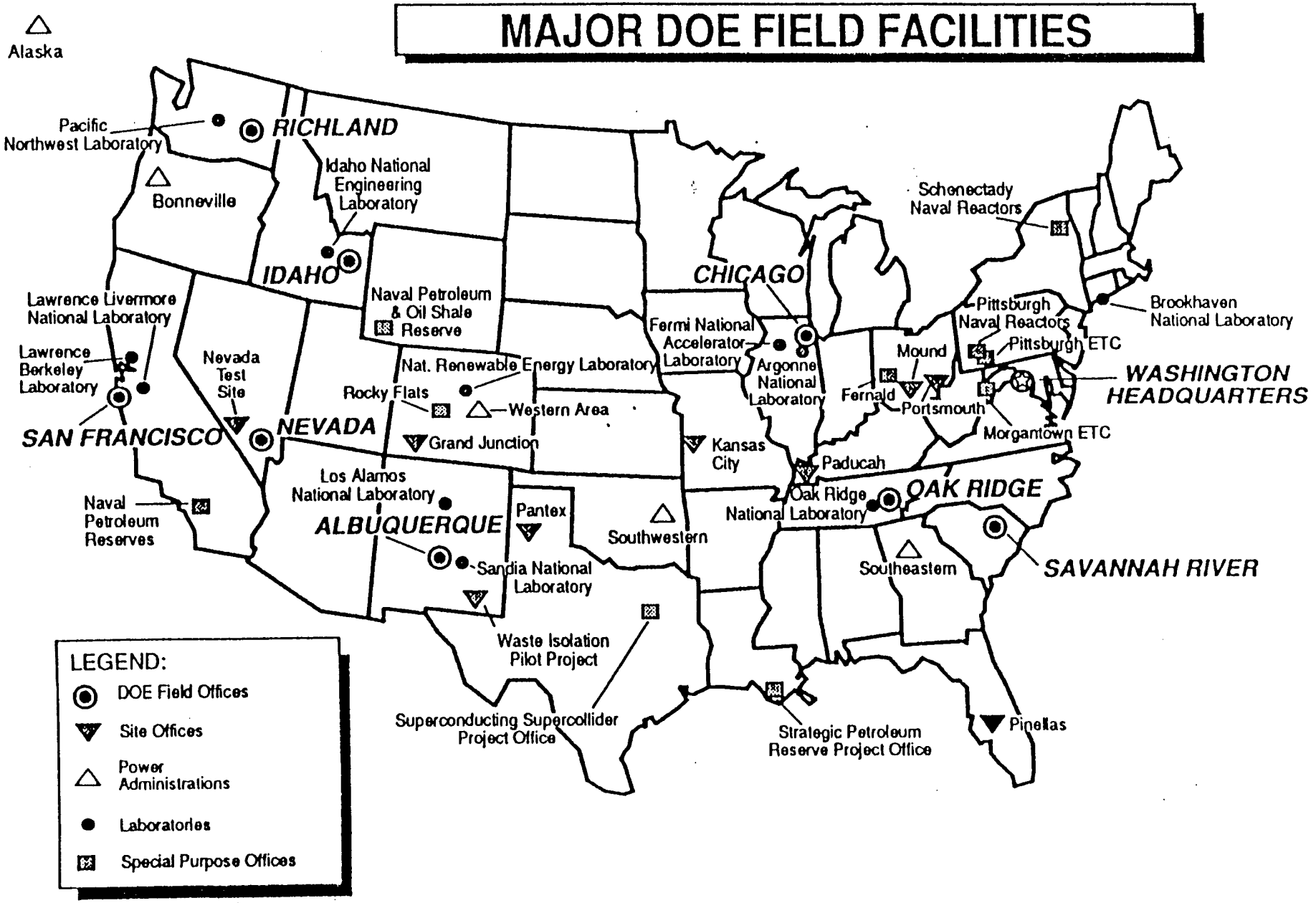
The National Park Service administers the nationwide system of parks encompassing over 72 million acres of public lands that includes areas of natural, cultural, and scientific significance. These areas include parks, monuments, historic sites, battlefields, seashores, and lake shores, and recreation areas.

The Office of Surface Mining protects the public and the environment from the adverse effects of coal mining while allowing access to the coal that is

important to the nation's energy needs. To accomplish its mission, the Office regulates current surface coal mining operations and repairs eligible mined areas left without adequate reclamation, and which continue, in their unreclaimed condition, to degrade the quality of the environment, prevent or damage beneficial use of land or water resources, or endanger public health or safety.

The Office of Territorial and International Affairs is responsible for assisting the Secretary of the Interior, as the Secretary plans and directs the Administration's policies and recommended solutions for the problems encountered in the economic, social, and political development of the insular areas of American Samoa, Guam, the Northern Mariana Islands, the U.S. Virgin Islands, and the Trust Territory of the Pacific Islands. The Office serves as the Secretary's prime point of contact for all insular affairs. The Office also coordinates the Department's various international activities.

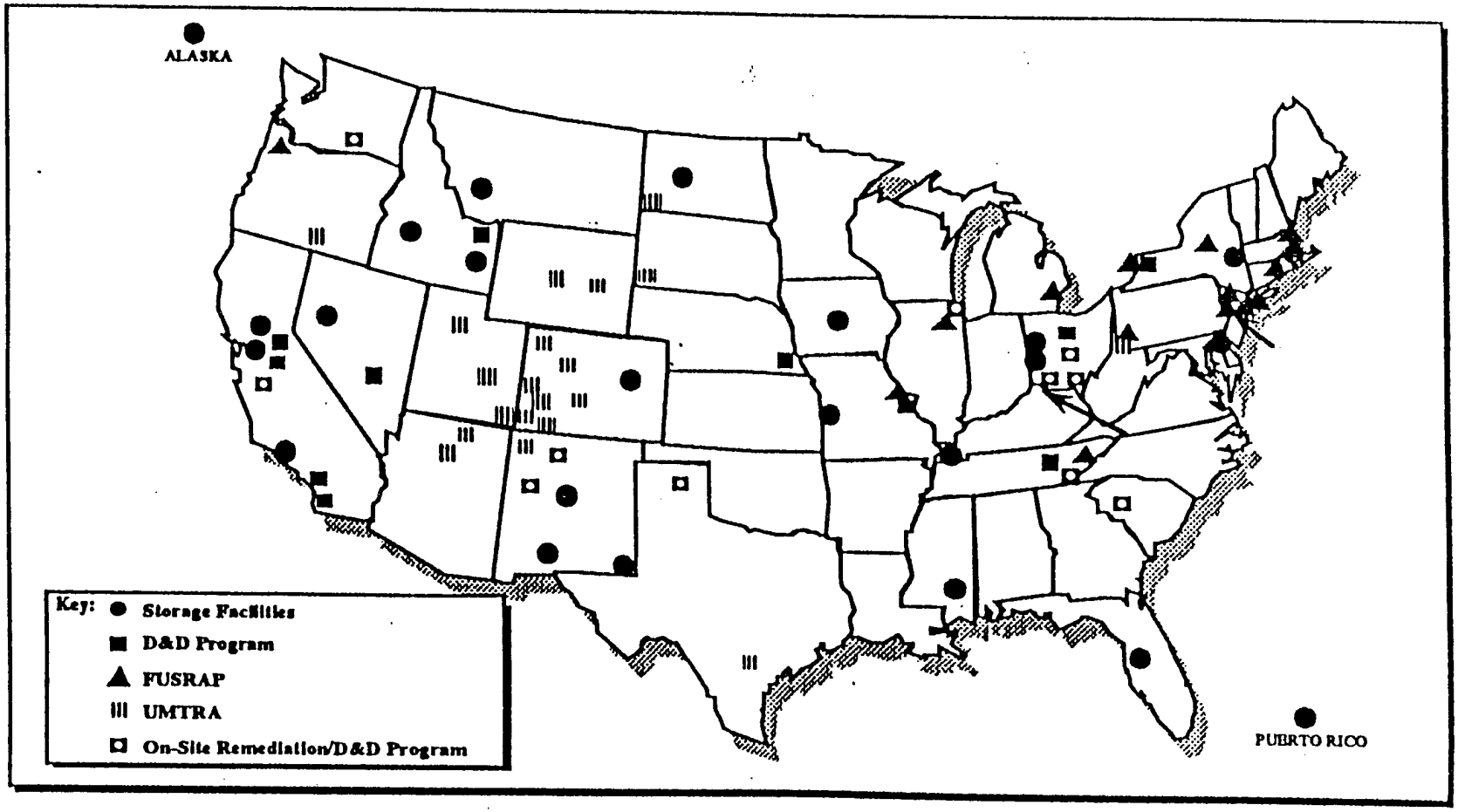
MAJOR DOE FIELD FACILITIES



Appendix E

DOEMAP

DOE ENVIRONMENTAL RESTORATION SITES



D&D Decontamination and Decommissioning
FUSRAP Formerly Utilized Sites Remedial Action Program
UMTRA Uranium Mill Tailings Remedial Action

BIBLIOGRAPHIC INFORMATION ON ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT TECHNOLOGY NEEDS

1. Incentives and Barriers to Commercializing Environmental Technologies: Results of an Environmental Technology Market Needs Assessment, March 1990, Prepared for the Office of Research and Development, U.S. EPA, Prepared by National Environmental Technology Applications Corporation.

This National Environmental Technology Applications Corporation (NETAC) report gives a current assessment of the incentives and barriers operating in the U.S. and defines some of the priority environmental technology needs perceived by senior-level individuals active in various aspects of the industry. Report information is drawn primarily from discussions held from mid-1988 to early 1989 with 86 senior-level individuals from companies, organizations, and regulatory agencies involved in the environmental industry.

2. Preliminary Draft Directory of Federal Agencies and Universities Research Centers Conducting R&D in Environmental Restoration and Waste Management, prepared by PAR Enterprises Incorporated and Applied Research Company, September 1991.

The directory provides a reference and information base of Federal agency and university capabilities in the areas of environmental restoration and waste management research and development that can be used to help meet technology transfer and joint demonstration goals and objectives. This document contains matrices matching technical requirements with Federal agency and university research center capabilities and profiles of Federal agency and university environmental restoration and waste management research and development activities.

3. Technology Needs Assessment Final Report (Predecisional Draft), Prepared for DOE's Office of Environmental Restoration by Chem-Nuclear Geotech, Inc., August 1991.

This report presents the results of the environmental restoration technology needs assessment conducted for DOE. The purpose of this study is to facilitate the identification and prioritization of technology deficiencies considered for DOE's environmental restoration problems. This document presents information (gathered through site visits) in three major subject areas: environmental restoration technology deficiencies, characterization needs, and other factors that influence environmental restoration. The needs in these areas are ranked into high, medium, and low priorities. The following were determined to be the most important and extensive technology deficiencies:

- Worker Safety/Public Health Concerns;
- Waste Minimization Methods;
- Performance Criteria for Systems/Waste Forms;
- Methods to Evaluate System/Waste Form Performance;
- Transfer of Technology from the Laboratory to the Field;
- Long-term effectiveness, Integrity, Repair, and Maintenance;
- Better Separation/Partitioning Techniques; and,
- Greater Capacity for Disposal of Treated/Untreated Wastes.

The following is a list of the characterization needs ranked as high-priority:

- Development of uniform approach for data quality objectives;
- Non-intrusive methods to determine boundaries of buried waste areas, waste forms, and utilities;
- Non-intrusive methods to locate and/or identify buried contaminants;
- Better methods to characterize the subsurface geology;
- Improved remote sampling techniques for tank sludge and other media that may contain high-level wastes;
- Real-time field analysis equipment to provide screening-level and decision-quality data;
- Fixed-base laboratories to improve sample turnaround time;
- Remote systems for analyses in isolated or hazardous areas;
- Improved methods to evaluate tank integrity and identify leaks; and,
- Equipment for in situ measurement of physical properties of tank wastes.

Other high-priority factors influencing environmental restoration are:

- Lack of waste disposal options and mixed-waste policy;
- Issues related to cleanup goals, risk assessment, and/or future land use;
- Issues related to regulatory and public acceptance;
- Data evaluation and management;
- Performance assessment of environmental restoration options; and,
- Educational issues related to personnel and technology transfer.

4. **Technology Needs Assessment Crosswalk Report (Draft), U.S. Department of Energy, DOE/ID/12584-117, GJPO-109, August, 1992.**

This report presents the results of the Technology Needs Assessment Crosswalk project. The project was a follow-up effort to the Technology Needs Assessment (TNA I) described in Item 3 above. One of the major findings of TNA I was the need to improve communication among DOE's Office of Environmental Restoration, Office of Technology Development, and Field Offices. The purpose of the Crosswalk Project was to enhance communication among these groups and to provide a mechanism to link environmental restoration problems with potentially applicable technologies that are currently under development. This report is

intended to function as a user's guide to information collected during the study. It does not provide detailed analysis or evaluation of the data.

5. Tri-Service Project Reliance Environmental Quality Area Summary, FY93-98 (Final Draft), U.S. Department of Defense, 1992.

This two-volume report is the first six-year Environmental Quality Science and Engineering plan prepared under the philosophy of Project Reliance. It describes the organization of DoD environmental research and development into seven areas: installation restoration, noise abatement, pollution prevention, base support, atmospheric compliance, global marine compliance, and terrestrial and aquatic assessment. Organizational responsibilities are assigned to each of the three services (Army, Navy, Air Force).

The document contains detailed roadmaps describing technologies which the services intend to develop to meet the technology needs of DoD. Appendices provide additional detail down to the individual project level. Although primarily an "approach" document, information on technology needs and funding is included.

Department of Defense
Tri-Service Environmental Quality Strategic Plan
R&D Program -- List of Required Technologies

Appendix G

PILLAR 1 -- CLEANUP

Expeditious, less costly remediation technologies which protect human health and the environment

Groundwater

- -Improved Aquifer Isolation Technology to Facilitate Remediation
- -Technology for Removal of Energetics/other organics Contamination
- -Improved Technology for Free POL Recovery from Aquifers
- -Method to contain the spread of an organic contamination plume
- -Process to remediate groundwater contaminated with hydrocarbon fuels
- -Treatment system for water contaminated with organic contaminants
- -Treatment system for water contaminated with chlorinated and dense hydrocarbons
- -Treatment system for water contaminated with mixtures of chlorinated solvents and hydrocarbons
- -Technique to maximize contaminant withdrawal with minimum water treatment
- -Treatment of Navy relevant contaminants in salt/brackish/ground water matrices

Sediment

- -Contaminated Sediment Isolation Technology
- -Dredge Spoil Area Decontamination & Reclamation Technologies
- -Selection Protocol for Optimal Remedial Technology Applications.
- -Water Column Protection Technologies During Sediment Removal
- -Improved marine sediment remediation technologies for metals, organics and PCBs

Sludges

- -Technologies for the Isolation and Decontamination of Sludges
- -Decontamination selection protocol for Sludges

PILLAR 1 -- CLEANUP

Expeditious, less costly remediation technologies which protect human health and the environment

Soils

-Lead Decontamination of Soil at Demolition Debris Disposal Sites
-Removal of Lead from Soil along Building Perimeters
-Decontamination of Soils Containing Energetic Materials
-Hazardous Emissions Suppression Technology For Use During Soil Removal
-Technology to Remove/Neutralize Unexploded Ordnance and Ordnance Residues
-Recovery and Disposal of Low Level Rad Waste
-Decontamination Techniques in Cold Climates
-Safe Removal/Deactivation of Buried Chemical Ordnance
-Methods for Decontamination of Reactive Soil or Soil With Large Chunk Energetics
-Isolation and Treatment of for Heavy Metals in Soil
-Technologies to Minimize Volume of Disposal Residues
-Technologies for Non-radioactive Mixed Waste
-Process to remediate soils contaminanted with hydrocarbon fuels
-Remedial treatment technology for soils contaminated with chlorinated and nonchlorinated organics
-Remediation alternatives for active mission areas located on contaminated filled lands (mole piers)

PILLAR 1 -- CLEANUP

Expeditious, less costly remediation technologies which protect human health and the environment

Structures

-Technologies to remediate Lead-Based Paint contaminated structures
-Techniques for Treatment/Disposal (to include safe volume reduction) of Contaminated Structures
-Decontamination of equipment
-Remediation techniques for marine structures leaching or spreading chemical contaminants
-Decontamination technology for sunken ships contaminated with PCBs

Surface Water

-Prevention of Aquifer Recharge with Contaminated Surface Water
-Minimization/Treatment of Monitoring Well Development Wastewater
-Isolation and Treatment Technology for Contaminated Surface Water and Surface Water Impounds
-Near-shore and open ocean hazardous material cleanup/reclamation
-Near-shore and open-ocean oil spill cleanup/recovery technology

PILLAR 1 -- CLEANUP

Develop use-based risk assessment methodologies

Fate/Transport

- -Improved Fate, Effects and Transport Models for Groundwater
- -Degradation Pathway and Intermediates Fate and Transport Models
- -Fate and Effects Modelling of Lead in Soil & Landfills
- -Improved Environ. Risk Assessment Methods for sediment Removal
- -Improved fate/effects methodology for sludges
- -Describe and quantify natural remediation process to support no-action alternative remedial action strategies for jet fuel contaminated sites
- -Site environmental and exposure assessment tool
- -Prediction capability to describe contaminant dispersion to/in the marine environment from Navy shoreside operations and HW sites
- -Understand processes responsible for transport of contamination at the air/water column and seafloor interfaces
- -Identify and understand the build-up/erosion patterns of shallow water sediments to predict effects of removal, burial and capping of contaminated material in marine harbors and bays
- -Predict transformations of contaminants in marine sediments

Effects Data

- -Carcinogen Risk Assessment Model Based on Exposure Duration
- -Systems for Modeling Exposure Duration Risks To Site Workers
- -Methods to Predict Degradation Produced From Decontamination of Military Unique Compounds
- -Standardized, regulator approved protocols for conducting environmental marine and terrestrial risk assessments
- -Assessment technologies which integrate chemical, biological and simulation/modeling techniques for surface water
- -Characterize response of microbial populations to pollution insults
- -Improved understanding of hydrodynamic/chemical forces impacting marine structures

PILLAR 1 -- CLEANUP

Improved site characterization and monitoring

Field Sampling

- -Statiscally Valid Methods for Determining Site Sampling Methods
- -Improved Field Identification & Measurement of Asbestos in Air
- -Safe Screening and Handling Methods for Mixed Wastes in Labs
- -Methods for Sampling & Analyzing Bioremediation Off-gases
- -Improved Standards and Analytical Techniques for Defining "Clean"
- -Lead detection in soil along building perimeters
- -Technology for rapid real-time monitoring in all media at contaminated sites
- -Standard test methods for validating monitoring devices
- -Improved sensor technologies for measurement of environmental contaminants
- -Long-term, in-place monitoring of remediation effectiveness
- -Improved Field analytical methods to supplement traditional sampling and laboratory analysis
- -Range Impact area pollution assessment technologies
- -Develop Non Point Source discharge identification technologies (non-remote sensing)
- -Small arms range pollution assessment technologies
- -Improved chemical analysis technology for fingerprinting organic contaminants
- -Increased understanding of heavy metal speciation in the marine water column and sediments

Sensing

- -Remote Sensing Technology for Remediation Site Characterization and Monitoring
- -Detect unexploded ordnance and ordnance residues
- -Safe detection of buried chemical ordnance
- -Improved ground and Sea truthing technology
- -Remote Non-point source discharge identification technologies
- -Improved buried and underwater ordnance detection

PILLAR 1 -- CLEANUP

Improved site characterization and monitoring

Database Development

- -Improved Subsurface Condition Description and Simulation
- -Integrated data collection and management system for clean up sites
- -Integrated computer graphics presentation of site data with operations information
- -Real-time site status reporting

PILLAR 2 -- COMPLIANCE

Satisfy Clean Air Act (CAA) provisions

Control emissions (primary pollutants, VOCs, toxics)

- Control air emissions from cleaning processes
- Control VOC air emission controls from Industrial Waste Treatment Process
- Control toxics from metal finishing processes
- Control emissions from metal rework operations
- Control emissions from FTF wastewater treatment processes
- Control jet and rocket engine test cell emissions
- Control/Reduce VOC emissions from coatings, strippers and cleaners
- Control of VOC emissions from ordnance manufacturing and demilitarization
- Control emissions from ship propulsion systems
- Control emissions from ship auxiliary systems
- Guidelines for Emissions Reduction Credits
- Model Guidelines for Accidental Release Program
- Need for reformulated or clean fuels for non-tactical vehicles in O_3 Non-attainment areas
- Control particulate emissions from paint/coatings removal operations
- Control emissions (NO_x, SO_x, particulates) from energetics manufacture and stationary sources
- Capture explosive gases (energetics manufacture)

Sampling/monitoring

- Real time monitoring of toxic air emissions
- Assessment of airborne contaminant dispersion over water
- Remote sensing of air quality
- Regulatory requirements warning system
- DoD-Wide Emissions Management System & Database
- System to measure airborne lead from LBP abatement
- Relate air emissions to production levels
- Robust sensors for harsh environments
- Measuring airborne asbestos from abatement
- Open Burning/Open Detonation (OB/OD) emissions measurement and characterization
- Assess atmospheric impact of air base and aircraft operations for compliance with CAA and for EIAP procedures N/P-8, 10, 11

PILLAR 2 -- COMPLIANCE

Satisfy Clean Water Act (CWA) Provisions

Control discharges

- Recover/recycle metals from industrial processes
- Reduce sludge generation in metals treatment processes
- Control fire training facilities wastewater
- Eliminate phosphate and organics interference problem at IWTP
- Non-polluting biocides for shipboard systems
- Control open ocean oil spills
- Control blackwater/greywater from ships
- Control discharges from ships bilge
- Control discharges from ships ballast
- Remove and treat Nitrocellulose Fines and other military unique compounds from water
- Control Nonpoint Source Discharge
- Cost-effective stormwater treatment technology
- Sludge treatment technology
- Advanced treatment technology for sanitary wastewater
- Alternatives to chlorine for disinfecting wastewater discharges

Sampling/monitoring

- Remote sensing of marine environmental parameters related to military operations
- Advanced chemical analytical methods for contaminant detection in seawater
- Advanced lab & field data analysis
- Standardized protocols for assessing marine environments
- Improved biomonitoring capability
- Environmental contaminant spill/leak alarm
- Relate discharges to production levels of military unique compounds
- Wastewater assessment and toxicity testing
- Hazard assessment of military-unique compounds in wastewater
- Methodology for storm water Pollution Prevention Plans

PILLAR 2 -- COMPLIANCE

Satisfy Resource Conservation and Recovery Act (RCRA) provisions

Treatment (incineration, thermal (Sub-Part-X), biological, chemical)
- Develop technology for rocket motor propellant removal and destruction
- Advanced incineration capability for hazardous waste (HW)
- Alternatives to OB/OD for destruction of energetics waste
- Enzyme and bacterial treatment technology
- Understanding of the chemical, biological, and physical degradation process of contaminants in the marine environment
- Shipboard HW treatment and reduction
- Treatment of PCB-contaminated equipment
- Cost-effective treatment/resue of Redwater
- Cost-effective treatment of Pinkwater
- Capture of NC Fines from wastewater

Storage (UST management, container storage, conforming storage)
- Environmentally safe storage capability
- Capability to locate, identify and manage Aboveground and Underground Tanks
- Emergency response technology for leaking tanks
- Improved cleanup procedures for locations where UST leaked

Disposal (land, deep well)
- Environmentally sound composite materials destruction and disposal
- Develop alternative non-hazardous solid waste disposal capabilities
- Develop alternative ordnance disposal methods
- Develop alternative HW disposal techniques
- Develop alternative lithium batteries disposal capability
- Develop disposal capability for PCB-contaminated weapon systems

Administration (closure plans, characterization)
- Model plans and systems for satisfying regulatory requirements
- Models for optimum solid waste management at military installations
- Real time tracking of hazardous materials and hazardous waste

Sampling/monitoring
- Sampling/Handling protocols for non-radioactive mixed HW
- Identify components of ordnance items to be treated as HW

PILLAR 2 -- COMPLIANCE

Noise

Assessment and modeling

- Assess noise impacts of fixed wing aircraft on environment around air bases and along training routes

- Integrated annoyance measurement system for all source types
- Definitive Noise Annoyance Index
- Integrating Helicopters into NOISEMAP
- NATO Standard Methods for noise measurement and prediction
- Interface of Noise Contour System With GIS Systems
- Method to Incorporate Weather and Terrain into Noise Contours
- Effects of Weapons Systems Noise on Rare & Endangered Species
- Effects of Weapons Systems Noise on Wilderness & Park Enjoyment
- Land use assessment tools for less noise sensitive areas
- Algorithms For Sound Propagation over Rough Terrain
- Develop Physical Models for Noise Prop When Can't Math Model

Impact mitigation

- Helicopter noise control
- 3-D Analysis Procedures to Implement Physical Models
- Blast Noise Mitigation in Structures
- Training Range Noise Control
- Impulse Noise Mitigation
- Noise protection technologies for marine mammals

Measurement and monitoring

- Improved Blast Noise Monitoring System
- Comprehensive Noise Management and Analysis System

PILLAR 2 -- COMPLIANCE

Other regulations (TSCA, ESA, MPRSA, MMPA, NEPA, FIFRA)

- Method to accurately predict toxic corridors and far field impact of disasters associated with rocket launches
- Technology to comply with foreign environmental compliance requirements
- Protect the health of Navy personnel from environmental pollution
- Tracking/monitoring technology for marine mammals
- Criteria to determine when a marine mammal is impacted by certain Navy operations
- Techniques for conducting operations in environmentally sensitive areas
- Information database for harassment/incidental marine mammal "take" likely occurrences
- Solid/plastic waste cleanup in Antarctica
- Control "introduced species" in ships ballast
- Capability to store plastic waste aboard ships and submarines
- Technologies fo comply with MARPOL special areas requirements
- Analytical methods to measure Chemical Surety Material (CSM) in All Media
- Hazard Assessment Methodologies for CSM
- Treatment Technology for Removal of Military-Unique Compounds from drinking water
- Standards for Military-Unique Compounds in Drinking Water
- Improved drinking water technology
- Capability to comply with changing drinking water regulations
- Hazard Assessment of Military-Unique Compounds in Drinking Water
- Improved methods for radon reduction
- Improved identification and assessment of pesticides/herbicides/rodenticides
- Improved physical removal of pesticides/herbicides/rodenticides
- Improved chemical/thermal destruction of medical waste
- Shoreside/shipboard technology for desalinization of polluted influents

PILLAR 2 -- COMPLIANCE

Support responsible regulatory standards

Effects data

- Establish risk/hazard based action levels

Fate/Transport Models

- Increased understanding of chemical speciation of heavy metals in marine and estuarine ecosystems
- Identify and understand processes responsible for transport of contaminants between the air/marine water/marine sediment interfaces
- Sampling/monitoring protocol for anti-fouling toxics
- Technologies to assess impacts of dredged material on disposal sites

PILLAR 3 -- POLLUTION PREVENTION

Reduce hazardous waste by 50% by 1997 from baseline 1992

Machine and metal work

- Metal rework waste reduction technologies
- Identify non-hazardous alternatives for hazardous cutting fluids
- Hazardous cutting fluids reuse/reclamation technologies
- Technologies to reduce hazardous dusts

Cleaning and degreasing

- Solvent recycling/reclamation technology
- Non-polluting, non-toxic cleaning and degreasing technology
- Low/non-residue blast cleaning capability
- Reduce HW generated from solid materials contaminated with oil, grease, and solvents RM p-26, 27
- Objective measures for determining acceptable surface cleanliness
- Improved methods of determining when solvent is spent
- Non-Solvent cleaning techniques

Metal plating and surface finishing

- Non-chromate containing sealant/adhesive technology
- Reuse/recycling of HW generated from electroplating operations
- Recovery/recycle of metals from dilute metals contaminated wastewater
- Reduce volume of contaminated rinse water from electroplating rinse operations
- Non-hazardous alternatives for chromium in electroplating operations
- Non-hazardous alternatives for chromium in alodine and anodize processes
- Non-hazardous alternatives for cadmium in electroplating operations
- Non-hazardous alternatives for cyanide in electroplating operations
- Non-hazardous alternatives for nickel in electroplating operations

PILLAR 3 -- POLLUTION PREVENTION

Reduce hazardous waste by 50% by 1997 from baseline 1992

Painting and coating
- Non-hazardous corrosion protection paints and coatings
- Non-hazardous antifouling/fouling release hull coatings
- Eliminate chromate waste generation from corrosion protection processes
- Reduce hazardous waste from paint container disposal
- Minimize paint application wastes
- Non-hazardous Chemical Agent Resistant Coatings (CARC Paint)
- Reuse/recycle paint sludge and filters

Paint stripping
- Cost-effective non-polluting paint stripping methods
- Non-polluting, low-VOC chemical strippers
- Improved blast grit recycling technology
- Reduce hazardous waste generation from plastic media blasting
- Eliminate chromate waste generation from paint stripping processes
- Reduce hazardous waste generation from chemical paint stripping operations
- Develop environmentally safe paint stripping operation for small parts
- Technology to recycle/reuse paint-removal media

Ordnance manufacturing
- Propellant/explosives recycling/reuse
- Clean burning propellants
- Improved processes to reduce wastes in ordnance manufacturing
- Solventless processing technology for energetics
- Technology to regenerate explosive-contaminated activated carbon
- Reduce Redwater production
- Minimize Depleted Uranium (DU) waste from manufacture
- Methods to permit use of reformulated energetics

Ordnance Demilitarization
- Beneficial uses of waste explosives/propellants
- Model for optimizing demilitarization decisions (prevention vs. control tradeoffs)

Reduce hazardous waste by 50% by 1997 from baseline 1992

Shipboard effluents
- Polymeric discharge control technology
- Transformation of hazardous substances (plastics) into environmentally safe materials
- Non-polluting ship lubricant technology
- Biodegradable packaging technology
- Environmentally sound aircraft fuel management technology
- Non-polluting refueling process
- Non-polluting shipboard waste stream systems
- Prevention of hazardous discharge from ship in-water hull cleaning

Pesticides/herbicides/rodenticides
- Alternative, non-toxic pesticides/herbicides/rodenticides
- Improved chemical management systems

Non-point source pollution
- Prevent non-point source discharges

Other waste
- Improved technology for non-polluting treatment of boiler water
- Apply compliance-based methodologies to reducing HW and hazardous materials use, handling and storage requirements
- Non-VOC sealant and adhesive technology
- Hazardous materials substitution
- Reduce hazardous waste generation from IWTP sludges
- Methods for reuse/recycle of POL (petroleum, oils, lubricants)
- Methods for reuse/recycle of antifreeze
- Minimization of waste from Lead Based Paint (LBP) debris
- Methods to recover/reuse batteries

Composite material
- Next generation non-toxic, non-polluting composites

Eliminate need to purchase Ozone Depleting Substances (ODS) by end of 1995

Refrigerants
- Safe, affordable chemical substitutes for ODS refrigerants
- Re-engineer existing shipboard/shoreside plants for use with new non-ODS refrigerants
- Recycling/stockpiling/reusing non-replaceable ODS
- Develop alternatives to ODS climate control and refrigeration
- Retrofit sealing systems to eliminate leakage of CFC substitutes

Foams
- Non-ODS alternative to AFFF applications

Solvents
- Non-ODS solvents for aircraft/weapons/shipboard/shoreside applications
- Improved technology for managing solvent waste streams
- Replacements for chlorinated cleaners/degreasers
- Develop process(s) necessary to recycle/recover aqueous/nonaqueous replacements for CFCs

Firefighting agents
- Redesign firefighting systems and sensors
- Recycling/stockpiling/reusing non-replaceable fire fighting agents
- Eliminate Halon use in fire control and fire training
- Safe,affordable substitutes for ODS firefighting agents
- Improved ADPE (automated data processing equipment) firefighting systems

Aerosols
- Non-polluting alternatives to current aerosol propellants

Sterilants
- Alternative sterilization systems

PILLAR 3 -- POLLUTION PREVENTION

Develop environmentally sound weapon systems and platforms

Concept Development
- Including environmental considerations/factors in concept selection

Design
- New materials/designs to protect structures from environmental exposure
- Integrated pollution prevention systems for environmentally sound ships
- Models/theories for improved corrosion control
- Environmental life cycle cost model
- Improved environmental impact assessment methods for new systems
- Methods for identifying non-hazardous alternative materials
- Method to check system design documentation (e.g., specifications) for hazardous materials

Test and evaluation
- Environmental noise signature measurement protocols
- Methods to assess environmental impacts of new systems during test and evaluation

Operations
-

Maintenance
- Methodology to check logistics support documentation for hazardous materials

Disposal
- Non-hazardous demilitarization/decommissioning technologies for weapon systems and components
- Demilitarization of Depleted Uranium penetrator rounds
- Demilitarization of Reactive Armor-clad Combat Vehicles

Fate/effects
- Three dimensional models of the basic physical, chemical, and biological fate and effects from systems/platforms pollutant discharges into the environment

Reduce solid waste by 50% by 1997 (1992 baseline) weight for land and zero total plastics discharge from ships by 1998

Trash and construction
- Improved shipboard compaction technology
- Degradable plastics technology
- Non-hazardous shipboard pulping technology
- Plastics substitution and recycling
- Improved materials recycling and reuse technology
- Beneficial uses of non-hazardous demolition debris
- Soild waste management optimization model
- Recyclable containers
- Minimum packaging
- Recycle/reuse waste wood and plastics

Water treatment
- Reduction of sludge volume

Shipboard effluents
- Oily-waste processing technology (ashore)
- Bilge water processing technology
- Grey water reduction and processing

Other
- Beneficial uses of waste tires
- Beneficial uses of non-hazardous sludges

Reduce greenhouse gas emissions (GGE)

Measure contribution of GGE to atmosphere
- Models for determining effect of GGE on atmosphere
- Improved sampling instrumentation for GGE
- Improved laboratory analysis technology
- Baseline emissions and sources

Develop control strategies
- Reducing chemical emissions
- Eliminating/reducing hydrocarbon fuel use
- Improved emissions treatment
- Improve efficiencies of mechanical systems
- Criteria and model for source prioritization
- Substitute technologies for GGE emitting activities
- Substitutes for GGE chemicals

Alternate fuels
- Alternative/renewable energy sources

PILLAR 4 -- CONSERVATION/STEWARDSHIP

Predicate use planning and real property management decisions on natural and cultural resource capabilities and constraints

Natural and cultural resource baseline data

- Methods for standard, comprehensive, cost effective inventory and monitoring to fully characterize ecosystems and cultural resources
- Standard methodologies for condition assessment, treatment, and maintenance of historic structures, buildings, and landscapes
- Information management protocol and analytical standards
- Spatial presentation and analysis of natural and cultural resources data
- Procedures to collect and integrate remote and field data

Carrying capacity

- Develop comprehensive modelling capability for ecological carrying capacity of terrestrial and marine ecosystems
- Investigate the fundamental causal relationships between military operations and environmental carrying capacity
- Classify land in terms of carrying capacity
- Match land use requirements with capacity of natural resources to support intended uses and conserve resources
- Spatial and temporal analysis of the impacts of military activity on natural and cultural resources
- Integrate natural and cultural data with other physical attributes of installations
- Assess effects of base closures and realignments on natural and cultural resources

Environmental impacts from training/testing

- Economic impact forecast system (EIFS)
- Capability to evaluate training and testing activities and their effects on natural and cultural sites
- Enhanced data for NEPA analysis and decision-making documentation
- Capability to assess the effects of training-induced erosion and vandalism on archeological sites
- Enhance environmental education materials and programs to effect an environmental ethic

PILLAR 4 -- CONSERVATION/STEWARDSHIP

Predicate use planning and real property management decisions on natural and cultural resource capabilities and constraints

Land scheduling and management systems
- Strategies for long-term multiple-use land management
- Incorporate environmental considerations into the training planning and scheduling process
- Identify terrain requirements for successful training and develop procedures for optimal use of terrain
- Spatial analysis methods to identify and display land scheduling alternatives

Land/range design and improvement
- Low-maintenance landscape design protocols
- Stabilizing and maintaining severely disturbed landscapes/terrain
- Reduce land damage and subsequent lost land use capability
- Techniques to maintain suitable training/testing land areas

Erosion control
- Develop dynamic models and programmatic solutions to near shore and surf zone erosion
- Develop mineral/pollutant transfer assessment capability for erosion zones
- Reduce excessive soil erosion and restore landscapes
- Assess effects of erosion on the spatial integrity of archeological sites

Water quality
- Identify basic physical, chemical, geological and biological processes that impact wetlands and marine water quality
- Ensure effective management of fresh water assets
- Analyze and model effects of mission activities on water quality

Cultural resources/historical site management
- Capability to evaluate and minimize effects of base operations (engineering and housing activities) on historic structures, landscapes, and buildings while maintaining their use
- Spatial and temporal modeling of cultural resources and their relationships to landscape features and processes
  Long-term stabilization of archeological sites and maintenance of historic structures
- Technical guidelines for preserving significant cultural resources and curation artifacts

Forestry management
- Assess the effect of various timber management activities on significant natural and cultural resources sites and habitats
- Guidelines for forestry management and archeological site location and protection

Protect the biological health of the environment

Wetlands
- Assess functions and values of wetland resources
- Identify wetland sites that have potential for meeting specific installation management objectives
- Computer-based wetlands mapping system
- Guidelines for wetlands protection, restoration, creation, management

Coastal zone
- Improved capability for environmental monitoring and assessment for pollution/contamination effects
- Assess and prioritize non-point sources of pollution at military installations in the coastal zone
- Meet coastal zone management requirements
- Reduce impacts of coastal erosion

Marine/harbor
- Improved harbor assessment and remediation
- Understanding of trace metal/biological feedback mechanlsms affecting estuarine/harbor metal contaminants
- Control and manage sediments

Forest
- Model potential deforestation effects on local ecosystems
- Technology for optimum forestation/cultivation processes
- Techniques to reduce fungal diseases spread by insects in damaged vegetation
- Biological and mechanical management strategies to reduce noxious plant propagation
- Reduce the transport and introduction of harmful pests

Other "sensitive" ecosystems
- Methods to inventory, monitor, and manage sensitive ecosystems
- Geographic information process tools to analyze the relationship of sensitive ecosystems to other land resources

PILLAR 4 -- CONSERVATION/STEWARDSHIP

Improve protection of threatened/endangered (T&E) species and marine mammals

Training/testing impact analysis
- Scientific data and analysis standards regarding the impacts of military activities on T&E species and marine mammals
- Ability to evaluate training/testing objectives and requirements and effects upon T&E species and marine mammals

Critical habitat requirement
- Protection guidelines for critical habitat requirements

Species management/protection
- Rapid impact assessment impact of specific operations on T&E species and marine mammals
- Determine effects of pollutants on aquatic life and T&E species
- Technologies to reduce "incidental take" of marine mammals/T&E species
- Strategies for mitigation of impacts of mission activities on listed species
- Guidelines and standards for generating species management documentation
- Integration of mission and T&E species management requirements
- Techniques and procedures for the protection of T&E species on military land

Species propagation/recovery
- Fundamental understanding of T&E species ecosystems
- Guidelines for evaluating and reporting on the status of T&E species
- Standards, techniques and procedures for species propagation, enhancement and recovery

Habitat management
- Identify and understand the underlying processes for the maintenance of habitats and populations
- Identify the effects of habitats or species loss on surrounding ecosystems
- Data and analysis standards regarding impact of military activities on T&E species habitat
- Standards for documentation in support of various regulatory requirements to maintain biodiversity
- Analysis and management of information related to the spatial relationships of habitat
- Identify and develop management strategies to optimize land use while maintaining sustained use and biodiversity

DEPARTMENT OF ENERGY TECHNOLOGY NEEDS FOR WASTE MANAGEMENT

The following needs list was derived from several sources. A number of technology needs assessments have been carried out in the past by different Offices within DOE as well as some site specific assessments. The sources from which this list has been written include:

1. *DOE Defense Waste Management Needs Assessment/Resolution Document* (1988, sponsored by the National Low Level Waste Management Program and HAZWRAP).

2. *Basic Research Needs for the Management and Disposal of DOE Wastes* (April 1991, sponsored by the DOE Office of Energy Research).

3. *Issues Statements of the Strategic Roadmaps for Albuquerque, the Oak Ridge Reservation, INEL, and the Rocky Flats Plant.*

4. *Hanford Technology Needs Assessment and Prioritization* (1991).

5. *Technology Needs for Treatment of DOE's Low Level Mixed Waste* (1992, prepared by the Mixed Waste Treatment Project).

6. *Minutes from DOE/HAZWRAP Research and Development Technology Needs Assessment Review Meetings* 1987, 1988, 1989, DOE/DP, DWTM/HAZWRAP, DOE/HWQP-61, -78, -93)

Historical Complex-Wide Technology Development/Demonstration Needs List

Characterization

1. Innovative techniques for sampling heterogeneous wastes.

2. In situ waste characterization analyzers.

3. Automatic analytical sampling technology.

4. Portable waste characterization instruments.

5. Equivalent [to EPA approaches for hazardous wastes] methods for mixed waste analysis that are compatible with currently available equipment and radiological control requirements.

6. Capability to verify/validate waste package contents received from generators.

7. Analytical methods that create minimum waste.

8. Building or acquiring of adequate, qualified analytical laboratory capacity.

9. Non-contacting analysis of drummed (or otherwide packaged) waste.

Waste Retrieval

1. Reduction of caked, crusted, crystallized, etc., solids to a retrievable/transportable form.

2. Containment schemes for dust and vapors created during retrieval operations.

3. Efficient mechanisms for transport of powdered solids.

4. Robotic mechanisms for retrieval in high hazard environments.

Pretreatment

1. Develop Cs/Sr/Co specific zeolites (specify matrix).

2. Mercury recovery techniques (specify matrix).

3. General heavy metals recovery (specify matrix).

4. Efficient radionuclide separation:

   a. (Aqueous) Develop ion specific complexing/immobilizing agents.

   b. (Aqueous) Develop new reagents for the dissolution of sludges and solids.

   c. (Aqueous) Develop radionuclide and fission product specific microbial immobilization agents.

   d. (Inorganic solids) Develop pyrochemical processes for separating radionulides and fission products from inorganic matrices.

5. Develop efficient, omnivorous size reduction equipment (shredding, chopping, macerating, cryofracture, etc.)

6. Decontamination techniques that do not create mixed waste.

   a. CO_2 pellet blasting.

   b. Water jet stripping.

   c. Pulsed laser stripping/volatilization.

Treatment

1. Cost/operating data on available innovative technologies.

2. Develop publicly acceptable incineration technology.

3. Develop thermal treatment technology alternatives to incineration.

   a. Supercritical water oxidation.

   b. Molten salt oxidation.

   c. Plasma reactors - both high and low temperature.

4. Processes to recover and reuse nitric acid (identify matrix).

5. Cyanide treatment (identify matrix).

6. Nitrate treatment (identify matrix).

7. Ferrocyanide treatment (identify matrix).

8. Separation techniques for removing RCRA listed inorganics from non-RCRA listed matrices (identify inorganics and matrices).

9. Solar photo-oxidative treatments for waste waters.

10. Spent nuclear fuel reconditioning.

11. Destruction or removal of RCRA listed wastes from mixed waste.

12. Actinide conversion technology.

13. Electrochemical decomposition of RCRA listed organics and anions.

Waste Form and Packaging

1. ^{90}Sr and ^{137}Cs waste forms.

2. ^{99}Tc and ^{129}I waste forms.

3. Borosilicate glass and ceramic or glass ceramic HLW waste form formulations.

4. Waste loading vs. performance criteria for HLW waste forms.

5. Fluorite-based oxide waste forms for TRU.

6. Phosphate-based ceramic waste form for TRU.

7. Improved concrete forms for liquid LLW.

8. Improved concrete forms for LLW incinerator ash.

9. Reuse of decontaminated material for waste form packaging.

Storage and Disposal

1. Valid risk assessment procedures.
2. Improved coatings and overpacks for extension of storage lifetimes.
3. Improved confinement integrity sensors.
4. Remote stacker-retriever systems.
5. Remote storage facility survey (RCRA) systems.

The Interim 1992 Site-Specific Technology Needs List

Characterization: Capacity

Site/Field Office	*Need*
FEMP	Qualified Analytical Laboratory Capacity
AL	Analytical Laboratory Capacity
SAN	Increased Capacity for Mixed Fission Products

Characterization: In-Situ

FEMP	In-situ Waste Characterization Analyzers
RL	Characterization of Buried Waste

Characterization: General

AL	Protocols for Wastes Which Have No EPA SW-846 Protocols
AL	Sampling/Analytical Strategies Based on ALARA Concerns
AL	Improved Sensitivities for TRU Detection
AL	Comparability Among TRU Waste Assay Methods
AL	Reliable TRU Assay in the Presence of High Gamma Dose Rates
AL	Tritium Assay in Heterogeneous Waste
AL	Measurement Techniques for Assessment of Mixed Fission Products and Mixed Activation Products in LLW
AL	RH Waste Characterization - Tomography/Gamma Scan (WIPP)
AL	^{3}H Offgas Measurement from TRUPACT-II Transported Containers (WIPP)

AL	Analysis of R/A Nuclide Content in Sealed TRU Waste Packages
SAN	SW-846 Equivalent Methods for Mixed Waste that are Compatible with Current Equipment and Radiation Control Requirements.

Characterization: Monitoring

AL	Real Time Monitoring R/A and Super LL in Waste Water
AL	Real Time Radiation Monitoring During Waste Handling (WIPP)
RL	Characterization (on-line) of Liquid Waste
RL	On-line monitoring of metal concentrations in grout production, HWVP
RL	On-line chemical process monitors to quantify major constituents (nitrates, etc.) in grout production, HWVP
RL	On-line monitoring of temperature in grout during processing and setup
RL	Moisture monitoring in salt cake (1% accuracy at 10% concentration)
RL	Monitoring of gases in tank headspaces and during processing
RL	Monitoring of organics in tanks and during processing
SAN	Portable analyzers

Retrieval

RL	Remote Retrieval of Caissons, Small Items, Unstable or Reactives in High Activity Environments (180 m^3 TRU)
ID(ICPP)	Remote Application of Calcine Pneumatic Transport System (2000 m^3)
ID(ICPP)	Standardized Method for Entering and Interfacing Retrieval Equipment with UST's (300K gal)

Pretreatment

ID	Metal Separation and Waste Sorting (36,000 m^3 TRU, X+4300 m^3/yrMLLW)
ID	Metal Size Reduction Equipment (same volumes and rates as above)
AL	Declassification of Classified Wastes

RL	Dissolution/leach chemistry of Hanford tank wastes
RL	Organic and nitrate/nitrite destruction techniques
RL	Separation of Cs/Sr/TRU from tank waste supernates
RL	Solid/liquid separation by flocculation/settling or mechanical devices for effective separation of tank wastes
RL	Compact or modual processing for pretreatment of Hanford tank waste

Treatment: Mixed Waste

FEMP	Permitted Treatment for Solid Mixed Waste
FEMP	Treatment Facility for the Stabilization of Toxic Metal (TCLP) Bearing Mixed Waste (14,000 ft^3)
AL	Treatment of Scintillation Vials
AL	Treatment of Contaminated Oils
AL	Treatment of Mixed Waste Lab Packs
AL	Activated Lead and Cadmium Assay and LDR Treatment
SAN	Remove Radioactive Material from Trimsol or Water (5 tons/yr)
OR	Mixed Waste-Uranium Leaching from Soils
OR	Stabilization of Mixed Waste
SAN	Centralized Facility for pH Neutralization of Mixed Waste which is Hazardous due to pH only ($1m^3$ + $0.06m^3$/yr)
SAN	Separation of Hg from Mixed Waste with No Secondary Stream Generation (100+ yd^3)

Treatment: TRU

RL	In-Situ Treatment of Buried TRU/TRUM (100,000 m^3)
ID	Data for Retention and Volatilization of TRU and HVPM During High Temperature Processing (36,000 m^3 TRU, X + 4300 m^3/yr MLLW)
ID	Stabilization Media for TRU Isotope Contaminated Treated Waste Streams (SVARAA [same volumes and rates as above]).
ID	Melting and Vitrification of INEL Waste in the Bureau of Mines/ASME Ash Melters (SVARAA).

ID(ICPP)	TRUEX Solvent Extraction Process Compatible with High Fluoride Concentrations (300K gal)

Treatment: Hazardous and Reactive

AL	Explosives Disposal to Replace Open Burning
RL	Treatment of Pyrophorics, Reactive Compounds, and Alkalai Metals (Low Volume)
RL	Liquid Effluent Treatment for Hazardous and R/A Components
OR	Treatment of Mercury Contaminated Waste
SAN	Set Risk Levels for R/A Materials that Meet Safety Requirements
SAN	Volume Reduction of Bulky Equipment, Gloveboxes, Etc. $1m^3/yr$
SAN	Centralized Facility for the Smelting of Induced Lead (0.02 m^3/yr)
ID(ICPP)	Remotely Operated Hydro, CO_2, and Sand Blasting Equipment for Minimization of Exposure and Waste During Decon Operations (complex-wide)

Treatment: LLW

OR	TOSCA Incinerator Ash Treatment
OR	Leachate Treatment from Disposal Facilities

Storage

FEMP	Remote Drum Survey System for Storage Facility (30,000 Drums)
RL	Interim Storage of N-Reactor Irradiated Fuel (2100 Metric Tons of Uranium)

Disposal

ID(ICPP)	Long Term or Permanent Entombment Technology Requiring Little Monitoring for the Underground Portions of Facilities (complex-wide)
OR	Engineered Waste Form Performance
OR	Low level Waste Transportation

United States
Environmental Protection
Agency

Superfund/RCRA EPA/542/R-92/004

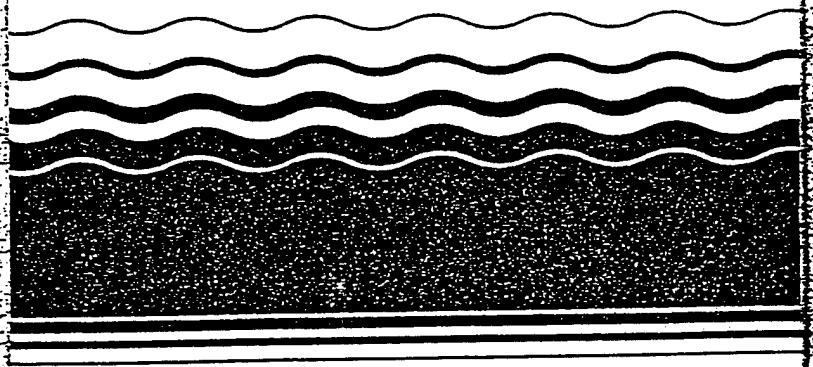
EPA

Selected Alternative and Innovative Treatment Technologies for Corrective Action and Site Remediation

(A Bibliography of EPA Information Resources)

Spring Update
May 1992

New Publications Appear In Italics



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Appendix I

A. Conferences and International Surveys

Forum on Innovative Hazardous Waste Treatment Technologies - Domestic and International (Abstract Proceedings):
First Forum, Atlanta, GA. **EPA/540/2-89/055**
Second Forum, Philadelphia, PA. **EPA/540/2-90/009**
Third Forum , Dallas, TX. **EPA/540/2-91/016**

NATO/CCMS Project — International Evaluation of In-Situ Biorestoration of Contaminated Soil and Groundwater. **EPA/540/2-90/012**

Remedial Action, Treatment, and Disposal of Hazardous Waste: Proceedings of the 18th Annual RREL Hazardous Waste Research Symposium. **EPA/600/R-92/028**

B. Technology Survey Reports/Guidance

Advancing the Use of Treatment Technologies for Superfund Remedies. **OSWER Directive 9355.0-26**

Approaches for Remediation of Uncontrolled Wood Preserving Sites. **EPA/625/7-90/011**

Assessment of Technologies for Remediation of Radiation at Contaminated Superfund Sites. **EPA/540/2-90/001**

Furthering the Use of Innovative Treatment Technologies in OSWER Programs. **OSWER Directive 9380.0-17FS**

General Methods for Remedial Operation Performance Evaluation. **EPA/600/R-92/028**

Guide to Treatment Technologies for Hazardous Wastes at Superfund Sites. **EPA/540/2-89/052**

Guidance on Remedial Action for Superfund Sites with PCB Contamination. **EPA/540/G-90/007**

Handbook: Stabilization Technologies for RCRA Corrective Action. **EPA/625/6-91/026**

Handbook on In Situ Treatment of Hazardous Waste-Contaminated Soils. **EPA/540/2-90/002**

Innovative Operational Treatment Technologies for Applications to Superfund Sites. **EPA/540/2-90/006**

Innovative Treatment Technologies: Overview and Guide to Information Sources, October 1991. **EPA/540/9-91/002**

Innovative Treatment Technologies: Semi-Annual Status Report, Number 3, April 1992. **EPA/540/2-91/001**

Innovative Processes for Reclamation of Contaminated Subsurface Environments. **EPA/600/S2-90/017**

On-Site Treatment of Creosote and Pentachlorophenol Sludges in Contaminated Soil. **EPA/600/2-91/019**

Remediation of Contaminated Sediments. **EPA/625/6-91/028**

Remediation of Sites Contaminated with TCE. **EPA/625/J-91/030**

Selection of Control Technologies for Remediation of Lead Battery Recycling Sites. **EPA/540/2-91/014**

Seminar Publication - Corrective Actions: Technologies and Applications. **EPA/625/4-89/020**

Subsurface Contamination Reference Guide. **EPA/540/2-90/01**

Summary of Treatment Technology Effectiveness for Contaminated Soil - Final Report. **EPA/540/2-89/053**

Superfund Engineering Issue-Treatment of Lead Contaminated Soils. **EPA/540/2-91/009**

Superfund Innovative Technology Evaluation Program - SITE Program Fact Sheet. **OSWER Directive 9380.1-03AFS**

Superfund Land Disposal Restriction (LDR) Guides. **OSWER Directives 9347.3-01FS though 09FS**

Superfund Treatability Clearinghouse Abstracts. **EPA/540/2-89/001**

Survey of Materials-Handling Technologies Used at Hazardous Waste Sites. **EPA/540/2-91/010**

Technological Approaches to the Cleanup of Radiologically Contaminated Superfund Sites. **EPA/540/2-88/002**

Technologies of Delivery or Recovery for the Remediation of Hazardous Waste Sites. **EPA/600/S2-89/066**

Technology Screening Guide for Treatment of Soils and Sludges. **NTIS PB89-132674**

The Feasibility Study Development and Screening of Remedial Action Alternatives. **OSWER Directive 9355.3-01FS3**

The Superfund Innovative Technology Evaluation Program: Technology Profiles (Fourth Edition). **EPA/540/5-91/00?**

C. Treatability Studies

Regional Guide: Issuing Site-Specfic Treatability Variances For Contaminated Soils and Debris from Land Disposal Restrictions (LDRS). **OSWER Directive 9380.3-08FS**

Analysis of Treatability Data for Soil and Debris: Evaluation of Land Ban Impact on Use of Superfund Treatment Technologies. **OSWER Directive 9380.3-84**

Conducting Treatability Studies Under RCRA. **OSWER Directive 9380.3-09FS**

Guide for Conducting Treatability Studies Under CERCLA, Interim Final. **EPA/540/2-89/058**

Guide for Conducting Treatability Studies Under CERCLA, Soil Washing. **EPA/540/2-89/058**

Guide for Conducting Treatability Studies Under CERCLA, Aerobic Biodegradation Remedy Screening. **EPA/540/2-91/013B**

Inventory of Treatability Study Vendors, Draft Interim Final. **EPA/540/2-90/003a**

The Remedial Investigation Site Characterization and Treatability Studies. **OSWER Directive 9355.3-01FS1**

Treatability of Hazardous Chemicals in Soils: Volatile and Semi-Volatile Organics. **NTIS DE89-016897**

Treatability Potential for EPA Listed Hazardous Wastes in Soil. **NTIS PB89-166581**

Treatability Potential for 56 EPA Listed Hazardous Chemicals in Soil. **NTIS PB89-174446**

Treatability Studies Under CERCLA: An Overview, 12/89. **OSWER Directive 9380.3-02FS**

D. Ground Water

A Guide to Pump and Treat Ground Water Technology, November 1990. **EPA/540/2-90/018**

Biorestoration of Aquifers Contaminated with Organic Compounds. **NTIS PB89-103527**

Chemical Enhancements to Pump-and-Treat Remediation. ****EPA/540/2-91/009**

Contaminant Transport in Fractured Media: Models for Decision Makers (Issue Paper). ****EPA/540/4-89/004**

Dense Nonaqueous Phase Liquids-A Workshop Summary. ****EPA/600/R-92/030**

Emerging Technology Report - Removal and Recovery of Metal Ions from Ground Water.
(Evaluation Report) **EPA/540/5-90/005a**
(Data and Supporting Information) **EPA/540/5-90/005b**

Estimating Potential for Occurrence of DNAPL at Superfund Sites. ****EPA Publication 9355.4-07FS**

Evaluation of Ground Water Extraction Remedies.
Vol. 1, Summary Report, **NTIS PB90-18358**
Vol. 2, Case Studies (Interim Final), **NTIS PB90-274440**
Vol. 3, General Site Data, Data Base Reports (Interim Final), **NTIS PB90-274457**

Facilitated Transport (Issue Paper). ****EPA/540/4-89/003**

Ground Water Issue: Dense Nonaqueous Phase Liquids. ****EPA/540/4-91/020A**

Ground Water Issue-Reductive Dehalogenation of Organic Contaminants in Soils and Ground Water. ****EPA/540/4-90/054**

Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites. **NTIS PB89-18461**

In Situ Aquifer Restoration of Chlorinated Aliphatics by Methanotrophic Bacteria. **** EPA/600/2-89/033**

Opportunities for Bioreclamation of Aquifers Contaminated with Petroleum Hydrocarbons. **NTIS PB88-148150**

Performance Evaluations of Pump-and-Treat Remediations (Issue Paper). ****EPA/540/4-89/005**

E. Thermal Treatment

Applications Analysis Report - American Combustion Pyretron Destruction System. **EPA/540/A5-89/008**

Applications Analysis Report - ECOVA, Inc: Infrared Incineration System. **EPA/540/A5-89/007**

Engineering Bulletin - Mobile/Transportable Incineration Treatment. **EPA/540/2-90/014**

Engineering Bulletin - Thermal Desorption Treatment. **EPA/540/2-91/008**

Experience in Incineration Applicable to Superfund Site Remediation. **EPA/625/9-88/008**

High Temperature Thermal Treatment for CERCLA Waste: Evaluation and Selection of Onsite and Offsite Systems. **EPA/540/X-88/006**

F. Biological

A Field Evaluation of Bioremediation of a Fuel Spill Using Hydrogen Peroxide. **NTIS PB88-130257**

Applications Analysis Report-Biotrol: Biotreatment of Ground Water. ***EPA/540/A5-91/001***

Bioremediation of Hazardous Waste. **EPA/600/9-90/041**

Bioremediation of Contaminated Surface Soil. **NTIS PB90-164047**

Demonstration Bulletin: Aqueous Biological Treatment System (Fixed Film Biodegradation). **EPA/540/M5-91/001**

Engineering Bulletin - Slurry Biodegradation. **EPA/540/2-90/016**

Enhanced Bioremediation Utilizing Hydrogen Peroxide as a Supplemental Source of Oxygen. **NTIS PB90-183435**

Interactive Simulation of the Fate of Hazardous Chemicals During Land Treatment of Oily Wastes: Ritz User's Guide. **NTIS PB88-195540**

In Situ Bioremediation of Spills from Underground Storage Tanks. **NTIS PB89-219976**

Mobility and Degradation of Residues at Hazardous Wase Land Treatment Sites at Closure. **NTIS PB90-212564/A5**

Removal of Volatile Aliphatic Hydrocarbons in a Soil Bioretor. **NTIS PB88-170568**

The Federal Technology Transfer Act: Opportunities for Cooperative Biosystems Research with the U.S. EPA. **CERI-90-114**

Transformation of Halogenated Aliphatic Compounds. **NTIS PB88-249859**

G. Physical Chemical

Applications Analysis Report - Chemfix Technologies, Inc., Chemical Fixation/Stabilization. **EPA/540/A5-89/011**

Applications Analysis Report - EmTech Solidification Process, Douglassville, PA. **EPA/540/A5-89/001**

Application Analysis - International Waste Technologies, In Situ Stablization/Stabilization, Hialeah, FL. **EPA/540/A5-90/005**

Applications Analysis Report-AWD Technologies: In Situ Vapor Extraction and Steam Vacum Stripping. **EPA/540/A5-91/002**

Applications Analysis Report-BioTrol, Inc.: Soils Washing System. **EPA/540/A5-91/003**

Applications Analysis Report - CF Systems Organics Extraction System. **EPA/540/5-90/002**

Applications Analysis Report - Terra Vac In Situ Vacuum Extraction System. **EPA/540/5-89/003**

Applications Analysis Report - NOVATerra, Inc.): In Situ Steam/Hot Air Stripping. **EPA/540/5-90/008**

Applications Analysis Report - Ultrox International Ultraviolet Ozone Treatment for Liquids. **EPA/540/A5-89/012**

Applications Analysis - Soliditech, Inc. Solidification/Stabilization Process, Morganville, NJ. **EPA/540/A5-90/005**

Cleaning Excavated Soil Using Extraction Agents: A State-of-the Art Review. **NTIS PB89-212757**

Comprehensive Report on the KPEG Process for Treating Chlorinated Wastes. **NTIS PB90-163643/AS**

Development of Electroacoustical Soil Decontamination (ESD) Process for In Situ Application. **EPA/540/5-90/004**

Engineering Bulletins:

Chemical Dehalogenation	**EPA/540/2-90/015**
Chemical Oxidation Treatment	**EPA/540/2-91/025**
Soil Washing Treatment	**EPA/540/2-90/017**
Solvent Extraction Treatment	**EPA/540/2-90/013**
In Situ Soil Flushing	**EPA/540/2-91/021**
In Situ Soil Vapor Extraction	**EPA/540/2-91/006**
In Situ Steam Extraction	**EPA/540/2-91/005**

Evaluation of BESTtm Solvent Extraction Sludge Treatment Technology 24 Hour Test. **EPA/600/S2-88/051**

Field Studies of In Situ Soil Washing. **EPA/600/S2-87/110**

Handbook-Vitrification Technology for the Treatment of Hazardous and Radioactive Waste. **EPA/540/R-92/012**

Innovative Technology: In Situ Vitrification. **OSWER Directive 9200.5-251-FS**

Radio Frequency Enhanced Decontamination of Soils Contaminated with Halogenated Hydrocarbons. **EPA/600/S2-89/008**

Soil Vapor Extraction Technology: Reference Handbook. **EPA/540/2-91/003**

State of Technology Review: Soil Vapor Extraction Systems. **NTIS PB89-195184**

Technology Evaluation Report-U.S. EPA, RREL: Debris Washing System. **EPA/540/5-91/006**

Treating Chlorinated Wastes with the KPEG Process. **EPA/600/S2-90/026**

H. Technical Support

Ground Water Research - Technical Assistance Directory. **EPA/600/9-89/048**

Hazardous Substance Research Centers Program: Program Summary, FY 1991. **21R-1005**

Innovative Hazardous Waste Treatment Technologies: A Developers Guide to Support Services. **EPA/540/2-91/012**

ORD Technical Assistance Directory. **CERI-**

ORD Topical Directory. **EPA/600/9-86/006**

OSWER Source Book for Training and Technology Transfer. **NTIS PB92-102169/AS**

Technical Support Services for Superfund Site Remediation and RCRA Corrective Action. **EPA/540/8-91/091**

U.S. Bureau of Reclamation Assistance to the Superfund Program. **OSWER Directive 9355.15FS**

Use of Office of Research and Development's Bioremediation Expertise in Superfund Removal Program. **NTIS PB-90-249798**

I. Community Relations

A Citizen's Guide To:

- *Innovative Treatment Technologies for Contaminated Soils, Sludges, Sediments, and Debris*	**EPA/542/F-92/001**
- *How Innovative Treatment Technologies Are Being Successfully Applied at Superfund sites*	**EPA/542/F-92/002**
- *Soil Washing*	**EPA/542/F-92/003**
- *Solvent Extraction*	**EPA/542/F-92/004**
- *Glycolate Dehalogenation*	**EPA/542/F-92/005**
- *Thermal Desorption*	**EPA/542/F-92/006**
- *In-Situ Soil Flushing*	**EPA/542/F-92/007**
- *Bioventing*	**EPA/542/F-92/008**
- *Using Indigenous and Exogenous Microoganisms in Bioremediation*	**EPA/542/F-92/009**
- *Air Sparging*	**EPA/542/F-92/**
- *Fact Sheet*	**EPA/542/F-92/**

Understanding Bioremediation: A Guidebook for Citizens. **EPA/540/2-91/002**

J. Bulletin Board System/Databases

Alternative Treatment Technology Information Center (ATTIC): a comprehensive automated bibliographic reference that integrates existing hazardous waste data into a unified, searchable resource. The on-line access number for ATTIC is (301) 670-3808. The system operator can be reached at (301) 670-6294.

Hazardous Waste Superfund Data Collection: a bibliobraphic data base for the EPA Headquarters Library Collection on the subject of hazardous waste available through the EPA Library Network. For more information, contact Felice Sacks, EPA Headquarters Library, (202) 260-3021.

Records of Decision System (RODS): an on-line data base which contains the full-text of Records of Decisions for Superfund hazardous waste sites. The number for RODS support staff is (202) 260-3770.

The Clean-Up Information Bulletin Board (CLU-IN): a publicly accessible, on-line computer system that fosters technology transfer and facilitates communication among those involved in solid and hazardous waste clean-up. The on-line access number for CLU-IN is (301) 589-8366. The system operator can be reached at (301) 589-8368.

Vendor Information System for Innovative Treatment Techologies (VISITT): a new data base developed by EPA to provide current information on vendors of innovative treatment technologies. For more information, contact VISITT HOTLINE at 800-245-4505 or 703-883-8848.

K. Technology Newsletters

Tech Trends (a newsletter on applied technologies for Superfund removals and remedial actions and for RCRA corrective action.

No. 7, December 1991	**EPA/540/M-91/005**
No. 8, March 1992	**EPA/540/N-92/001**

Bioremediation in the Field (a newsletter on applications of bioremediation technologies under EPA's Bioremediation Field Initiative.

No. 4 December 1991	**EPA/540/2-91/027**
No. 5 March 1992	**EPA/540/M-92/001**

L. The Federal Remediation Technologies Roundtable

Accessing Federal Data Bases for Contaminated Site Clean-Up Technologies. **EPA/540/8-91/008**

Bibliography of Federal Reports and Publications Describing Alternative and Innovative Treatment Technologies for Corrective Action and Site Remediation. **EPA/540/8-91/007**

Mission Statement. **CERI-91-56**

Synopses of Federal Demonstrations of Innovative Site Remediation Technologies. **EPA/540/8-91/009**

These Reports Can Be Obtained From:

EPA/530 (Solid Waste) RCRA Docket and Information Center	401 M ST. SW, WH-562 Washington, DC 20460 (202)260-9327
+EPA/ or CERI	Cincinnati, OH 45268 (513)569-7562
++OSWER Directives-Superfund Document Center	401 M St. SW, OS-245 Washington, DC 20460 Attn. Superfund Directives (202) 260-9760
NTIS	5285 Port Royal Rd. Springfield, VA 22161 (703) 487-4650
**Publications Available from EPA/Ada	Kay Cooper U.S. EPA, P.O. Box 1198 Ada, OK 74820 FTS 743-2354 (405) 332-8800

+There is no charge for single copies of EPA reports available through CERI.

++Non-EPA parties must obtain OSWER Directives through NTIS.

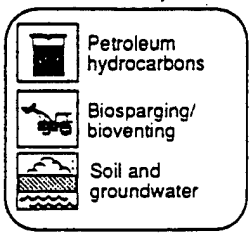
EPA
U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office

EPA/542/N-92/003 No. 9 June 1992

TECH TRENDS

The applied technologies journal for Superfund removals and remedial actions and RCRA corrective actions

In Situ Biosparging with Bioventing Cleans Both Saturated and Unsaturated Zones



by D.H. Kampbell,
R.S. Kerr Environmental Research Laboratory

The technique of biosparging combined with bioventing is being tested to remediate an aviation gasoline spill at the Coast Guard's Traverse City, Michigan, site. EPA's Robert S. Kerr Environmental Research Laboratory has already found that bioventing (injecting air into the unsaturated zone above the water table) and biosparging (injecting air into the saturated zone below the water table) promote biodegradation of petroleum hydrocarbons (TPH). The purpose of air injection is to volatilize the contaminants into a soil gas stream in both saturated and unsaturated subsurface zones so that the contaminants will be more readily biodegraded by aerobic microorganisms in the soil. This *in situ* method should perform better and should be more cost effective than above-ground soil removal treatment or groundwater pump-and-treat methods. Further, the system produces little or no air emissions of hydrocarbon contaminants.

Prior to the pilot demonstrations at Traverse City, laboratory treatability studies were performed using surface soil from the spill site. The studies demonstrated that bioremediation from venting and sparging would be feasible for this site. For the actual pilot demonstration, grass was planted on a 75' x 90' rectangular area over the plume of contamination. Next, a nutrient solution was applied for dispersion throughout the unsaturated subsurface to support enhanced microbial activity. For the bioventing part of the demonstration, two blowers in a nearby building were connected to aeration transfer piping and to screened air injection wells with adjustable depths to force air flow into the unsaturated zone just above the water table. Blower rates in the injection

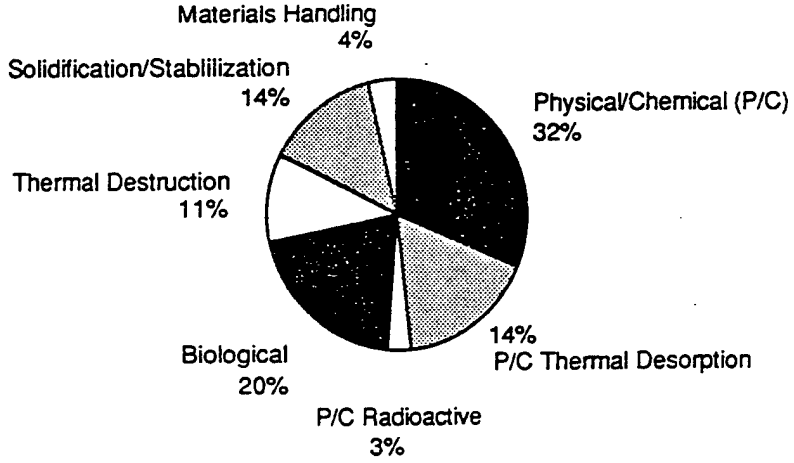
(see Biosparging page 2)

Summer SITEs

We are doing something new in this issue of *Tech Trends*. Usually we only tell you about Superfund Innovative Technology Evaluation (SITE) demonstrations *after* they happen and results are available. In this issue, we let you know about upcoming SITE demonstrations you can visit this summer. See page 3 for details.

Also, the ATTIC Database now contains all pre- and post-demonstration information from 76 SITE Demonstration Program Projects. See adjacent pie chart.

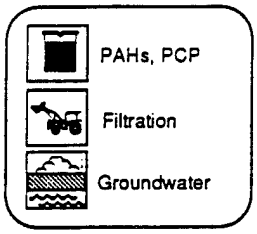
SITE Demo Program Technologies in ATTIC



76 technologies reported. Source documents include Demonstration Bulletins, Technology Profiles, Technology Evaluation Reports, and Applications Analysis Reports.

SBP Membrane Filtration Reduces Groundwater Contaminants

by Kim Kreiton,
Risk Reduction Engineering Laboratory



EPA's Superfund Innovative Technology Evaluation (SITE) Program demonstrated a membrane microfiltration process that effectively separates contaminants and concentrates them into a smaller volume of groundwater prior to treatment. The SBP Technologies, Inc., membrane technology was tested in Pensacola, Florida, at the American Creosote Works Site, where wood preserving wastes such as polyaromatic hydrocarbons (PAH) and pentachlorophenol (PCP) had seeped from capped former waste lagoons into an aquifer.

The membrane filtration unit consists of two stainless steel tubes. The outer tube acts as a shell that houses the second porous stainless steel tube. There is a space between the two tubes. On the inside of the inner tube a membrane forms and is continuously regenerated from the recirculation of an aqueous slurry of membrane formation chemicals. When feedwater enters the inner tube, the membrane functions as a hyperfiltration unit. It retains contaminants with molecular weights of 200 and higher, while allowing a large portion of the water and the chemical species that have a lower molecular weight to pass through the membrane walls where they are collected in the space between the inner and outer tubes. The heavier contaminants that cannot pass through the membrane wall are collected in a holding tank for subsequent treatment. The volume of water containing these heavier contaminants is significantly less than the initial volume of water fed into the filtration tube, since much of the water passed through the membrane into the space between the inner and outer tubes. The permeated water can be disposed of in a manner consistent with local permitting requirements. The cost of treating the reduced volume of water with the greater concentration of heavier contaminants is less than that of treating the original volume of waste water.

For the SITE demonstration, the filtration unit operated for six days. Each day, approximately 1,000 gallons of feedwater were run through the unit during a two-hour period. The concentrated contaminant water was recycled until the desired volume reduction was achieved. Average PAH concentrations in the feedwater were approximately 47 milligrams per liter (mg/L) and average PCP concentrations were 2.4 mg/L. The system concentrated the feedwater to 20% of the original volume. This contained 80% of original contaminants which represents approximately 30% of the phenolic compounds and greater than 95% of the PAHs.

Based on the SITE demonstration, the SBP system appears effective in concentrating waste streams rich in PAHs but probably would not be suitable for phenols. The system can be customized for a wide range of contaminants—for example, waste streams containing high molecular weight or non-polar organic contaminants such as polychlorinated biphenyls. The process may also be useful for separating other emulsified or dispersed organics that do not lend themselves to simple physical phase separation.

An Applications Analysis Report and a Technology Evaluation Report describing the complete SBP SITE demonstration will be available in the Fall of 1992. For more information now, and to get on the mailing list for the Report, call Kim Kreiton at the Risk Reduction Engineering Laboratory in Cincinnati, Ohio, at 513-569-7328.

Biosparging

(from page 1)

wells were adjusted to five cubic feet per minute. This low blower rate created a long air stream retention time of 24 hours so that microbes would have a chance to mineralize the pollutants. The injected air volatilized the contaminants into soil gas components. After air injection began, TPH soil gas levels were near 5,000 mg/L in the plot area. Venting and subsequent biodegradation eventually reduced soil gas levels to less than 50 mg/L.

After completion of bioventing, biosparging was started at the pilot demonstration. Aeration injection points were inserted in the saturated zone of the plot area to a depth of about ten feet below the water table. The same blower injection system that was used for the bioventing was used. The injected air removed water soluble hydrocarbons trapped in the soil capillaries and groundwater by vaporizing the contaminants as the air bubbled up through the groundwater. The contaminants, now in a vapor phase, were then further aerated upward into the unsaturated zone. Here they were biodegraded by the bioventing process described above.

The pilot demonstration showed that biosparging was effective in removing the water-solubilized hydrocarbons in the groundwater. For example, after biosparging began, soil gas contaminant concentrations in the unsaturated zone increased from 20 mg/L to 6,000 mg/L for volatile TPHs. Final benzene levels in the underlying groundwater near the water table were less than 5 micrograms per liter (µg/L) compared to initial concentrations of 133 µg/L.

We already know that biosparging can remove water-dissolved phase fuel in the groundwater. However, when fuel globules are entrapped in capillary matrices, the capillaries act as a physical barrier that hinders or prevents the injected air from transforming the fuel into vapors. The full effectiveness of sparging is being evaluated by collection and analysis of vertical profile core samples at different times. Final results should be available by September, 1992.

For more information, call Don Kampbell at the Robert S. Kerr Environmental Research Laboratory in Ada, Oklahoma, at 405-332-8800.

Upcoming SITE Demos

Several Superfund Innovative Technology Evaluation (SITE) program demonstrations are planned for this summer. Below is a brief description of the technologies to be demonstrated, the name of the developers and the EPA contacts to call for more information and visitor days.

Dechlorination

Region 1

Chemical Waste Management's (CWM) DeChlor/KGME process involves the dechlorination of liquid-phase halogenated compounds, particularly polychlorinated biphenyls (PCB). KGME, a CWM proprietary reagent, is the active ingredient in a nucleophilic substitution reaction in which the chlorine atoms on the halogenated compounds are replaced with fragments of the reagent. The products of the reaction are a substituted aromatic compound (no longer a PCB aroclor) and an inorganic chloride salt. For more information, contact Reinaldo Matias at 513-569-7149.

Thermal Gas Phase Reduction

Region 5

A patented process from ELI EcoLogic International, Inc., is based on the gas-phase, thermochemical reaction of hydrogen with organic and chlorinated organic compounds at elevated temperatures. At 850 degrees Celsius or higher, hydrogen reacts with organic compounds to produce smaller, lighter hydrocarbons. This reaction is enhanced by the presence of water, which can also act as a reducing agent. Because hydrogen is used to produce a reducing atmosphere devoid of free oxygen, the possibility of dioxin or furan formation is eliminated. Visitor days are projected for the week of September 8, 1992. For more information, call Gordon Evans at 513-569-7684.

In Situ Biotreatment

Region 5

The geolock and bio-drain treatment platform from International Environmental Technology is a bioremediation system that is installed in the soil or waste matrix. The technology can be adapted to soil characteristics, contaminant concentrations and geologic formations in the area. The system is composed of an *in situ* tank, an application system and a bottom water recovery system. All types and concentrations of biodegradable contaminants can be treated by this system. Through direct degradation or co-metabolism, microorganisms can degrade most organic substances. Visitor days are projected for August 1992. For more information, call Randy Parker at 513-569-7271.

Solvent Extraction

Region 1

A soil restoration unit from Terra-Kleen Corporation is a mobile solvent extraction remediation device for the on-site removal of organic contaminants from soil. Extraction of soil contaminants is performed with a mixture of organic solvents in a closed loop, counter-current process that recycles all solvents. Terra-Kleen Corporation uses a combination of up to 14 solvents, each of which can dissolve specific contaminants in the soil and can mix freely with water. None of the solvents is a listed hazardous waste, and the most commonly used solvents are approved by the Food and Drug Administration as food additives for human consumption. The solvents are typically heated to efficiently strip the contaminants from the soil. For more information, call Mark Meckes at 513-569-7348.

Solvent Extraction

Region 5

The BEST Solvent Extraction process from Resources Conservation Company is a mobile solvent extraction system that uses one or more secondary or tertiary amines [usually triethylamine (TEA)] to separate organics from soils and sludges. The BEST technology is based on the fact that TEA is completely soluble in water at temperatures below 20 degrees Celsius. For more information, call Mark Meckes at 513-569-7348.

Thermal Desorption

Region 5

The Soil Tech anaerobic thermal desorption processor heats and mixes contaminated soils, sludges and liquids in a special rotary kiln that desorbs, collects and recondenses hydrocarbons from solids. The unit can also be used in conjunction with a dehalogenation process to destroy halogenated hydrocarbons through a thermal and chemical process. For more information, call Paul dePercin at 513-569-7797.

Soil Washing

Region 10

The soil washing system from BESCORP is a gravity separation system to treat lead-contaminated soils. The advantage of the system is that it is a very simple system derived from mining technology. It is assumed that solubilized lead will partition to fine fraction and that using a density separation system will remove the dense metallic lead. For more information, call Hugh Masters at 908-321-6678.

*U.S. Government Printing Office: 1992 — 650-653

ATTIC

Out of the ATTIC

Finding Cleanup Alternatives for TCE and PCE

If you are looking for alternatives for cleaning up a site containing soil and groundwater contaminated with trichloroethylene (TCE) and perchloroethylene (PCE), you should consider calling the Alternative Treatment Technology Information Center (ATTIC) database.

If you search the ATTIC database using the key word "soil" you will find over 750 reports. You could narrow this list by performing a free-text search of the Summary Paragraphs for "TCE" and "PCE". If you decide to omit the Records of Decisions you will find 31 reports on technologies such as biodegradation, *in situ* soil venting, radio frequency enhancement, vacuum extraction, low-temperature thermal technology, granular activated carbon, soil washing, ultraviolet oxidation and incineration. One document that might catch your eye is "Treatment Technologies for Hazardous Waste Part II: Alternative Techniques for Solvent Wastes." Another document is from the Superfund Innovative Technology Evaluation program and is called "AWD Technologies, Inc. Integrated Vapor Extraction and Steam Stripping." This second report describes a system that simultaneously treats groundwater and soil contaminated with volatile organic compounds (VOCs). The technology can effectively remove over 90 of the 110 volatile compounds listed in 40 CFR Part 261, Appendix VIII. Removal efficiencies were as high as 99.99% for VOCs in groundwater and 99.9% for VOCs in soil gas. [Note: This AWD technology was previously featured in the March 1991 issue of *Tech Trends*.]

From the Bulletins section of the ATTIC system, you can download a complete text of an EPA engineering bulletin on *in situ* soil vapor extraction, a report of a demonstration of the steam injection technology in Huntington Beach, California, and an EPA engineering bulletin on granular activated carbon treatment. You can also download a technology update from EPA's Center Hill Research Facility in Cincinnati, Ohio, that describes advantages of using hydrofracturing to increase the surface area in extraction wells.

By searching ATTIC's Risk Reduction Engineering Laboratory Treatability Database for TCE and PCE, you can find information on: chemical and physical properties; environmental data including risk estimates for carcinogens and water quality criteria; and performance data of water treatment technologies, such as activated sludge, chemical assisted clarification, air stripping, trickle filtration, chemical oxidation, granular activated carbon, reverse osmosis, ultraviolet radiation and packed activated carbon.

ATTIC provides the names and phone numbers of several EPA personnel that could be contacted for more information on the technologies. There is no charge for accessing, searching or downloading information from the ATTIC system. Information on the ATTIC system is available from the system operator at 301-670-6294 or from Joyce Perdek of EPA's Risk Reduction Engineering Laboratory at 908-321-4380.

To order additional copies of this or previous issues of *Tech Trends*, call the publications unit at CERI at (513) 569-7562 and refer to the document number on the cover of the issue. **To be included on the permanent mailing list** for *Tech Trends*, call (703) 308-8800.

Tech Trends welcomes readers' comments and contributions. Address correspondence to:
Managing Editor, *Tech Trends* (OS-110W), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, DC 20460.

EPA

United States
Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office (OS-110W)
Washington, DC 20460

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EPA/542/N-92/003

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BIBLIOGRAPHIC INFORMATION ON
ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT
EMERGING TECHNOLOGIES

1. **Innovative Treatment Technologies: Semi-Annual Status Report (Third Edition), U.S. EPA Office of Solid Waste and Emergency Response, EPA/540/2-91/001 April, 1992.**

This twice-yearly report documents and analyzes the selection and use of innovative treatment technologies in the Superfund Program. The purpose of the report is to allow better communication between experienced technology users and those who are considering innovative technologies to clean up contaminated sites. In addition, the information will enable technology vendors to evaluate the market for innovative technologies in Superfund over the next several years and will be used by EPA's Technology Innovative Office to track progress in the application of innovative treatment.

This report documents the use of the following innovative treatment technologies to treat groundwater, soils, sediments, sludge, and solid-matrix wastes:

- Ex situ bioremediation
- Chemical treatment
- In situ flushing
- Soil washing
- Thermal desorption
- Air sparging
- In situ bioremediation
- Dechlorination
- In situ vitrification
- Solvent extraction
- Soil vapor extraction
- Contained recovery of oily wastes

The document includes information on 210 applications of innovative treatment technologies for remedial actions and 18 applications for emergency response actions. It contains several summary lists of the Superfund sites for which innovative treatment technologies have been selected or used, including sites by EPA region, and sites by type of innovative technology and status of application of the innovative treatment technology. The principal part of the document contains detailed, site-specific information for sites where innovative treatment has been selected. Performance and operating data on 21 remedial and removal innovative projects that have been completed is also summarized. Information was collected through analyses of Records of Decision, review of OSWER tracking systems and telephone interviews with EPA regional staff.

2. **Synopses of Federal Demonstrations of Innovative Site Remediation Technologies, Prepared by the Member Agencies of the Federal Remediation Technologies Roundtable, EPA/540/8-91/009, May 1991.**

This report is a collection of abstracts compiled by the Federal Remediation Technology Roundtable describing field demonstrations of innovative technologies to treat hazardous waste. The collection is intended to be an information resource for hazardous waste site project managers for assessing the availability and viability of innovative technologies for treating contaminated ground water, soils, and sludge. It is also intended to assist government agencies coordinate ongoing hazardous waste remediation technology research initiatives, particularly those sponsored by EPA, DOD, and DOE.

The demonstrations described in this report have all been sponsored by EPA, DOD, or DOE. In total, 75 different demonstrations in seven different technology categories are described. The seven technology categories are bioremediation, chemical treatment, thermal treatment, vapor extraction, soil washing, solidification/stabilization, other physical treatment. The report contains a matrix listing these demonstrations, the type of contaminant, media that can be treated, and the treatment setting for each innovative technology.

3. **Accessing Federal Data Bases for Contaminated Site Clean-Up Technologies, Prepared by the Member Agencies of the Federal Remediation Technologies Roundtable, EPA/540/8-91/008, May 1991.**

This publication provides information on accessing Federal data bases for innovative remediation technologies. The data base profiles contained in this document were identified through a review of Agency reports, articles, and publications; as well as a through telephone interviews with data base experts. This document is intended to be a reference tool that provides information on those systems maintaining data on remedial technologies.

This document contains profiles for three types of data systems: technology data bases, expert systems, and bulletin boards. The technology data bases provide bibliographical and technical information on the uses of various remedial action technologies, including innovative technologies. The expert systems aid decision-makers in selecting remedial action alternatives. Those listed in this document incorporate modules which provide the user with information on how to access Agency technology transfer systems, relevant conferences, seminars; they also have the capability to provide or display information on remedial technologies.

4. **Bibliography of Federal Reports and Publications Describing Alternative and Innovative Treatment Technologies For Corrective Action and Site Remediation, Prepared by the Member Agencies of the Federal Remediation Technologies Roundtable, EPA/540/8-91/007, May 1991.**

This document is intended to publicize the accessibility of Federal documents pertaining to innovative and alternative technologies to treat hazardous wastes. The bibliography contains references for documents and reports from EPA, the U.S. Army, the U.S. Army Corps of Engineers, the U.S. Navy, the U.S. Air Force, DOE, DOI, and the Bureau of Reclamation.

This bibliography addresses technologies which provide for the treatment of hazardous wastes. It does not contain information or references for containment or other non-treatment strategies, such as landfilling or capping. The main focus of the bibliography is on innovative technologies for which detailed cost and performance data are not available.

This bibliography is broken into the following nine topic areas:

- International Surveys and Conferences,
- Technology Survey Reports,
- Treatability Studies,
- Thermal Processes,
- Solidification/Stabilization,
- Biological,
- Physical/Chemical,
- Data Bases, and
- Document Sources.

5. **The Superfund Innovative Technology Evaluation Program: Technology Profiles, Fourth Edition, Prepared by the EPA Office of Solid Waste and Emergency Response, EPA/540/5-91/008, November 1991.**

This document profiles 129 demonstration, emerging, and monitoring and measurement technologies under evaluation by the Superfund Innovative Technology Evaluation (SITE) Program. Each technology profile contains a description of the technology, a discussion of its applicability to various wastes, an update on its development or demonstration status, any available demonstration results, and demonstration and technology contacts.

6. **The Superfund Innovative Technology Evaluation Program: Spring Update to the Technology Profiles, Fourth Edition, Prepared by the EPA Office of Solid Waste and Emergency Response, EPA/540/R-92/012, April, 1992.**

This update bulletin highlights progress and significant developments in the Superfund Innovative Technology Evaluation (SITE) Program, focusing on new technologies developed or demonstrated since the publication of bibliographic item 5 above.

7. **Innovative Treatment Technologies: Overview and Guide to Information Sources, Prepared by EPA's Office of Solid Waste and Emergency Response, EPA/540/9-91/002, October, 1991.**

This document is a compilation of information on innovative treatment technologies now being used in the Superfund program. It provides a broad overview of innovative treatment technologies to assist site managers in their initial evaluation of innovative treatment technologies, primarily those that treat organic contamination. The technologies discussed include the following.

- incineration
- soil washing
- dechlorination
- vacuum extraction
- ground water treatment
- thermal desorption
- solvent extraction
- bioremediation
- in situ vitrification

8. **Preliminary Draft Directory of Federal Agencies and Universities Research Centers Conducting R&D in Environmental Restoration and Waste Management, prepared by PAR Enterprises Incorporated and Applied Research Company, September 1991.**

The directory provides a reference and information base of Federal agency and university capabilities in the areas of environmental restoration and waste management research and development that can be used to help meet technology transfer and joint demonstration goals and objectives. This document contains matrices matching technical requirements with Federal agency and university research center capabilities and profiles of Federal agency and university environmental restoration and waste management research and development activities.

9. **Fiscal year 1991 Annual Report to Congress, U.S. DOE Office of Environmental Restoration and Waste Management Office of Technology Development, 1992.**

The National Defense Authorization Act for Fiscal Years 1990-1991 (Public Law 101-189) directed the Department of Energy to submit an Annual Report to Congress on research and development activities focusing on the reduction of environmental hazards and contamination resulting from defense waste, and environmental restoration of inactive defense waste disposal sites. This document complies with that requirement, describing the Department's EM technology development Fiscal Year 1991 activities and their practical applications in groundwater and soils cleanup, waste retrieval and waste processing, waste minimization and waste avoidance, and various supporting technologies and infrastructure programs.

10. **Navy Shoreside Environmental RDT&E Newsletter, Department of the Navy, Naval Facilities Engineering Command, Alexandria, Virginia, first issue July, 1992.**

A quarterly publication, this newsletter updates work that is underway at different Navy laboratories. It is intended to assist in compliance and provide useful and timely information for the innovative solution to a wide variety of environmental problems.

11. **NTIS 1992 Catalog of Products and Services, U.S. Department of Commerce, National Technical Information Service, 1992.**

This catalog contains information on access and contents for newsletters, reports, computerized data, bibliographies, and other government information products. "Environment" is one of the key topic areas covered, and particular attention is paid to remediation and waste management information.

WASTECH '92

A Cooperative Program Advancing the Use of Innovative Waste Treatment Technologies

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Annapolis, Maryland 21401
410-266-3311
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PROJECT PROFILE

WASTECH '92 is a cooperative project conducted by and for engineers and scientists and for the user community. The project seeks to further the application of innovative waste treatment technologies whose development is sufficiently advanced to warrant use. To this end, Project participants, technical and professional societies, individual engineers and scientists, and the waste management community at large will develop consensus-based monographs identifying the benefits, limitations, design criteria, and relative economic viability of selected innovative technologies.

Organization

The Project originated primarily from the substantial expenditures USEPA has made and continues to make to develop innovative methods for remediation of hazardous waste sites and contaminated soils and groundwater. The agency believes that several technologies offer improved performance and cost savings over traditional methods. To help foster use of these technologies, WASTECH '92 will develop eight authoritative, consensus-based monographs in the following general areas:

Bioremediation
Chemical Destruction
Chemical Extraction
Soil Washing/Flushing
Solidification/Stabilization
Thermal Desorption
Thermal Destruction
Vacuum/Vapor Extraction

This project is funded by the United States Environmental Protection Agency, Department of Defense, and Department of Energy and is being managed by the American Academy of Environmental Engineers operating under the direction of a Steering Committee chaired by Frederick G. Pohland, Ph.D., P.E., DEE, President-Elect of the Academy. The Steering Committee is composed of nationally recognized waste treatment experts who are also leaders in professional societies and associations with a strong professional interest in waste management including the Air and Waste Management Association, American Institute of Chemical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, Hazardous Waste Action Coalition, National Water Well Association, Society for Industrial Microbiology, and Water Environment Federation. The Project, representing a significant professional challenge and opportunity, has engendered exceptional interest and enthusiasm among all the early participants.

(over, please)

February 1, 1992

MANAGED BY THE AMERICAN ACADEMY OF ENVIRONMENTAL ENGINEERS

Appendix L

Project Methodology

The Steering Committee devoted considerable time and effort to planning the Project, selecting the technologies to be documented, and identifying experts to draft the monographs. The experts make up Task Groups, generally of five members, that will draft monographs on the selected technologies. The composition of each Task Group is designed to balance the interests of the various groups involved in waste treatment and site remediation -- industry, consultants, research, academe, and government. The Task Groups have access to a comprehensive data base compiled by EPA which will be supplemented from other sources. In addition, they may call upon other experts for their voluntary suggestions and contributions.

The development process will be fully public. A two-stage review will elicit comments by organizations and members of the professional community at large to ensure that the finished monographs represent a consensus on the state of the art of the selected technologies. Following the Steering Committee's review of the Task Groups' manuscripts, review and acceptance by professional and technical organizations having substantial interest and competence relating to the technologies addressed will be sought.

Schedule

The Project began in July 1991, and delivery of the completed monographs is scheduled for September 1993. The Project is being conducted in three phases. The first phase was dedicated to planning and organization. The second phase is devoted to preparation of the monographs and completing a two-stage peer review. The third phase consists of distribution of the completed work to practicing engineers and users; making revisions to incorporate continuing technological advances; and developing additional monographs as new technologies arise.

Summary

Remediation of hazardous waste sites and treatment of contaminated soils and groundwater is a major national problem of which the public is keenly aware. The public broadly perceives, as well, that remedies depend largely upon the efforts of engineers and scientists. The cleanup, then, is not merely one of the many problems facing our country in which engineers and scientists must take the lead, but it is also one in which their role in finding a solution is particularly visible.

Therefore, WASTECH '92 presents the professional community both a significant challenge and an opportunity. The challenge lies in the demanding task of forging truly consensus-based monographs that effectively identify the benefits, costs, limitations, and design criteria for the selected innovative technologies. The opportunity lies in the chance to seize the lead in providing better, more cost effective remediation of hazardous wastes sites and soil and groundwater contamination.

GENERIC CENTER RESEARCH PROGRAM

Research grants are concentrated in six generic mineral technology areas of broad applicability across the minerals industry. Each generic area has one lead institution that coordinates research activities in the area, provides for an annual seminar, and operates a reference center that disseminates research results relating to its particular area of research expertise.

Generic Area	Lead Institutions	Affiliates
Mine Systems Design and Ground Control	Virginia Polytechnic Institute and State University	University of Alabama Colorado School of Mines University of Idaho Southern Illinois University University of Kentucky Michigan Technological University University of Missouri-Rolla University of Nevada-Reno University of Utah West Virginia University
Comminution	University of Utah	University of California-Berkeley University of Minnesota Michigan Technological University University of Nevada-Reno Virginia Polytechnic Institute
Mineral Industry Waste Treatment and Recovery	University of Nevada-Reno	University of Arizona University of California-Berkeley Colorado School of Mines Purdue University Michigan Technological University University of Missouri-Rolla Columbia University University of Oklahoma University of Utah

Pyrometallurgy	University of Missouri-Rolla	University of Arizona Colorado School of Mines University of Idaho Purdue University University of Kentucky Columbia University Ohio State University University of Utah
Respirable Dust	Pennsylvania State University	University of Minnesota Massachusetts Institute of Technology Michigan Technological University West Virginia University
Marine Minerals Technology	University of Mississippi	Louisiana State University The following institutions that are not mineral institutes are affiliated with this generic center: University of Hawaii University of Georgia University of Michigan Rice University

Tuscaloosa Research Center (TURC)
University of Alabama Campus
P.O. Box L
Tuscaloosa, Alabama 35486-9777
Phone: (205) 759-9421

- Fine Particle and Waste Technology
  - Separation Science
  - Process Kinetics
  - Leaching and Process Control
  - Environmental Technology
- Advanced Ceramics Material
  - Powder Processing
  - Severe Service Applications
  - Composite Structure and Properties

Alaska Field Operations Center (AFOC)
201 E. 9th Ave., Suite 101
Anchorage, Alaska 99501-3689
Phone: (907) 868-2454

- Mineral Resource Assessments
- Resource Evaluations
- Engineering and Economic Analysis

Denver Research Center (DRC)
P.O. Box 25086
Building 20, Denver Federal Center
Denver, Colorado 80225-0086
Phone: (303) 236-0697

- Advanced Mine Systems
  - System Analysis
  - Mine Design
- Ground control
  - Rock Mechanics
  - Mine Structure Design
  - Hazard Detection and Evaluation
- Geotechnology
  - Geophysics
  - Mine Supports

Intermountain Field Operations Center (IFOC)
P.O. Box 25086
Building 20, Denver Federal Center
Denver, Colorado 80225

Twin Cities Research Center (TCRC)
5629 Minnehaha Avenue South
Minneapolis, Minnesota 55417-3099
Phone: (612) 725-4610

- Rock Mass Behavior
  - Blasting Research
  - Geotechnology
  - Subsidence Research
- Advanced Mining
  - In Situ Systems
  - Geochemical/Hydraulic
  - Geomineralogy/Chemistry
- Safety Research
  - Mine Equipment
  - Mine Fires
  - Human Factors
- Fragmentation
  - Rock Fragmentation
  - Novel Fragmentation
- Health Research
  - Diesel Research
  - Dust/Aerosol Technology
  - Coal Cutting Technology

Rolla Research Center (RORC)
P.O. Box 280
1300 Bishop Avenue
Rolla, Missouri 65041-0280

- Alternative Processing
  - Metal Joining
  - Electrolysis
- Chemical Metallurgy
  - Pyrometallurgy
  - Membrane Technology
- Resource Processing
  - Mineral Dressing
  - Electrochemistry

Reno Research Center (RERC)
1605 Evans Avenue
Reno, Nevada 89512-2295
Phone: (702) 784-5261

- Hydrometallurgy
  - Leaching Platinum Group Metals
  - Automobile Shredder Fluff
  - Graphite Recovery
  - Molten and Aqueous Electrolysis
  - Molten Metal Theory
- Analytical Services
  - Mineral Analysis
  - Environmental Analysis
  - Precious Metals Analysis
- Chemical Processes
  - Zeolite
  - Bioleaching
  - Heap Leaching
- Metallurgical Processing
  - Chemical Leaching
  - Microwave Technology
  - Pyrometallurgical Reduction
  - In Situ Leaching

Albany Research Center (ALRC)
1450 Queen Avenue, S.W.
Albany, Oregon 97321-2198
Phone: (503) 967-5893

- Materials Science
  - Wears Technology
  - Corrosion Science
  - Advanced Materials
  - Composite Materials - Intermetallics
  - Rapidly Solidified Alloys
  - Fabrication and Physical Characterization
- Mineral Engineering
  - Secondary Resource Assessment/Recovery
  - Process Mineralogy
  - Environmental Technology
  - Extraction Technology
- Metallurgical Chemistry
  - Extraction Metallurgy
  - Basic Process Development
  - Advanced Nonoxide Powders
  - Corrosion-Resistant Concrete Powders

Pyrometallurgy
- Electric Furnace Steelmaking
- Casting Technology
- Ferroalloy Prereduction and Smelting
- Nonferrous Smelting/Resmelting/Refining

Analytical
- Elemental Analysis
- Microanalysis
- Characterization
- Phase or Compound Identification

Pittsburgh Research Center (PRC)
Cochrans Mill Road
P.O. Box 18070
Pittsburgh, Pennsylvania 15236-0070
Phone: (412) 892-6601

Theoretical Support
- Computer Software
- Computer Hardware
- Communications

Explosives
- Characterization
- Evaluation
- Detonation Fundamentals
- Safety Analysis

Fire and Explosions
- Detection
- Propagation
- Extinguishment
- Control

Environmental Technology
- Acid Mine Drainage
- Abandoned Mine Fire Control

Dust Control and Ventilation
- Dust Control
- Ventilation
- Water-Jet-Assisted Cutting

Electrical and Electronic Systems
- Electrical
- Instrumentation
- Automation/Robotics

Mining Systems and Human Engineering
- Education and Training
- Human Factor/Biomechanics
- Noise
- Life Support
- Haulage
- Hoisting
- Equipment

Ground and Methane Control
- Geological Assessments
- Geotechnical Engineering
- Subsidence Engineering
- Methane Drainage

Salt Lake City Research Center
729 Arapeen Drive
Salt Lake City, Utah 84108-1283
Phone: (801) 524-6100

Analytical Chemistry
- Chemical Unit
- Physical Unit

Chemical Processes
- Biohydrometallurgy
- Chemical Metallurgy

Metallurgical Processes
- Flotation Fundamentals
- Flotation Applications

Minerals Engineering
- Strategic Metals
- Advanced Materials
- Precious Metals

Spokane Research Center (SRC)
E. 315 Montgomery Avenue
Spokane, Washington 99207-2291
Phone: (509) 484-1610

Mine Geotechnical Engineering
- Solid Waste Management
- Mine Geotechnical Analysis

Ground Control
- Ground Support System
- Support Rock Interaction Mechanics

Mine Development
- Metal-Nonmetal Underground Mining
- Underground Industrial Hazards

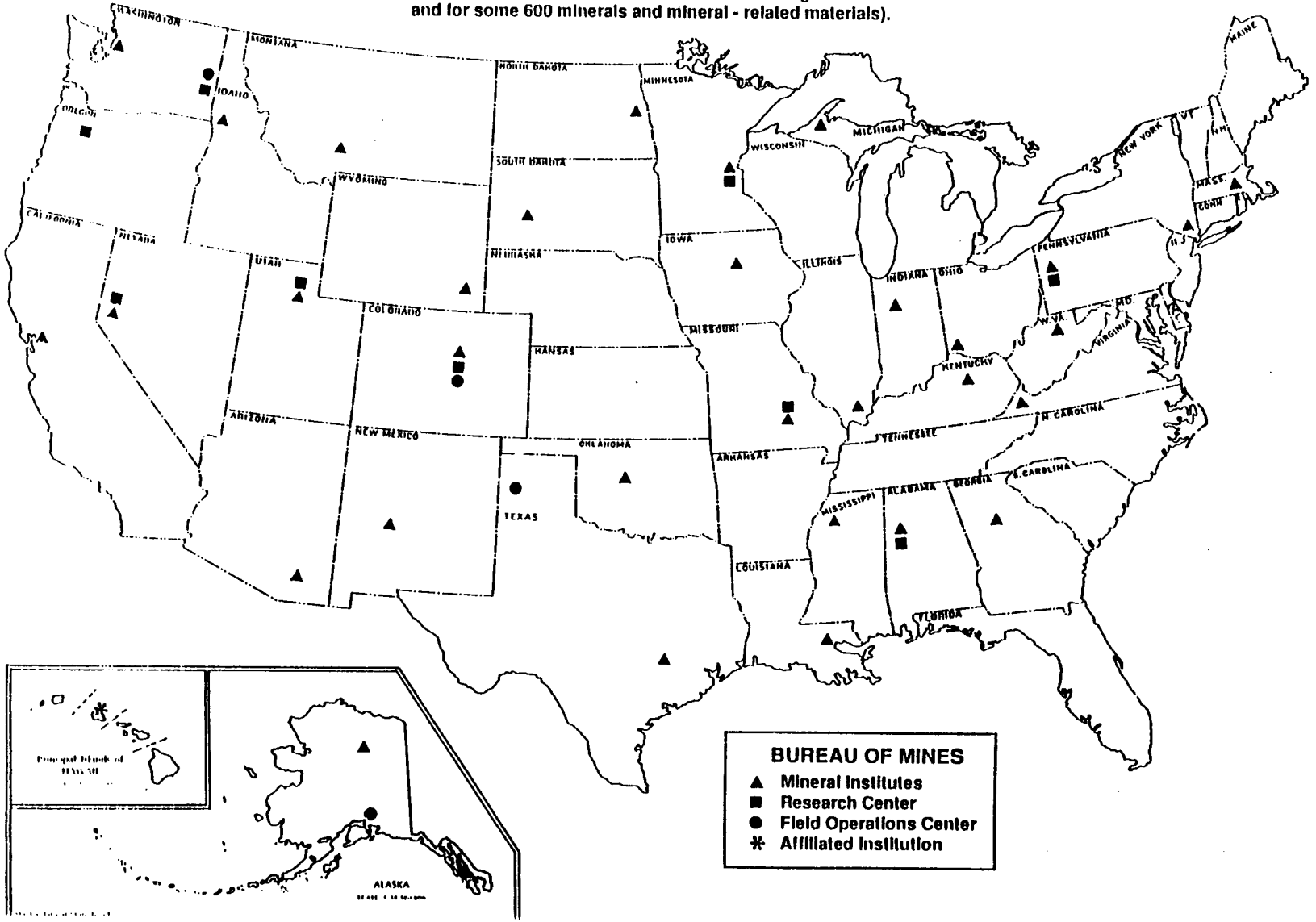
Western Field Operations Center (WFOC)
E. 360 Third Avenue
Spokane, Washington 99202-1413
Phone: (509) 353-2712

Resource Evaluation
- Mineral Land Assessment

Engineering and Economic Analysis
- Minerals Availability
- Inventory of Land Use Restraints
- Environmental Impact Statements
- Ocean Minerals Assessment
- Mineral Land Assessment

BUREAU OF MINES FIELD FACILITIES

(The Bureau of Mines also maintains staff expertise for mineral activities in all 50 states in the U. S. and 168 foreign countries and for some 600 minerals and mineral - related materials).



6-M

United States Environmental Protection Agency | Office of Solid Waste and Emergency Response | Office of Research and Development | EPA/540/F-93/XXXPS May 1991

Superfund Innovative Technology Evaluation Program

SITE Program Fact Sheet

SITE PROGRAM OVERVIEW

The Superfund Innovative Technology Evaluation (SITE) program supports development of technologies for assessing and treating waste from Superfund sites. The SITE program was authorized by the Superfund Amendments and Reauthorization Act of 1986 with the goal of identifying technologies, other than land disposal, that are suitable for treating Superfund wastes. The program provides an opportunity for technology developers to demonstrate their technologies' capability to successfully process and remediate Superfund waste. EPA evaluates the technology and provides an assessment of potential for future use for Superfund cleanup actions. The SITE program has currently evaluated and/or supported RD and D efforts for more than 100 innovative treatment technologies. The SITE program is administered by EPA's Risk Reduction Engineering Laboratory (RREL) in Cincinnati, Ohio.

This fact sheet describes the four components of the SITE Program with particular emphasis on the Demonstration Program, which conducts evaluation demonstrations of operating alternative technologies. This page of the fact sheet summarizes the overall SITE Program. Subsequent pages provide additional detail about each program component. This fact sheet also contains a list of contacts for further information, and an order form for technology transfer publications and videos.

COMPONENTS OF THE SITE PROGRAM

The SITE program integrates four related components, the Demonstration Program, the Emerging Technologies Program, the Measurement and Monitoring Technologies Program, and the Technology Transfer Program.

DEMONSTRATION PROGRAM

The Demonstration Program provides engineering, cost, reliability, and applicability data on new Superfund remediation technologies by sponsoring field demonstrations of pilot or full-scale technologies. Technology developers demonstrate their methods on selected wastes, and EPA analyzes, evaluates and disseminates the test results. Typically, no funding is made available to the developer during this process. Figure 1 illustrates the categories of technologies currently enrolled in the Demonstration Program.

Innovative Technologies Program

This supplement to the Demonstration Program was established to encourage private sector development and commercialization of EPA-developed hazardous waste treatment technologies for use at Superfund sites. The Federal Technology Transfer Act of 1986 authorized the EPA/industry partnership that is necessary to bring these technologies to commercialization. This will enable EPA laboratories to collaborate with industry, thus facilitating development of the technologies and reducing the market risk.

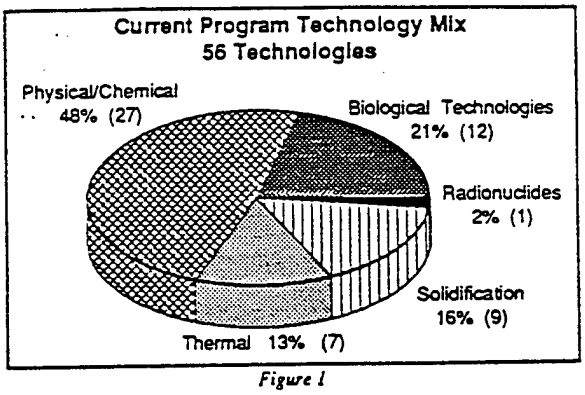


Figure 1

EMERGING TECHNOLOGIES PROGRAM

The Emerging Technologies Program (ETP) supports the development of new, innovative technologies by following laboratory and bench-scale technologies through pilot-scale testing. The ETP provides up to two years of financial assistance to private developers for technology research and development through cooperative agreements.

MEASUREMENT AND MONITORING TECHNOLOGIES PROGRAM

The Measurement and Monitoring Technologies Program (MMTP) is designed to improve the accuracy of Superfund site characterization efforts. The MMTP tests the ability of advanced technologies to assess the nature and extent of contamination, and evaluate cleanup levels. Funding is generally not provided to developers under this program.

TECHNOLOGY TRANSFER

The Technology Transfer portion of the SITE program disseminates information from the other three programs to increase awareness and use of alternative technologies for assessing and remediating Superfund sites. Technology transfer occurs through reports, brochures, videos, seminars, public meetings and site visits, conference exhibits, and technical support to EPA Regions, States, and Superfund contractors.

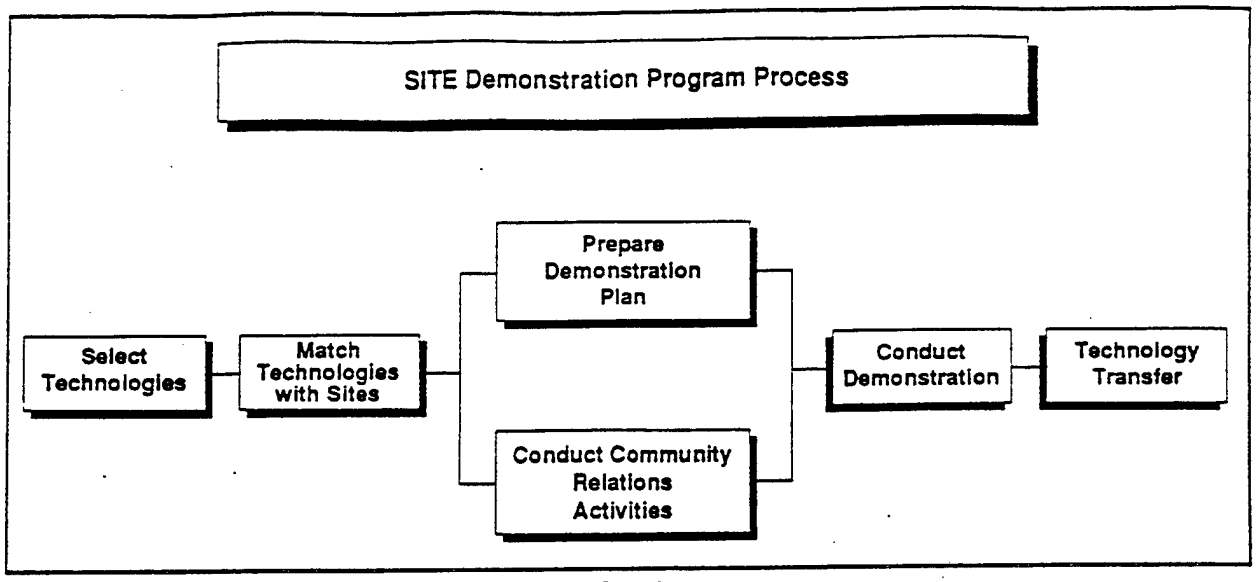


Figure 2

DEMONSTRATION PROGRAM PROCESS

The Demonstration Program selects technologies and conducts field demonstrations through the process illustrated in Figure 2. Each step in the process is discussed below.

Select Technologies: In January of each year EPA solicits applications for the demonstration program. Developers submit proposals which are reviewed and accepted by EPA.

Match Technologies with Site: EPA and the developer select a site for the demonstration based on several considerations: the developer's waste and location preferences, relevance of the technology to the site cleanup, and Regional needs. EPA meets with Regional and State representatives, the developer and other interested parties to visit sites prior to making a final selection.

Prepare Demonstration Plan: EPA develops a Demonstration Plan that details how to sample waste for testing, prepare the selected site for the demonstration, dispose of residual materials, and evaluate the technology in the field. Both EPA and the technology developer must approve the Demonstration Plan.

Conduct Community Relations Activities: In most cases, opportunity for public comment is required prior to the actual demonstration. EPA prepares fact sheets on the demonstration, designates a period for the public to comment, and may hold local public meetings and/or land site visits.

Conduct Demonstrations: The demonstration of the selected technology can last from a few days to several months. The technology developer is financially responsible for mobilizing and operating the technology. EPA prepares the site, provides utilities, collects samples, performs QA field and laboratory audits, and evaluates the results. EPA also handles the logistical arrangements for a Visitor's Day where the Regional and State officials, the public and interested professionals are invited to view the demonstration.

Conduct Technology Transfer: After the demonstration, EPA prepares an Applications Analysis Report that assesses the overall applicability of the technology to other sites and wastes, and includes technology cost, performance, and reliability information. In addition, EPA prepares a Technology Evaluation Report which presents a summary of the demonstration and evaluation results. Contact John Martin at 513-569-7758 for further information.

Innovative Technologies Program

Through cooperative research and development agreements (CRDAs), EPA laboratories will work closely with industry to develop and commercialize on-site destruction and hazardous waste cleanup technologies. Through the program, EPA is involved in the development of a variety of technologies. Examples include:

- Mobile Debris Washer;
- Base Catalytic Destruction System (BCD - APEG - KPEG);
- Volume Reduction Unit (VRU); and
- Excavation Technique and Foam Suppression Methods.

For further information on this program, contact Steve James at (513) 569-7877.

EMERGING TECHNOLOGIES PROGRAM (ETP) HIGHLIGHTS

The Emerging Technologies Program is supporting 30 technologies and is currently planning to fund 13 projects from the 1990 solicitation. Solicitation for preproposals occurs in July of each year, the selected developers are then invited to submit a Cooperative Agreement Application for review. Final selection of projects is made in March of each year.

This is a co-funding effort between the developer and EPA, with EPA funding up to $150,000 each year. Funding for the second year is determined by the progress of the first year's research. Funding support for the program has also been received from the Department of Energy, and the Department of Defense (Air Force).

Several projects completed from the first year solicitation are being invited into the Demonstration Program. Program emphasis is being placed on innovative processes, that may be capable of field scale efforts in the second year of research. This provides a stronger basis for moving into the Demonstration Program. Contact Norma Lewis at 513/569-7758 for further information.

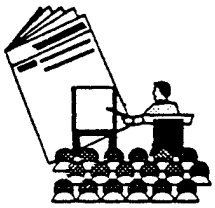
MEASUREMENT AND MONITORING TECHNOLOGIES PROGRAM OBJECTIVES

The Measurement and Monitoring Technologies Program, based at EPA's Environmental Monitoring System Laboratory in Las Vegas, Nevada, sponsors research on advanced Superfund site assessment technologies. MMTP objectives include:

- Identifying existing technologies that can enhance field monitoring and site characterization;
- Supporting development of monitoring capabilities that cannot be cost-effectively addressed with current technology;
- Demonstrating those technologies that emerge from the screening and development phases of the program; and
- Preparing protocols, guidelines and standard operating procedures for new methods.

For further information on MMTP, please contact Eric Koglin, FTS 545-2432 or (702) 798-2432.

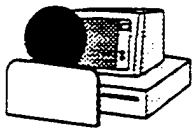
TECHNOLOGY TRANSFER ACTIVITIES



Technical information gathered through all of the SITE programs is exchanged through a variety of activities. Data results and status updates are disseminated to increase awareness of alternative technologies available for use at Superfund sites. A wide array of media are utilized to reach decision makers involved in Superfund sites including:

- SITE brochures, publications, reports, videos and fact sheets;
- Pre-proposal conferences on SITE solicitations;
- Public meetings and on-site visitors' days;
- Seminar series;
- SITE exhibit displayed at nationwide conferences;
- Innovative technologies program exhibition;
- Networking through forums, professional associations, centers of excellence, regions, and states; and
- Journal articles.

Alternative Treatment Technology Information Center (ATTIC)



The Alternative Treatment Technology Information Center (ATTIC) is an information retrieval network that can provide up-to-date technical information on innovative treatment methods for hazardous wastes. Information available through the ATTIC database includes abstracts and executive summaries from over 1200 technical documents and reports. These abstracts and summaries, delineated by technology, are categorized into five groups: (1) Thermal Treatment; (2) Biological Treatment; (3) Solidification/Stablilzation Processes; (4) Chemical Treatment; and (5) Physical Treatment. The Attic Database provides the user with access to innovative technology demonstration studies, a variety of treatability, cost analysis models, migration and sampling databases, underground storage tank case histories and remediation ideas. The ATTIC network can also enable access to expert assistance, a calender of events, and a list of publications.

ATTIC can be accessed through an online system, a system operator or through a disk-based version. For assistance and/or information call the ATTIC operator at 301-816-9135.

SITE PROGRAM CONTACTS

ORD/RREL Contacts:

Demo Program	John Martin FTS 684-7758 513-569-7758	Emerging Program	Norma Lewis FTS 684-7665 513-569-7665

Regional Contacts:

REGION	NAME	REGION	NAME
1	Diana King FTS 833-1676 617-573-9676	6	Don Williams FTS 255-2197 214-655-2197
2	Peter Moss FTS 264-4703 212-264-4703	7	Dana Trugley FTS 276-7705 913-551-7705
3	Paul Leonard FTS 597-8485 215-597-8485	8	Gerald Snyder FTS 330-7504 303-294-7405
4	John Risher FTS 347-1586 404-347-1586	9	John Blevins FTS 484-2241 415-744-2241
5	Steve Ostrodka FTS 886-3011 312-886-3011	10	John Barich FTS 399-8562 206-533-8562

Headquarters Contacts:

OSWER /TIO	John Quander FTS 398-8845 703-308-8845	ORD/ OEETD	Richard Nalesnik FTS 382-2583 202-382-2583

SITE DEMONSTRATION PROGRAM ACCOMPLISHMENTS

The Agency has successfully completed 20 field technology demonstrations at Superfund sites as indicated in Table 1. In addition, four measurement and monitoring technologies have been field demonstrated. SITE project results may be obtained by contacting the EPA Center for Environmental Research Information (CERI) at (513) 569-7562 or FTS 684-7562.

Table 1

Completed Field Demonstrations

REGION SITE/ DEVELOPER	DESCRIPTION	PROJECT MANAGER
I Groveland Wells, MA; Terra Vac. Inc.	In-Situ vacuum extraction of VOCs in soil	Mary Stinson FTS: 340-6683 201-321-6683
II New Bedford Harbor, MA; CF Systems Corp.	Solvent Extraction to Remove PCBs from sediments	Laurel Staley FTS: 684-7863 513-569-7863
Imperial Oil, NJ; Soliditech, Inc.	Solidification/ stabilzation of heavy metals and organics	Walter Grube FTS: 684-7798 513-569-7798
III Douglassville, PA; Hazcon, Inc. (IM-TECH)	Solidification/ stabilization of volatile and semi-volatiles, organics, PCBs, and heavy metals	Paul dePercin FTS: 684-7797 513-569-7797
Palmerton, PA; E.I. DuPont DeNemours & Co.	Membrane Microfiltration	John Martin FTS: 684-7758 513-569-7758
Monaca, PA; Horsehead Resource Development Co.	Flame Reactor	Donald Oberacker FTS: 684-7510 513-569-7510
IV G.E. Hialeah, FL; International Waste Technology	In-situ solidification of PCBs	Mary Stinson FTS: 340-6683 201-321-6683
Peak Oil, FL; Shirco Infrared System, Inc.	Transportable IR thermal processing systems for treatment of PCBs, organics, lead, and other metals in soil and sludge material	Howard Wall FTS: 684-7691 513-569-7691
Risk Reduction Engineering Lab, Cincinnati, OH (Kentucky and Georgia locations)	Debris Washing System	Naomi Barkley FTS: 684-7854 513-569-7854
V Rose Township, MI; Shirco IR Systems, Inc.	Infrared Incinerator System	Howard Wall FTS: 684-7691 513-569-7691
McGillis & Gibbs, MN; Biotrol	Soil washing	Mary Stinson FTS: 340-6683 201-321-6683
McGillis & Gibbs, MN; Biotrol	Biotreatment of groundwater	Mary Stinson FTS: 340-6683 201-321-6683
VI EPA's Combustion Research Facility, AR; American Combustion Technologies, Inc.	Pyretron oxygen and airburner for use with a rotary kiln incinerator	Laurel Staley FTS: 684-7863 513-569-7863
IX Lorentz Barrel and Drum, CA; Ultrox International, Inc.	UV/ozone oxidation of organics in groundwater	Norma Lewis FTS: 684-7665 513-569-7665
McColl Site Fullerton, CA; Excavation Techniques	Excavation & Foam Suppression of Volatiles	Jack Hubbard FTS: 684-7507 513-569-7507
Lockheed Site Burbank, CA; AWD Technologies, Inc.	Integrated In-Situ Vapor Extraction & Steam Vacuum Stripping Process	Gordon Evans FTS: 684-7684
McColl Site, CA; Ogden Environmental Services	Circulating fluidized bed combustor	Douglas Grosse FTS: 684-7844 513-569-7844
Annex Terminal, San Pedro, CA; Toxic Treatments, Inc.	In-situ steam - airstripping of volatile organics in soil	Paul DePercin FTS: 684-7797 513-569-7797
Selma Site, Fresno, CA; Silicate Technology Corp.	Silicate Compounds by Solidification/ Stabilization	Edward Bates FTS: 684-7774 513-569-7774
X Portable Equipment Company, OR; Chemfix	Chemical fixation/ stabilization of organics and inorganics in	Ed Barth FTS: 684-7669 513-569-7669

SITE PROGRAM DOCUMENTS

The following SITE demonstration project publications are available from EPA. Indicate your choice by checking the appropriate box(es) on the order form below. The form may be copied.*

General Publications

- ☐ Technology Profiles (EPA/540/5-90/006)

Project Results

American Combustion - Oxygen Enhanced Incineration
- ☐ Technology Evaluation (EPA/540/5-89/008)
- ☐ Applications Analysis (EPA/540/A5-89/008)

CF Systems Corp. - Solvent Extraction
- ☐ Technology Evaluation (EPA/540/5-90/002)
- ☐ Applications Analysis (EPA/540/A5-90/002)

Chemfix Technologies, Inc. - Chemical Fixation/Stabilization
- ☐ Technology Evaluation (EPA/540/5-89/011)
- ☐ Applications Analysis (EPA/540/A5-89/011)

Hazcon - Solidification
- ☐ Technology Evaluation (EPA/540/5-89/001a)
- ☐ Applications Analysis (EPA/540/A5-89/001)

IWT In-Situ Stabilization
- ☐ Technology Evaluation (EPA/540/5-89/004a)
- ☐ Applications Analysis (EPA/540/A5-89/004)

Shirco-Infrared Incineration
- ☐ Technology Evaluation - Peak Oil (EPA/540/5-88/002a)
- ☐ Technology Evaluation - Rose Township (EPA/540/5-89/007a)
- ☐ Applications Analysis (EPA/540/A5-89/007)

Soliditech, Inc. - Solidification
- ☐ Technology Evaluation (EPA/540/5-89/005a)
- ☐ Applications Analysis (EPA/540/A5-90/005)

Terra Vac - Vacuum Extraction
- ☐ Technology Evaluation (EPA/540/5-89/003a)
- ☐ Applications Analysis (EPA/540/A5-89/003)

Ultrox International - Ultraviolet Ozone Treatment for Liquids
- ☐ Technology Evaluation (EPA/540/5-89/012)
- ☐ Applications Analysis (EPA/540/A5-89/012)

☐ Check here if you would like your name placed on the SITE mailing list

Your Name and Mailing Address (please print)

MAIL TO: **ORD Publications**
26 W. Martin Luther King Drive (G72),
Cincinnati, Ohio 45268

* Documents ordered through ORD Publications are free of charge.

SITE VIDEOCASSETTES

SITE Program videos are also available on selected sites for a small fee. These videos contain footage of actual field demonstration activities, including Visitor Day programs. For further information contact Marilyn Avery, Foster Wheeler Enviresponse, Inc., 8 Peach Tree Hill Rd., Livingston, N.J. 07039, Phone: 908-906-6860.

EPA/542/N-92/002 No. 1 June 1992

EPA

U.S. Environmental Protection Agency

Office of Solid Waste and Emergency Response

Technology Innovation Office

VISITT

Vendor Information System for Innovative Treatment Technologies

An Intermittent Bulletin on a New Database for Innovative Remediation Technologies

VISITT Profiles 155 Innovative Technologies

VISITT contains information on vendors of innovative technologies to treat ground water in situ, soils, sludges and sediments. It includes technologies at all stages of development—bench, pilot, or full. Exhibit 1 lists the types of technologies included in VISITT, and the number of technologies in each category, by status. Based on the information provided by vendors, nearly 40 percent of the innovative technologies in VISITT are commercially available at full scale. Seventeen technologies treat ground water in situ, 132 treat soil, 115 treat sludge, and 94 treat sediments. 123 technologies treat organics, 70 inorganics (primarily metals), and 25 treat organics and inorganics present in the same waste or media. Exhibit 2 lists the names and addresses of each vendor in the system by technology.

The basic information on each technology includes the vendor name, address, and phone number; technology description, highlights, and limitations; and the contaminant and waste/media treated. Many of the vendors with technologies at the pilot and full scale also provide a summary of performance data, project names and contacts, available hardware and capacity, unit price information, treatability study capabilities, and literature references. Performance data, project information, and literature citations can be used to substantiate a vendor's claims.

New Database Links Technology Vendor to the Remediation Professional

The U.S. Environmental Protection Agency (EPA) is pleased to announce the availability of the Vendor Information System for Innovative Treatment Technologies (VISITT). This database has been developed by the Technology Innovation Office (TIO) within the Office of Solid Waste and Emergency Response (OSWER). This is part of a broad effort to promote the use of innovative treatment technologies for the cleanup of soil and ground water contaminated by hazardous waste. VISITT is designed to capture current information on the availability, performance, and cost of innovative treatment to remediate contaminated hazardous waste sites.

VISITT is available on diskettes compatible with personal computers using DOS operating systems. Version 1.0 of the database contains detailed information on 155 technologies offered by 97 developers and vendors. VISITT gives these companies an opportunity to market their capabilities, and enables Federal, state, and private sector environmental professionals to screen innovative technologies for application to specific sites. VISITT also identifies vendors who perform treatability studies and provide cleanup services.

EPA is already preparing for the next VISITT update (Version 2.0) early next year. EPA invites all vendors of innovative technology to submit technology information for this update. Instructions for submitting information are given later in this bulletin.

Menu-Driven Design Delivers Flexible, Easy to Use Search, View and Print Capability

VISITT provides environmental professionals with rapid access to up-to-date information on 155 innovative technologies and the 97 companies that offer them. VISITT's menu-driven design allows the user to search the extensive technology information for particular applications and technology types. The user, for example, can enter a waste description to identify innovative technologies in the system that treat such wastes. The user can also locate specific sites where vendors may have conducted treatability studies or cleanups.

Once the database identifies the technologies and vendors meeting the user's requirements, the user can then review such information as available equipment, performance data, and experience. Printing options include printing all of the technology information for a given vendor, or only those data fields of particular interest.

Appendix O

Vendors Provide EPA With Up-To-Date Information on Innovative Treatment Technologies

EPA has designed a questionnaire, the *VISITT Vendor Information Form* (EPA/540/2-91/011, No. 2), for vendors, suppliers, and manufacturers of innovative remediation technologies. Depending on the technology status, a vendor completes some or all of the form and submits it to EPA for consideration and review. EPA first reviews the technology for eligibility. The eligible innovative remediation technologies included in Version 1.0 are listed in Exhibit 1. Other innovative technologies, such as pyrolysis, may also be added if they are submitted in the future. *Technologies not included in VISITT represent established treatment technologies for contaminated soil and ground water: incineration, solidification/stabilization, and above-ground water treatment technologies.*

Also not included are technologies applicable only to industrial waste streams, such as waste minimization methods.

Secondly, EPA reviews the contents of the form for clarity and completeness to enhance the usefulness of the information. Information, such as units of measurement, are standardized as much as possible to allow comparisons among vendors and technologies. EPA works with the vendor to correct any deficiencies prior to loading the information in the database. *It is important to note that submissions are vendors' claims; EPA does not review or certify the accuracy or veracity of the information.*

Exhibit 1. Summary of Technology Types and Stage of Development

Technology Types	Bench Scale	Pilot Scale	Full Scale	Total Technologies
Acid Extraction	2	2	1	5
Adsorption - In Situ	0	1	1	2
Air Sparging - In Situ Groundwater	0	0	1	1
Bioremediation - General	2	2	0	4
Bioremediation - In Situ Groundwater	3	1	5	9
Bioremediation - In Situ Soil	3	2	4	9
Bioremediation - Slurry Phase	2	4	7	13
Bioremediation - Solid Phase	1	4	9	14
Bioventing	0	2	1	3
Chemical Treatment - Dechlorination	2	0	1	3
Chemical Treatment - In Situ Groundwater	0	1	0	1
Chemical Treatment - Other	5	2	5	12
Delivery/Extraction System	0	2	1	3
Electrical Separation	0	3	0	3
Magnetic Separation	1	0	0	1
Material Handling	0	5	1	6
Off-Gas Treatment	2	2	0	4
Slagging - Off-Gas Treated	0	1	1	2
Soil Flushing - In Situ	1	1	0	2
Soil Vapor Extraction	0	1	2	3
Soil Vapor Extraction-Thermally Enhanced	1	1	2	4
Soil Washing	4	7	4	15
Solvent Extraction	1	6	2	9
Thermal Desorption	1	1	1	3
Thermal Desorption - Off-Gas Treated	0	5	10	15
Vitrification	2	0	0	2
Vitrification - Off-Gas Treated	0	6	1	7
Total	33	62	60	155

Hardware and Software Requirements for the VISITT Database

VISITT is offered on a 5 1/4 inch or 3 1/2 inch floppy disk, accompanied by a user manual. The database requires a personal computer with at least 640K of RAM (random access memory), an operating system of DOS Version 3.3 or higher (i.e., IBM or IBM-compatible), and three megabytes of hard disk storage. The database is compiled, and requires no other software to operate. VISITT is compatible with most printers and Local Area Networks (LANs). EPA, through PRC Environmental Management Inc., offers technical assistance to correct any hardware or software problems associated with installing or using VISITT.

EPA is studying the feasibility of offering VISITT on-line through an existing electronic bulletin board, such as EPA's ATTIC (Alternative Treatment Technology Information Center) or CLU-IN, TIO's own bulletin board system. Placing VISITT on-line would allow more frequent updates to the system.

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How to Submit Information for VISITT

Suppliers, manufacturers, and vendors of innovative treatment technologies who want to be considered for inclusion in VISITT must complete a *VISITT Vendor Information Form* (EPA/540/2-91/011, No. 2). To receive a form, call U.S. EPA's Office of Research and Development Publications at 513-569-7562. **The deadline for submittals for Version 2.0 is September 1, 1992.**

Exhibit 2. List of Vendors by Technology

Inclusion in the U.S. Environmental Protection Agency's Vendor Information System for Innovative Treatment Technologies (VISITT) does not mean that the EPA approves, recommends, licenses, certifies, or authorizes the use of any of the technologies. Nor does the EPA certify the accuracy of the data. This listing means only that the vendor has provided information on a technology that EPA considers to be eligible for inclusion in this database.

ACID EXTRACTION

Cognis, Inc.
2330 Circadian Way
Santa Rosa, CA 95407
(707) 576-6200

International Remediation Corporation
1952 West Parkway Boulevard
Salt Lake City, UT 84119
(801) 977-0559

IT Corporation
304 Directors Drive
Knoxville, TN 37923
(615) 690-3211

Microbial Biotechnology, Inc.
1803 Tarrant Lane, Suite 200
Colleyville, TX 76180
(800) 543-8680

ADSORPTION - IN SITU

Dynaphore, Inc.
2709 Willard Road
Richmond, VA 23294
(804) 672-3464

Environmental Fuel System, Inc.
PO Box 1899
Bandera, TX 78003
(512) 796-7767

AIR SPARGING - IN SITU GROUNDWATER

Groundwater Technology, Inc.
100 River Ridge Drive
Norwood, MA 02062
(609) 587-0300

BIOREMEDIATION - GENERAL

Bio-Remediation Services, Inc.
621 Old Santa Fe Trail #5
Santa Fe, NM 87501
(505) 983-5549

Cognis, Inc.
2330 Circadian Way
Santa Rosa, CA 95407
(707) 576-6200

Geo-Microbial Technologies, Inc.
East Main Street
Ochelata, OK 74051
(918) 535-2281

International Remediation Corporation
1952 West Parkway Boulevard
Salt Lake City, UT 84119
(801) 977-0559

BIOREMEDIATION - IN SITU GROUNDWATER

Battelle Pacific Northwest Laboratories
Battelle Boulevard, P.O. Box 999
Richland, WA 99352
(509) 376-7855

Environmental Technology Applications
2000 Tech Center Drive
Monroeville, PA 15146
(412) 829-5202

Geo-Microbial Technologies, Inc.
East Main Street
Ochelata, OK 74051
(918) 535-2281

Groundwater Technology, Inc.
100 River Ridge Drive
Norwood, MA 02062
(510) 671-2387

IT Corporation
312 Directors Drive
Knoxville, TN 37923
(615) 690-3211

Microbial Environmental Services, Inc.
11280 Aurora Avenue
Des Moines, IA 50322
(515) 276-3434

OHM Corporation
2950 Buskirk Avenue
Suite 315
Walnut Creek, CA 94596
(510) 256-7187

Remediation Technologies, Inc. (RETEC)
127 Kingston Drive
Chapel Hill, NC 27514
(919) 967-3723

Waste Stream Technology, Inc.
302 Grote Street
Buffalo, NY 14207
(716) 876-5290

BIOREMEDIATION - IN SITU SOIL

Biogenesis International
4346 Kinloch
Houston, TX 77084
(713) 463-6888

B&S Research, Inc.
14 Basswood Circle
Babbit, MN 55706

Environmental Technology Applications
2000 Tech Center Drive
Monroeville, PA 15146
(412) 829-5202

Geo-Microbial Technologies, Inc.
East Main Street
Ochelata, OK 74051
(918) 535-2281

Groundwater Technology, Inc.
100 River Ridge Drive
Norwood, MA 02062
(510) 671-2387

Microbial Biotechnology, Inc.
1803 Tarrant Lane, Suite 200
Colleyville, TX 76180
(817) 481-4128

Microbial Environmental Services, Inc.
11280 Aurora Avenue
Des Moines, IA 50322
(515) 276-3434

Mycotech Corporation
630 Utah Avenue
Butte, MT 59701
(406) 782-2386

University of Oklahoma
Dept. of Botany and Microbiology
770 Van Vleet Oval
Norman, OK 73019
(405) 325-3174

Waste Stream Technology, Inc.
302 Grote Street
Buffalo, NY 14207
(716) 876-5290

BIOREMEDIATION - SLURRY PHASE

Battelle Pacific Northwest Laboratories
Battelle Boulevard, Box 999
Richland, WA 99352
(509) 376-7855

Bogart Environmental Services, Inc.
3586 North Mount Juliet Road
P.O. Box 717
Mt. Juliet, TN 37122
(615) 754-2847

Cognis, Inc.
2330 Circadian Way
Santa Rosa, CA 95407
(707) 576-6200

Eimco Process Equipment Company
669 West 200 South
Salt Lake City, UT 84101-1604
(801) 526-2082

Encore Environmental
344 West Henderson Road
Columbus, OH 43214
(614) 263-9287

J.R. Simplot Company
P.O. Box 15057
Boise, ID 83715
(208) 389-7265

Microbial Biotechnology, Inc.
1803 Tarrant Lane, # 200
Colleyville, TX 76180
(817) 481-4128

OHM Corporation
2950 Buskirk Avenue, Suite 315
Walnut Creek, CA 94596
(510) 256-7187

Remediation Technologies, Inc. (RETEC)
1011 S.W. Klickitat Way, # 207
Seattle, WA 98134
(602) 577-8323

SBP Technologies, Inc.
2155 - D West Park Court
Stone Mountain, GA 30087
(404) 498-6666

Union Carbide Industrial Gases, Inc.
777 Old Saw Mill River Road
Tarrytown, NY 10591
(914) 789-3034

Waste Stream Technology, Inc.
302 Grote Street
Buffalo, NY 14207
(716) 876-5290

Yellowstone Environmental Science, Inc.
320 South Willson Avenue
Bozeman, MT 59715
(406) 586-3905

BIOREMEDIATION - SOLID PHASE

Alvarez Brothers
4401 North Main Street
Victoria, TX 77904
(512) 576-0404

Arctech, Inc.
5390 Cherokee Avenue
Alexandria, VA 22312
(703) 642-4189

Bioremediation, Inc.
P.O. Box 2010
Lake Oswego, OR 97035
(503) 624-9464

B&S Research, Inc.
14 Basswood Circle
Babbit, MN 55706

Ensite, Inc.
5203 South Royal Atlanta Drive
Tucker, GA 30084
(404) 934-1180

Environmental Technology Applications
2000 Tech Center Drive
Monroeville, PA 15146
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Geo-Microbial Technologies, Inc.
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(918) 535-2281

Microbial Biotechnology, Inc.
1803 Tarrant Lane, Suite 200
Colleyville, TX 76180
(817) 481-4128

Microbial Environmental Services, Inc.
11280 Aurora Avenue
Des Moines, IA 50322
(515) 276-3434

Mycotech Corporation
630 Utah Avenue
Butte, MT 59701
(406) 782-2386

OHM Corporation
2950 Buskirk Avenue, # 315
Walnut Creek, CA 94596
(510) 256-7187

Remediation Technologies, Inc. (RETEC)
7011 North Chaparral Avenue
Tucson, AZ 85718
(602) 577-8323

Roy F. Weston, Inc.
Weston Way
West Chester, PA 19380-1499
(215) 430-3101

Waste Stream Technology, Inc.
302 Grote Street
Buffalo, NY 14207
(716) 876-5290

BIOVENTING

Battelle Memorial Institute
Battelle Boulevard, Box 999
Richland, WA 99352
(509) 376-9428

Groundwater Technology, Inc.
100 River Ridge Drive
Norwood, MA 02062
(609) 587-0300

IT Corporation
312 Directors Drive
Knoxville, TN 37923
(615) 690-3211

CHEMICAL TREATMENT - DECHLORINATION

Chemical Waste Management, Inc.
1950 South Batavia Avenue
Geneva, IL 60134-3300
(708) 513-4332

Roy F. Weston, Inc.
One Weston Way
West Chester, PA 19380-1499
(215) 993-5040

Trinity Environmental Technologies, Inc.
62 East First Street
Mound Valley, KS 67354
(316) 328-3222

CHEMICAL TREATMENT - IN SITU GROUNDWATER

Geochem, Inc.
12265 West Bayand Avenue
Suite 140
Lakewood, CO 80228
(303) 988-8902

CHEMICAL TREATMENT - OTHER

Albert H. Halff Associates, Inc.
8616 Northwest Plaza Drive
Dallas, TX 75225
(214) 739-0094

Arctech, Inc.
5390 Cherokee Avenue
Alexandria, VA 22312
(703) 642-4189

Dr. G. A. Mansoori, Professor
University of Illinois at Chicago
Department of Chemical Engineering
810 South Clinton
Chicago, IL 60607
(312) 996-5592

Eli Eco Logic International, Inc.
143 Dennis Street
Rockwood, Ontario NOB 2K0
(519) 856-9591

EM&C Engineering Associates
1665 Scenic Avenue, #104
Costa Mesa, CA 92626
(714) 957-6429

EPS Environmental, Inc.
525 Palmer Avenue
Maywood, NY 07607
(201) 368-7902

Etus, Inc.
1511 Kastner Place
Sanford, FL 32771
(407) 321-7910

G.E.M., Inc.
124 West Second Street
Malvern, AR 72104
(501) 337-9410

High Voltage Environmental Applications
P.O. Box 24-8358
Miami, FL 33124
(305) 253-9143

IT Corporation
312 Directors Drive
Knoxville, TN 37923
(615) 690-3211

DELIVERY/EXTRACTION SYSTEM

Drilex System, Inc.
15151 Sommermeyer
Houston, TX 77041
(713) 937-8888

In-Situ Fixation Company
Division of R.P.M Company
1256 West Chandler Boulevard, Suite 16
Chandler, AZ 85224
(602) 821-0409

Millgard Environmental Corp.
12822 Stark Road
Livonia, MI 48151
(313) 261-9760

ELECTRICAL SEPARATION

Electrokinetics, Inc.
Louisiana Business and Technology Center
Louisiana State University
South Stadium Drive
Baton Rouge, LA 70803-6100
(504) 388-3992

Isotron Corporation
13152 Chef Menteur Highway
New Orleans, LA 70129
(504) 254-4624

Texas Engineering Experiment Station
Zachry Engineering Center, MS 3133
College Station, TX 77843
(409) 845-2945

MAGNETIC SEPARATION

S.G. Frantz Company, Inc.
31 East Darrah Lane
Lawrence Township, NY 08648
(609) 882-7100

MATERIALS HANDLING

Canonie Environmental Services Corp.
94 Inverness Terrace East, Suite 100
Englewood, CO 80112
(303) 790-1747

Eimco Process Equipment Company
669 West 200 South
Salt Lake City, UT 84101-1604
(801) 526-2082

Microfluidics Corporation
90 Oak Street
Newton, MA 02164-9101
(617) 969-5452

Recra Environmental, Inc.
10 Hazelwood Drive
Suite 106
Amherst, NY 14228-2298
(716) 691-2600

Resource Recovery, Inc.
Post Office Box 1016
Caribou, ME 04736
(207) 496-3331

Waste-Tech Services, Inc.
800 Jefferson County Parkway
Golden, CO 80401
(303) 279-9712

OFF GAS TREATMENT

Alcoa Separations Technology, Inc.
181 Thorn Hill Road
Warrendale, PA 15086
(412) 772-1332

KSE, Inc.
665 Amherst Road
Sunderland, MA 01375
(413) 549-5506

M.L. Energia, Inc.
P.O. Box 1468
Princeton, NJ 08542
(609) 799-7970

Purus, Inc.
2150 Paragon Drive
San Jose, CA 95131
(408) 453-7804

SLAGGING - OFF GAS TREATED

Agglo Recovery, Inc.
34 Leading Road
Rexdale, Ontario, Canada M9V 3S9
(416) 740-0188

Horsehead Resource Development Co., Inc.
200 Frankfort Road
Monaca, PA 15061
(412) 773-2279

SOIL FLUSHING - IN SITU

Scientific Ecology Group, Inc.
Nuclear Waste Technology Dept.
P.O. Box 598
Pittsburgh, PA 15230
(412) 733-6179

Waste-Tech Services, Inc.
800 Jefferson County Parkway
Golden, CO 80401
(303) 279-9712

SOIL VAPOR EXTRACTION

OHM Corporation
2950 Buskirk Avenue, Suite 315
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Terra Vac
356 Fortaleza Street
San Juan, PR 00901
(609) 530-0003

SOIL VAPOR EXTRACTION-THERMALLY ENHANCED

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Rockville, MD 20850
(301) 948-0040

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P.O. Box 999
MSIN #P7-41
Richland, WA 99352
(509) 376-0554

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1665 Scenic Avenue, #106
Costa Mesa, CA 92626
(714) 957-6429

Novaterra
373 Van Ness Avenue, Suite 210
Torrance, CA 90501
(213) 328-9433

Udell Technologies, Inc.
4701 Doyle Street, Suite 5
Emeryville, CA 94608
(415) 653-9477

SOIL WASHING

Bergmann USA
72 - II West Stafford Road
P.O. Box 535
Stafford Springs, CT 06076-535
(203) 684-6844

Bio-Recovery System, Inc.
2001 Copper Avenue
Las Cruces, NM 88005
(505) 523-0405

Biotrol, Inc.
11 Peavey Road
Chaska, MN 55318
(612) 448-2515

Canonie Environmental Services Corp.
94 Inverness Terrace East, Suite 100
Englewood, CO 80112
(303) 790-1747

Environmental Technology Applications
2000 Tech Center Drive
Monroeville, PA 15146
(412) 829-5202

Flo Trend System, Inc.
707 Lehman
Houston, TX 77018
(800) 762-9893

Geochem, Inc.
12265 West Bayaud Avenue
Suite 140
Lakewood, CO 80228
(303) 988-8902

Northwest Enviroservice, Inc.
P.O. Box 24443
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Seattle, WA 98124
(206) 622-1085

OHM Corporation
2950 Buskirk Avenue
Suite 315
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(510) 256-7187

On-Site Technologies, Inc.
1715 South Bascom Avenue
Campbell, CA 95008
(408) 371-4810

Onsite * Offsite Inc./Battelle PNL
2500 East Foothill Boulevard
Suite 201
Pasadena, CA 91107
(818) 405-0655

Roberts & Schaefer Company
Suite 400
120 South Riverside Plaza
Chicago, IL 60606
(312) 236-7292

Scientific Ecology Group, Inc.
Nuclear Waste Technology Department
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Pittsburgh, PA 15230
(412) 636-5885

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Stevenage Herts, England SG1 2BX
(043) 874-1122

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800 Jefferson County Parkway
Golden, CO 80401
(303) 279-9712

SOLVENT EXTRACTION

ART International, Inc.
100 Ford Road
Denville, NJ 07834
(201) 627-7601

CF System Corporation
3D Gill Street
Woburn, MA 01801
(617) 937-0800

Chemical Waste Management, Inc.
1950 South Batavia Avenue
Geneva, IL 60134
(708) 513-4324

Dehydro-Tech Corporation
6 Great Meadow Lane
East Hanover, NJ 07936
(201) 887-2182

EM&C Engineering Associates
1665 Scenic Avenue, 104
Costa Mesa, CA 92626
(714) 957-6429

Geo-Microbial Technologies, Inc.
East Main Street
Ochelata, OK 74051
(918) 535-2281

Resources Conservation Company
3630 Cornus Lane
Ellicott City, MD 21043
(301) 596-6066

SRE, Incorporated
158 Princeton Street
Nutley, NJ 07110
(201) 661-1969

Terra-Kleen Corporation
7321 North Hammond Avenue
Oklahoma City, OK 73132
(405) 728-0001

THERMAL DESORPTION

Chemical Waste Management, Inc.
1950 South Batavia Avenue
Geneva, IL 60134-3310
(708) 218-1785

EM&C Engineering Associates
1665 Scenic Avenue, 104
Costa Mesa, CA 92626
(714) 957-6429

Texarome, Inc.
1.5 miles East Highway 337
P.O. Box 157
Leakey, TX 78873
(512) 232-6079

Zimpro/Passavant Environmental System
301 West Military Road
Rothschild, WI 54474
(715) 359-7211

THERMAL DESORPTION - OFF GAS TREATED

Ariel Industries
403 Spring Creek Road
Chattanooga, TN 37411
(615) 899-6496

Canonie Environmental Services Corp.
800 Canonie Drive
Porter, IN 46304
(219) 926-8651

Chemical Waste Management, Inc.
1950 South Batavia Avenue
Geneva, IL 60134
(708) 513-4578

Encore Environmental
344 West Henderson Road
Columbus, OH 43214
(614) 263-9287

IT Corporation
304 Directors Drive
Knoxville, TN 37923
(615) 690-3211

Ogden Environmental Services, Inc.
3550 General Atomics Court
San Diego, CA 92121-1194
(619) 455-4105

Remediation Technologies, Inc. (RETEC)
9 Pond Lane
Damonmill Square
Concord, MA 01742
(508) 371-1422

Roy F. Weston, Inc.
1 Weston Way
West Chester, PA 19380
(215) 430-7423

Soil Purification, Inc.
P.O. Box 72515
Chattanooga, TN 37407
(404) 861-0069

Soiltech, Inc.
94 Inverness Terrace East
Suite 100
Englewood, CO 80112
(303) 790-1410

Southdown Thermal Dynamics
12235 FM 529
Houston, TX 77041
(800) 364-2402

Southwest Soil Remediation, Inc.
6262 North Swan Road
Suite 200-A
Tucson, AZ 85718-3600
(602) 577-7680

Texaco Syngas, Inc.
2000 Westchester Avenue
White Plains, NY 10650
(914) 253-6019

Thermotech System Corporation
5201 North Orange Blossom Trail
Orlando, FL 32810
(407) 290-6000

Waste-Tech Services, Inc.
800 Jefferson County Parkway
Golden, CO 80401
(303) 279-9712

VITRIFICATION

Contamination Control Services, Inc.
P.O. Box 1017
Easley, SC 29641
(803) 859-2048

EM&C Engineering Associates
1665 Scenic Avenue, 104
Costa Mesa, CA 92626
(714) 957-6429

VITRIFICATION - OFF GAS TREATED

Battelle Pacific Northwest Laboratories
Battelle Boulevard, P.O. Box 999
Mail Stop P7-41
Richland, WA 99352
(509) 376-6576

Bio-Electrics, Inc.
1215 West 12th Street
Kansas City, MO 64101
(816) 474-4895

Geosafe Corporation
2000 Logston Avenue
Richland, WA 99352
(509) 375-3268

Glasstech, Inc.
995 Fourth Street
Perrysburg, OH 43552
(419) 536-8828

Horsehead Resource Development Co., Inc.
200 Frankfort Road
Monaca, PA 15061
(412) 773-2279

Retech, Inc.
100 Henry Station Road
P.O. Box 997
Ukiah, CA 95482
(707) 462-6522

Western Product Recovery Group, Inc.
10690 Shadow Wood, Suite 132
Houston, TX 77043
(505) 672-9444

*U.S. Government Printing Office: 1992 — 622-692

REPRESENTATIVE FEDERAL RESEARCH
IN PROGRESS REPORTS

Order number 920618-145952-50 -001-001
page 11 set 3 with 12 of 12 items

USER SECURITY CODE		SDI
SPONSORING OFFICE CODE	EM-423	
RIP Item 11		
BASIS ACC. NUMBER	62389	
PROJECT TITLE		Anaerobic Biodegradation to Clean Chemically Contaminated Soils
PRINCIPAL INVESTIGATOR		Helt, J.E.
CORPORATE SOURCE	Argonne National Laboratory	
NON-STD DOE CONTRACT NO.		W-31109-ENG-38
PI CITY		Argonne
PI STATE		IL
PI ZIP		60439
PI PHONE NO.	C708-972-7335;F972-7335	
SPONSORING OFFICE TEXT		USDOE Office of Environmental Restoration and Waste Management, Office of Technology Development, Associate Director
BUDGET REPORT CODE-BAMT		EW4010100
TECHNICAL MONITOR	Frank, C.W.	
TM PHONE		C202-586-6382;F896-6382
PROJECT START DATE		901001
PROJECT COMPLETION DATE		930930
WORK STATUS		R91
CURRENT RECORD TYPE		WPAS
SUBJECT CATEGORIES		540220;550700
DESCRIPTOR(S)		SOILS/DETOXIFICATION;SOILS;DETOXIFICATION; ORGANIC MATTER;POLLUTANTS;ANAEROBIC CONDITIONS; BIODEGRADATION;FEASIBILITY STUDIES
ABSTRACT		This research project will lead to the development of an (ital in situ) process for cleaning soils that have been contaminated by organic chemicals. Anaerobic biodegradation will be the basis of the technology. The process will be designed to maximize the metabolism of a specific set of contaminants. The objectives of the first year's efforts are (1) To verify the technical feasibility of the proposed process, (2) to identify potential negative impacts on the altered soil environment, and (3) to evaluate the potential application of the process to specific DOE-DP sites.
USER SECURITY CODE		SDI
SPONSORING OFFICE CODE	EM-50	

RIF Item 12		
BASIS ACC. NUMBER	26393	
PROJECT TITLE		Microwave-Induced Plasma Incineration
PRINCIPAL INVESTIGATOR		Krause, T.R.
CORPORATE SOURCE	Argonne National Laboratory	
NON-STD DOE CONTRACT NO.		W-31109-ENG-38
PI CITY		Argonne
PI STATE		IL
PI ZIP		60439
PI PHONE NO.	C312-972-4356;F972-4356	
SPONSORING OFFICE TEXT		USDOE Office of Environmental Restoration and Waste Management, Office of Technology Development,

Associate Director

BUDGET REPORT CODE- BAMT	EW4010100
TECHNICAL MONITOR	Frank, C.W.
TM PHONE	C202-586-6382;F896-6382
PROJECT START DATE	871000
PROJECT COMPLETION DATE	930930
WORK STATUS	R91
CURRENT RECORD TYPE	WPAS
SUBJECT CATEGORIES	052001
DESCRIPTOR(S)	HAZARDOUS MATERIALS/COMBUSTION;CHLORINATED AROMATIC HYDROCARBONS/COMBUSTION;COMBUSTION;INCINERATORS PLASMA FURNACES;TEMPERATURE DISTRIBUTION; MICROWAVE EQUIPMENT
ABSTRACT	Chlorinated hydrocarbons, in particular, the decreasing solvents trichloroethane and trichloroethylene (TCEs), constitute a major hazardous waste problem at all Department of Energy-Defense Program sites. Thermal combustion, the presently recommended method for degrading chlorinated hydrocarbons, can produce significant quantities of chlorinated aromatic hydrocarbons (e.g., PCBs) as a by-product because of nonuniform temperature profiles in the oxygen-enriched environment of an incinerator. Microwave-induced plasma incineration is a promising alternative to thermal combustion processes. Microwave-induced plasma incineration can provide a more uniform and controllable temperature profile and can generate reactive species that initiate the degradation reaction at a much lower temperature than thermal combustion processes. Microwave-induced plasma incineration is particularly suited for treating low-level TCE concentrations in vapor streams. The objective of this work is to investigate the technical feasibility of detoxification of chlorinated hydrocarbons by microwave-induced plasma incineration.
USER SECURITY CODE	SDI
SPONSORING OFFICE CODE	RM-50

Online access to Government information continually updated

NTIS Bibliographic Database

The database contains summaries of *completed* government-sponsored studies from 1964 to the present—representing hundreds of billions of dollars of U.S. and foreign government research. The studies range from adhesives and administration to urban planning and zoology—70,000 new items each year.

Instant access to 1.6 million records

These summaries are available online to computers with modems.

▼ *Access to the NTIS Bibliographic Database*

The commercial services listed below provide online access to the database, with a password and instructions. If you do not have a personal computer, check either your company's library or a public or academic library—most already have access to the database.

The NTIS Bibliographic Database is available from:

BRS, (800) 345-4277

CISTI, in Canada, (613) 993-1210

DATA-STAR, (800) 221-7754

DIALOG, (800) 334-2564

ESA/IRS in Italy, FAX (39/6) 94180361

ORBIT, (800) 456-7248, in Virginia (703) 442-0900

STN International, (800) 848-6533, in Ohio and Canada (800) 848-6538

Batch searching and SDI service is available from NERAC, (203) 872-7000.

Addresses are on page 34.

▼ *Online help desk*

The Help Desk will answer your questions on the database and its subject content from 8:00 a.m. to 5:00 p.m., Eastern. Call (703) 487-4640.

▼ *Online training*

NTIS offers online training and presentations. For more information, call the NTIS Online Training Coordinator at (703) 487-4929.

▼ *FREE search guides*

These guides help you search for the material you need and help you take advantage of the subject categories used by NTIS. To get your copies, call (703) 487-4650 or use the form on page 43.

NTIS Subject Category Descriptions, number PR-832/827

Search Guide to the NTIS Database:
on BRS, number PR-831/827
on DIALOG, number PR-829/827
on ORBIT, number PR-830/827
on STN, number PR-837/827
on DATA-STAR, in preparation
on ESA/IRS, in preparation

▼ ***NTIS online newsletter***

The *NTIS Online Alert* suggests quick search techniques and new information about the NTIS Bibliographic and FEDRIP databases. To receive this free quarterly newsletter, use the form on page 43 and ask for PR-862/827.

NTIS Database on CD-ROM

DIALOG Information Services offers the database on CD-ROM from 1980 to the present; and SilverPlatter Information Service, Inc., offers it from 1983 to the present. Both services update the CD-ROM quarterly.

This is a flat-fee, unlimited use opportunity to review NTIS records. Local area network options are now available through both companies.

You will need a personal computer and a CD-ROM drive to read these discs. Contact the following for more information:

DIALOG, (800) 334-2564

SilverPlatter, (800) 343-0064

Addresses are on page 34.

The NTIS Bibliographic Database and the FEDRIP Database are available for lease. Call the Database Product Manager at (703) 487-4929.

Appendix Q