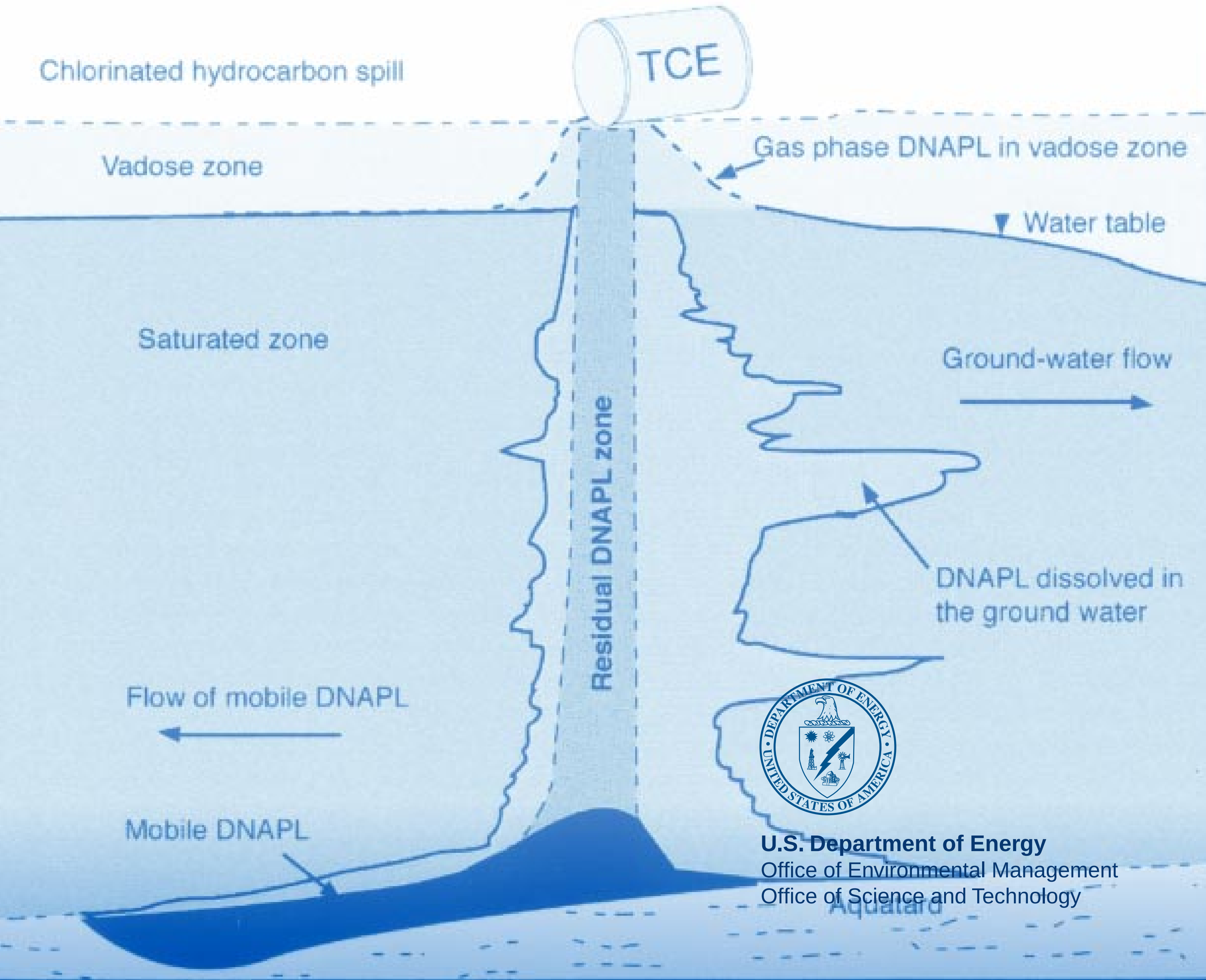
Federal Agencies Join Forces to Combat DNAPLs



U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology

DNAPLs—A Tough and Widespread Problem:

Federal agencies and private industry responsible for cleanup recognize that remediating dense, nonaqueous-phase liquids, or DNAPL sources is one of the most difficult environmental challenges they face. DNAPLs typically include industrial chlorinated solvents—trichloroethylene, perchloroethylene, and carbon tetrachloride. Many other volatile organic compounds and polychlorinated biphenyls are also common co-contaminants. DNAPLs are toxic, only marginally soluble in water, denser than water, and subject to becoming trapped in pore spaces between soil particles.

The U.S. Air Force estimates that chlorinated solvents are, after spilled fuel, the second most common contaminant in soils and groundwater and anticipates cleaning up nearly 600 sites. Approximately 30 sites at 15 DOE facilities are confirmed or believed to have high potential for DNAPLs.

One of the largest DOE spills, at the A/M Area at the Savannah River Site, may contain up to 1,750 tons of DNAPL, which has contaminated an estimated 4 billion gallons of otherwise potable groundwater. The chemical and physical behavior of these contaminants makes them difficult to detect, characterize, and treat and raises the possibility of health-threatening contamination continuing for centuries or even millennia.

Solution:

On April 6, representatives of four federal agencies signed a memorandum of agreement (MOA) to cooperatively test and document the cost and performance of three innovative technologies for treating DNAPLs—compounds that have traditionally proven difficult to characterize and remediate. Although the MOA was signed only recently, the Interagency DNAPL Consortium's (IDC) Core Management Team has been working together for more than a year to prepare for the side-by-side demonstration and comparison of DNAPL technologies. Early accomplishments of the team include delineating each agency's role in the project, selecting and characterizing the demonstration site at Launch Complex 34 at the Cape Canaveral Air Station in Florida, and selecting the vendors whose technologies will be demonstrated. Members of the consortium are the U.S. Department of Energy's Subsurface Contaminants Focus Area; the U.S. Environmental Protection Agency's National Risk Management Research Laboratory in Cincinnati, Ohio; the U.S. Department of Defense's Air Force Research Laboratory at Tyndall Air Force Base, Florida; the National Aeronautic and Space Administration's Kennedy Space Center, Florida; the U.S. Air Force 45th Space Wing at Patrick Air Force Base, Florida; and the Cape Canaveral Air Station, Florida.

Signing Ceremony at Cape Canaveral for the Memorandum for the Interagency Dense Nonaqueous Phase Liquid (DNAPL) Consortium. The project is demonstrating technologies for the characterization, remediation, and verification of a DNAPL site at Cape Canaveral. Other agencies participating include Environmental Protection Agency, U.S. Air Force, Department of Energy's Offices of Science and Technology and Environmental Restoration, and the National Aeronautics and Space Administration (NASA). The signing was held April 6, 1999 (see photo at left).

Also, on April 27, 1999 the U.S. DOE and the Ontario Ministry of the Environment signed an agreement to work jointly in the development and evaluation of technologies to remediate fractured bedrock sites contaminated by DNAPLs. Ground waters contaminated with DNAPLs in fractured bedrock pose potential threats to public health and the environment in Ontario as well as in the U.S. Through information gathered at the Smithville, Ontario demonstration site, DOE sites will be able to work on difficult problems in a shorter time frame.

More Progress Through Collaboration:

Tom Early of Oak Ridge National Laboratory, who has been supporting involvement by the Subsurface Contaminants Focus Area in this collaborative effort from the beginning, says that the IDC demonstration is the first time government agencies have joined together to test DNAPL innovative technologies. “We share the problem, and we’ll share the results.” Early mentions two factors that led to federal agencies agreeing to work together on DNAPLs: a realization among DOD, EPA, and DOE that technology development programs were receiving smaller budgets each year and the shift to an emphasis on cleanup.

Early says that it was recognized that “funding for technology development was on the downswing and that agencies could improve the retrograde funding picture” and leverage resources by working together. “Also, the emphasis began to move toward cleanup, using innovative technologies that we had in the toolbox now.” Instead of developing more technologies, more progress could be made by focusing on the testing of technologies that could be deployed within five to ten years. “We didn’t have a good way to compare these technologies, so we were at the point to jointly sponsor a side-by-side demonstration of their performance and cost.”

Early believes the testing at Cape Canaveral is only the first step. It will be necessary to conduct other comparative demonstrations “to test the robustness of these technologies at other sites with more complex conditions than exist at Launch Complex 34.”

DOE Subsurface Contaminants Focus Area Lead Office Manager Jim Wright also stresses the importance of collaboration. “This interagency collaborative effort to clean up a DNAPL-contaminated site at the NASA Launch Pad 34 will yield many benefits. First is the demonstrated ability to put together a major remediation project with multiple agencies sharing resources and expertise to solve a common problem. Second will be the verified cost and performance data that each agency can use to advance its baseline remediation techniques. And lastly, this effort will result in a willingness to address other common problems in a cooperative and cost-effective manner.”

Technologies Ready for Testing:

Because the traditional pump-and-treat technology is incapable of treating DNAPLs in a cost-effective manner and within a reasonable timeframe, the IDC’s Core Management Team has selected three innovative technologies to demonstrate their effectiveness and cost in removing DNAPL sources or destroying DNAPLs in situ. The Subsurface Contaminants Focus Area within DOE’s Office of Science and Technology has supported the development of all three selected technologies: Six-Phase Soil Heating, Dynamic Underground Stripping combined with Hydrous Pyrolysis/Oxidation, and In Situ Chemical Oxidation with Potassium Permanganate.

Six-Phase Soil Heating (SPSH)

OST Reference #5

Developed by Pacific Northwest National Laboratory, SPSH relies on indigenous soil moisture to create an in situ source of steam that strips volatile and semivolatile contaminants from soils. An electrical current passes through soil, which generates heat due to the soil's electrical resistance. The temperature within the remediation area is increased to the boiling point of water. Soil moisture becomes steam that is captured by vapor recovery wells for removal. Soil contaminants are also vaporized and are captured for ex situ treatment.

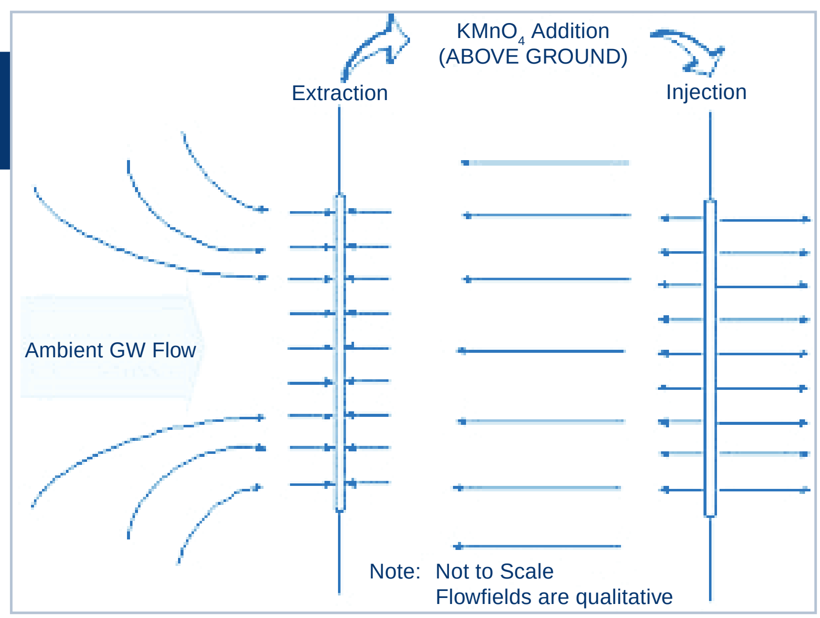
Benefits:

- Reduces VOC removal time to a few weeks for a typical site, whereas Soil Vapor Extraction (SVE) would require years for remediation
- Reduces costs over SVE (from 2 to 10 times)

In-situ Chemical Oxidation with Potassium Permanganate

OST Reference #167

In Situ Chemical Oxidation uses oxidant solutions to flush through a contaminated aquifer by injection and extraction through multiple horizontal and vertical wells. Potassium permanganate ($KMnO_4$), the oxidant, chemically decomposes a wide range of organic compounds into harmless breakdown products, such as carbon dioxide, chloride ions, and manganese dioxide. $KMnO_4$ is typically applied at concentrations of 1–3 percent solution via injection wells. This solution, which is easily handled, mixed, and injected, is nontoxic and nonhazardous.



Benefits:

- Fills a technology gap where remediation currently can't be done
- Expected to significantly lower risks: a long-term source of contamination will be removed using this technology
- Cost benefits expected: the cost of excavation/disposal for large sites will increase rapidly, and in situ gaseous reduction will show a cost advantage

Dynamic Underground Stripping (DUS) Plus Hydrous Pyrolysis/Oxidation

OST Reference #7

This process introduces oxygen into the underground to convert contaminants into benign products such as carbon dioxide, chloride ions, and water. To provide the oxygen, steam and air are injected in parallel pipes, building a heated, oxygenated zone in the subsurface. When injection is halted, the steam condenses and contaminated groundwater returns to the heated zone. The groundwater then mixes with the condensed steam and oxygen, which destroys dissolved contaminants. By destroying DNAPLs and dissolved contaminants in place, this process eliminates the need to handle, treat, and dispose of contamination at the surface.

Benefits:

- Significantly increases reaction rates; decreases remediation time
- Provides an economical alternative to pump-and-treat or pump-and-treat with vacuum extraction
- Encourages bioremediation—an important final step in soil and groundwater cleanup
- Eliminates need for further treatment, handling, and disposal requirements

Operational Details:

The three innovative DNAPL technologies will be tested in 50-ft by 75-ft cells that have been set up at the Engineering Support Building at LC-34. Testing, which will begin this summer and continue into the fall, will generate cost and performance data by which to evaluate and compare the in situ thermal and oxidation DNAPL remediation technologies. Technical reports, which are expected to be released in fall 2000, will document costs and performance and will be available for site owners, regulators, and stakeholders so that informed decisions can be made regarding the economics and performance capabilities of the DNAPL remediation technologies.

Florida State University's Institute for International Cooperative Environmental Research will provide day-to-day field project management through a cooperative agreement with DOE. The EPA Superfund Innovative Technology Evaluation (SITE) program will conduct quality assurance, quality control monitoring, and independent technology evaluations.

For more information:

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Office of Science and Technology home page:
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Subsurface Contaminants Focus Area Home Page
http://www.envnet.org/scfa/tech/dnapl/currdnapl.htm

IDC Home Page:
http://www.getf.org/dnaplguest

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