

Environmental Technology

The successful development and application of environmental technology is a critical factor to the continued success of the environmental restoration program. DoD has fostered technological advancement by investing in the entire technology development life-cycle from research, to demonstration, and eventually to commercialization.

"Just as powerful new technologies have helped to create many of the environmental problems, better, smarter, more well designed technologies can be a critical part of a solution for these problems"

--Vice President Al Gore

Wholesale investment in innovative technology is not DoD's primary focus; rather, DoD invests in technologies that address DoD-specific cleanup needs and that prove to be more efficient and effective than currently available technologies. To manage technology resources, DoD provides oversight and ensures accountability for all aspects of cleanup technology development and demonstration. As part of its oversight role, DoD focuses on identifying, understanding, and categorizing the needs of end users, such as project managers in the field, who need the most accurate and current technology information available to make effective environmental restoration decisions.

In addition, DoD seeks to consolidate technology demonstration and validation activities that occur across the Services and non-DoD organizations. To take advantage of the resources and experience of these organizations, DoD has partnered with Federal and state agencies, academic institutions, and the industrial and private sectors in various technology initiatives. These partnerships have allowed DoD to leverage resources and share lessons learned about the application of investigative, cleanup, and monitoring technologies. Cooperative ventures also enhance the market acceptance of technologies and improve relations with DoD's regulatory partners.

DoD's programmatic efforts focus on three major areas:

- Technology transfer
- Demonstration and certification of emerging technologies
- Development of new technology

Each of these areas is discussed below.

Technology Transfer

An important component of DoD's technology program is the collection and dissemination of data on technology availability and performance. Effectively disseminating information enables project managers to make more informed decisions

and allows promising technologies to reach commercialization more quickly. DoD has assumed a lead role in the collection and dissemination of technology information by facilitating technology transfer among development and demonstration programs and technology users.

A major impediment to the acceptance of new technologies by program managers, regulatory agencies, and communities is the lack of cost and performance data. Such data is needed to validate the effectiveness of technologies before they can be implemented widely. As a part of its efforts to expedite the collection and reporting of technology cost and performance data, DoD is working with the Federal Remediation Technologies Roundtable, an interagency organization created to facilitate collaboration among Federal agencies, such as the Department of Energy (DOE) and EPA, which also have a stake in technology development. The Federal Remediation Technologies Roundtable recently released the *Interagency Guide to Documenting Cost and Performance Information for Site Remediation Projects*. This guide will facilitate the standard reporting of data, broaden the use and usefulness of the information collected, increase confidence in the future effectiveness of remedial technologies, and enhance the organization, storage, and retrieval of relevant information.

To date, DoD has completed more than 20 Technology Application Reports based on the interagency guidance. In total, DoD, DOE, and EPA have completed more than 40 Technology Application Reports.

The DoD Environmental Technology Transfer Committee also has worked with the Federal Remediation Technologies Roundtable to develop the *Remediation Technologies Screening Matrix and Reference Guide, Second Edition (Screening Matrix)*. The *Screening Matrix* was designed to combine a number of Federal remediation technology documents into a single, easy-to-use compendium. The document consolidates similar documents published by the Army, Air Force, Navy, DOE, and EPA. The reference guide is intended to provide project managers with current, comprehensive information on available remediation technologies and facilitate the decision making process.

"Innovative technologies are critical to our country's national and environmental security. Through advanced technology, we can reduce the cost, risk, and time needed to meet the Department's environmental challenges. . . . Many barriers prevent innovative environmental technologies from being implemented at our installations. To overcome these, the Department has initiated the Environmental Security Technology Certification Program (ESTCP). Using our military facilities, ESTCP will demonstrate and validate the effectiveness of the most promising environmental technologies."

--William J. Perry, Secretary of Defense

To disseminate technology information, DoD is using the latest communication technologies including the World Wide Web, a subset of the Internet worldwide computer network. Rather than wait for technology reports to be published and distributed through traditional methods that are time-consuming and costly, project

managers can now access current technology information when and where they need it. DoD has published 20 Technology Application Reports on the Web and plans to publish the *Screening Matrix* and additional Technology Application Reports on the Web as they become available.

Installations across the country are also using the Web to share information on technology application with local communities and the environmental technology industry.

The collection and sharing of data on technology helps project managers to make informed decisions in the field and allows promising technologies to reach commercialization quickly.

Demonstration and Certification of Emerging Technologies

A major barrier to the acceptance of new technologies is lack of cost and performance data.

DoD's demonstration and validation programs provide project managers with a set of previously tested and certified technologies; these technologies can then be applied to sites with greater assurance of acceptable cost and performance.

DoD's flagship demonstration program is the Environmental Security Technology Certification Program (ESTCP). DoD established the ESTCP to demonstrate and certify that emerging technologies can address its most urgent environmental needs. Through this program, DoD identifies laboratory-proven technologies that can reduce restoration and compliance costs, risks, and implementation time. The program strategy involves transferring these technologies to the field for rigorous trials and documenting their cost, performance, and market potential.

In FY95 the ESTCP reviewed more than 120 proposals and selected and initiated 27 demonstration projects, 15 of which were related to environmental cleanup. Proposals were selected based on their relevancy to DoD needs, their projected cost/benefit, and their promise for commercial applicability.

Following each demonstration, the ESTCP will certify or validate the operational cost and performance of the demonstrated technology based on the rigorous evaluation conducted during field tests. All remediation demonstrations are conducted in coordination with local and regional regulatory agencies. Upon successful completion, these technologies will be approved by the regulatory agencies for implementation. For example, the Army Environmental Center jointly with EPA is currently evaluating a more cost effective advanced oxidation technology at Cornhusker Army Ammunition Plant in Nebraska. At the same time that these tests are conducted to meet the requirements of the local site, data is gathered to satisfy the broader regulatory and user community to enable these technologies to be rapidly transferred across DoD. ESTCP and the Services are also jointly seeking broader certification for site characterization

technologies developed by DoD. EPA is evaluating a fiber optic biosensor for detection of TNT and the California EPA is evaluating the Site Characterization and Analysis Penetrometer System (SCAPS).

DoD also coordinates technology demonstrations in programs operated outside of the Office of the Secretary of Defense. The Defense National Environmental Technology Demonstration Program established national test centers to compare demonstrations and evaluate cost-effective innovative technologies, thereby enabling the technologies to be transferred from research to full-scale use. DoD has coordinated the involvement of the Army, Navy, Air Force, EPA, and local regulatory officials in the demonstration program at five test installations. The Index of Other DoD Successes, included at the end of this report, highlights technology demonstration activities at participating installations.

The BRAC Public Affairs Office at the Presidio of San Francisco provides vital information regarding restoration activities including cleanup technology information on the World Wide Web. The home page is intended for use by the public as well as other environmental technology users in the field (<http://www.envcleanup.gov>).

Each of the individual Services also maintains technology development and demonstration programs. The Air Force Center for Environmental Excellence, the Army Environmental Center, and the Naval Facilities Engineering Service Center are leaders in cleanup technology demonstration.

In addition, the Navy Environmental Leadership Program, or NELP, has made great strides in the demonstration of innovative technologies at North Island Naval Air Station, California. For example, the TerraKleen soil washing technology, which was demonstrated in FY94 in cooperation with the EPA Superfund Innovative Technology Evaluation (SITE) Program, was placed in full-scale operation under a non-time-critical removal action to remediate soil contaminated with polychlorinated biphenyls at North Island Naval Air Station sites 4, 6, and 10. Upon completion of this action, the Navy anticipates closing the three sites with no further action required. Technology demonstration and full-scale performance data were distributed Navy-wide to facilitate the use of the technology at other Navy installations.

The Navy Environmental Leadership Program has also enhanced its partnering base with non-DoD agencies. For example, under a partnership with Clean Sites, SITE, EPA's Technology Innovation Office, and a private contractor, the NELP has initiated a new demonstration effort to showcase an *in situ* air stripping technology that simultaneously removes volatile organic contaminants from soil and groundwater.

The Navy Environmental Leadership Program has made great strides in demonstrating innovative technologies and partnering with other agencies.

DoD has also worked with other Federal agencies, states, and key stakeholder groups through the Federal advisory Committee to Demonstrate On-Site Innovative Technologies. The Committee, which includes western governors and Federal secretaries,

is developing new policies to improve stakeholder involvement in technology and cleanup decisions, streamline review and regulatory requirements for new technologies, and improve technology investment, procurement, and commercialization decision-making frameworks. The Committee will issue its recommendations in June 1996.

DoD will integrate successful approaches developed by the Committee into its policies and procedures. Western governors, who approved a codicil in June 1995 directing their state environmental regulatory agencies to work cooperatively to develop interstate mechanisms to speed acceptance of promising new technologies, will likely expand that effort nationally in the coming year.

DoD's efforts to improve stakeholder participation and acceptance will ultimately enhance private sector efforts at technology commercialization. To reach this goal of enhanced commercialization, DoD is working with the Western Governors' Association subcommittee on stakeholder issues to improve public acceptance of new technologies.

"Science and technology must be coupled with public understanding and trust."

--Tadd McCall, U.S. Air Force Deputy Assistant Secretary for Environment, Safety, and Occupational Health

Development of New Technology

Successful technology application begins with strong basic and applied research and development efforts. Establishing specific objectives based on clear user-generated requirements is crucial to the effective management and development of environmental technologies. This approach ensures that user specifications are met, resources are conserved, and duplication is avoided.

To coordinate and focus environmental technology development activities, DoD works with the Services to define technology needs. DoD then prioritizes and communicates Service-validated requirements to the technology development community. DoD supports new technology development through the Tri-Service Environmental Quality Laboratory Plan (sometimes called Green Book), which allows program funding to be matched to identified needs.

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Under the Tri-Service Environmental Quality Laboratory Plan, DoD integrates the direct-funded Research and Development programs with the Strategic Environmental Research and Development Program, the Services' environmental research and development programs, and the U.S. Army Corps of Engineers Civil Works research and development programs. To coordinate and leverage resources, DoD has implemented a strategic reliance plan where the Services are designated as leads for various cleanup technology focus areas. For example, researchers at the Air Force's Armstrong Laboratory are

developing a bioslurper system that improves the effectiveness of bioventing by removing free product before treatment.

The Strategic Environmental Research and Development Program is DoD's corporate environmental technology development mechanism. The program funds government laboratories, academic, and private industry research and development of technologies needed by DoD, DOE and EPA. The program categorizes its research and development activities into technology focus areas. The cleanup focus area accounts for the largest percentage of program funds and includes 34 cleanup related technology projects.

The Strategic Environmental Research and Development Program provides funds through DoD to support the development of technologies by DoD, DOE, and EPA.

The Mobile Underwater Debris Survey System (MUDSS) project is one of the Strategic Environmental Research and Development Program's promising new efforts. Through the MUDSS project, the program hopes to provide the Services with an effective technology for detecting unexploded ordnance on underwater ranges.

DoD is committed to the successful development and application of environmental technologies to ensure the continued success of its environmental restoration program. DoD has fostered the research, development, and transfer of new environmental technology and will continue that effort to provide better solutions for environmental problems thereby protecting human health and the environment.

Environmental Security Technology Certification Program-- Phytoremediation

Under a project sponsored by the Environmental Security Technology Certification Program, EPA is currently evaluating a phytoremediation technology that the Army Environmental Center believes to be a promising solution for groundwater contaminated with explosive waste.

The U.S. Army Environmental Center (AEC) is currently partnering with EPA, the Tennessee Valley Authority, and the U.S. Army Corps of Engineers Waterways Experiment Station to develop technologies to remediate groundwater contaminated with ordnance explosive waste. This collaborative effort is being sponsored by the Environmental Security Technology Certification Program.

Explosives contamination of groundwater is fairly common at DoD installations across the country. However, the current technologies being implemented to treat the contamination, such as granulated carbon and advanced oxidation, are expensive and resource intensive. The AEC partnering team has demonstrated a potential treatment technology called "phytoremediation," which involves pumping contaminated groundwater to artificial wetlands where plants are used to degrade explosive waste.

Unlike traditional technologies used to remediate explosive-contaminated groundwater, phytoremediation does not produce additional waste, is also self-sustaining, cost-effective, and it conserves resources.

Phase I of the phytoremediation demonstration began in July 1995. Phase II will be conducted at Milan Army Ammunition Plant in Tennessee, using constructed wetlands. AEC will use data collected from the demonstration to transfer design, implementation, and cost analysis information to both government and commercial users in the field.

Phytoremediation presents a wide variety of potential applications using wetland plants to remediate contaminated surface water and groundwater. Once this technology is proven effective in constructed wetlands, it could be implemented in natural wetlands, allowing users in the field to take advantage of naturally occurring conditions to solve the difficult problem of remediating explosives contamination in groundwater.

Intrinsic Bioremediation at Beaufort MCAS, South Carolina

The Marine Corps/Navy is demonstrating intrinsic bioremediation as an acceptable cleanup strategy at Beaufort Marine Corps Air Station (MCAS) in South Carolina. The demonstration, which was made possible through a partnership among Beaufort MCAS, the U.S. Geological Survey, and the Southern Division Naval Facilities Engineering Command, is also serving as the pilot program for the South Carolina Department of Health and Environmental Control in its effort to develop state regulatory guidance for the application of passive bioremediation to clean up contaminated groundwater. By combining their bioremediation, hydrogeologic, and regulatory expertise, the demonstration partners worked together to develop a process and protocol for demonstrating the acceptability of intrinsic bioremediation. Using intrinsic bioremediation at two fuel storage areas at Beaufort MCAS will accelerate the cleanup decision process and save at least \$600,000 when compared with conventional pump-and-treat methods.

Intrinsic bioremediation takes advantage of native bacteria to biodegrade organic contaminants in groundwater to acceptable levels. Intrinsic bioremediation is a viable cleanup alternative in areas where biodegradation rates are rapid relative to groundwater movement. The protocol for intrinsic bioremediation is based on rigorous scientific methodology that can determine whether natural attenuation is appropriate for site-specific conditions.

The demonstration of intrinsic bioremediation incorporates groundwater flow models with biodegradation rate measurements and site-specific parameters. In combination, the data can be used to predict the dispersion and migration of contaminant plumes over time. The accuracy of such predictions is being evaluated under actual field conditions through extensive sampling and monitoring.

Once state approval is granted for intrinsic bioremediation, Beaufort MCAS will continue to monitor groundwater under an approved plan and no additional activities should be required.

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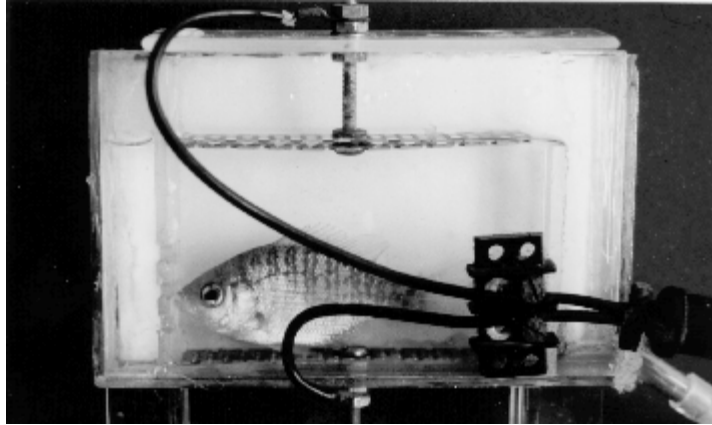
Navy Supply Corps School, Athens, Georgia...Community Involvement

Groundwater contamination from an underground gasoline storage tank had migrated about 1,000 feet downgradient of the Navy Supply Corps School (NSCS) in Athens, Georgia to the neighboring community. The large number of potentially affected property owners and the complex hydrogeology of the site indicated that significant resources, time, and cost would be required to completely remediate groundwater migrating from the NSCS property. In addition, conventional vertical groundwater recovery wells would have required access to numerous private properties.

A corrective action plan developed for the NSCS site provided an innovative solution for the unique conditions of the site. Keeping in mind the local community's concerns, the plan proposed that only one horizontal recovery well be drilled. Construction of the horizontal recovery well and installation of the ancillary treatment system was completed ahead of schedule, and actual recovery and treatment of contaminated groundwater began within 6 weeks of beginning construction. All phases of the cleanup are being conducted with no disruption of nearby property owners and residents. Treatment of the entire contaminant plume will be complete by FY98.

The Navy Supply Corps School remediated contaminated groundwater using an innovative technique which resulted in less disruption of the community, greater community acceptance, and time and cost savings.

Using Biomonitoring at Aberdeen Proving Ground, Maryland



Army scientists monitor the reactions of a bluegill fish in treated groundwater to determine its quality before the water is pumped into the Chesapeake Bay.

As a part of an interagency collaborative effort, the Environmental Health Research Detachment of the U.S. Army Institute of Environmental Medicine, located at Fort Detrick, Maryland, is working with Aberdeen Proving Ground in Maryland to use an innovative biomonitoring technology as the quality control element for implementing a complex groundwater treatment process.

Aberdeen Proving Ground is currently treating groundwater contaminated with metals, solvents, chemical agents, and explosive waste. To ensure that treated groundwater is clean before it is discharged back into the environment, the Environmental Health Research Detachment and Aberdeen Proving Ground have developed a biomonitoring technique. Before treated groundwater is pumped from Aberdeen Proving Ground into the adjacent Chesapeake Bay, scientists are using a ubiquitous species of fish, the bluegill, to determine the quality of treated groundwater.

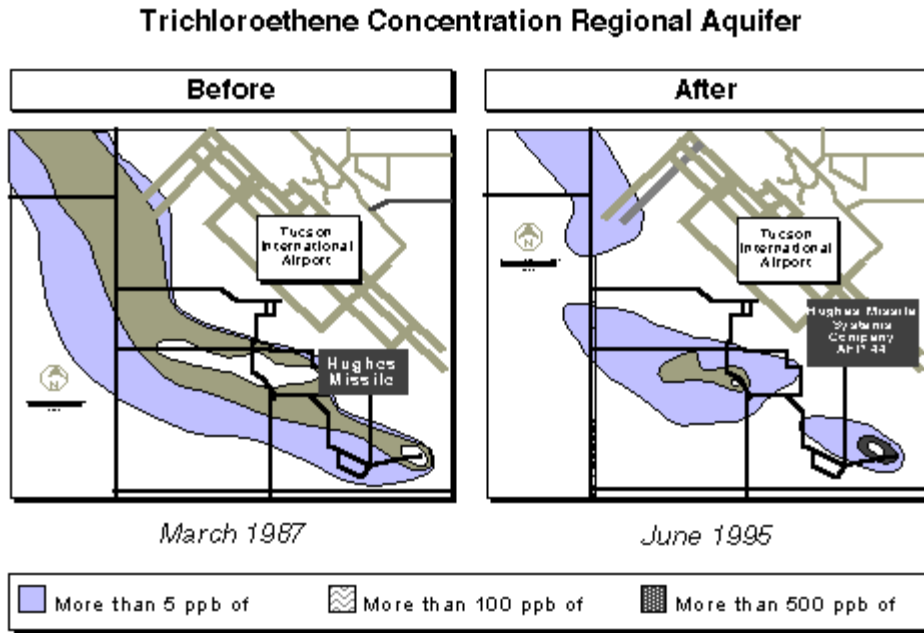
Effective research and development can also mean employing an existing technology to a currently unmet need rather than developing a new technology. The U.S. Army's efforts at Aberdeen Proving Ground illustrates an example of efficient dual-use technology in practice.

Using biological models to monitor the success of groundwater cleanup has resulted in significant cost savings. Initial results indicate a cost savings of between \$4 and \$5 million, which represents a 10 to 1 return on investment. Because of their obvious success, biomonitoring technologies will be used for future applications at similar sites. One opportunity for the expanded use of biological models is in the evaluation of contamination levels in wastewater effluent, an issue that DoD, EPA, and private industry must face on a regular basis. The specific species used to monitor the cleanup activities may change for each application, but the overall general process remains the same.

Public acceptance of the entire restoration program has been significantly enhanced by the development and use of biomonitoring technologies. The public is now assured that only "clean" water can be discharged to the Chesapeake Bay, one of the nation's richest ecological and recreational resources.

A new application of an existing biomonitoring technique will facilitate cost-effective verification of groundwater cleanup activities.

Exceptional Pump-and-Treat Results at Air Force Plant 44



Air Force Plant (AFP) 44 in Tucson, Arizona, is completing a substantial cleanup of a groundwater plume contaminated with the carcinogen, trichloroethene. In the early 1980s, when groundwater contamination was discovered and attributed to industrial activities at AFP 44, the Air Force and the contractor operating the plant took a proactive approach and constructed a state-of-the-art groundwater treatment plant. The treatment facility currently treats poor quality groundwater at a rate of 4.5 million gallons per day. Today, more than 8 years after construction and activation, the treatment facility has remediated about 11.5 billion gallons of groundwater to better than drinking water standards, and overall area of plume concentrations exceeding 100 parts per billion has been reduced by 80 percent.

In 1988, plume migration was successfully stopped, and since then it has been contained by operating the pump-and-treat system. At present, the 15-year completion time for remediating the plume is still on schedule, with a target date of 2002. In addition to treating trichloroethene-contaminated groundwater, the pump-and-treat system was also designed to reduce chromium concentrations to allowable levels. In 1994, ahead of schedule, the pump-and-treat system had successfully remediated chromium contamination in the groundwater.

By combining data from continuous monitoring of the plume with the results of hydrologic tracer studies, the installation is able to track the plume as it shrinks. The implementation of innovative procedures was made possible by the cooperative efforts of the Air Force, the University of Arizona, and regulatory agencies.

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Proving the Process Works... the Air Force Bioventing Initiative

Achieving high performance, routine use, and widespread acceptance is a major accomplishment for any new technology. The Air Force bioventing initiative serves as a shining example of efficient and effective technology development, demonstration, and commercialization. Within only several years of beginning research and development on bioventing, the Air Force advanced the technology into numerous demonstration programs. Soon thereafter, EPA and many states approved the Air Force use of the bioventing technology. Since then, the Air Force has successfully transferred the technology to the commercial market, where it is now one of the most widely used methods of cleaning up soil contaminated with petroleum hydrocarbons. In addition, the Air Force has disseminated extensive cost and performance data to the environmental