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Cooking Up Solutions
Cleaning Up With Lasagna™

People in Paducah, Kentucky are not necessarily talking about pasta when they brag about their Lasagna™. Named after the subsurface layering of sands, silts, and clays, Lasagna™ is an innovative technology that reduces trichloroethene (TCE) contamination in soil in a manner that is faster, more effective, and less costly than traditional cleanup options.

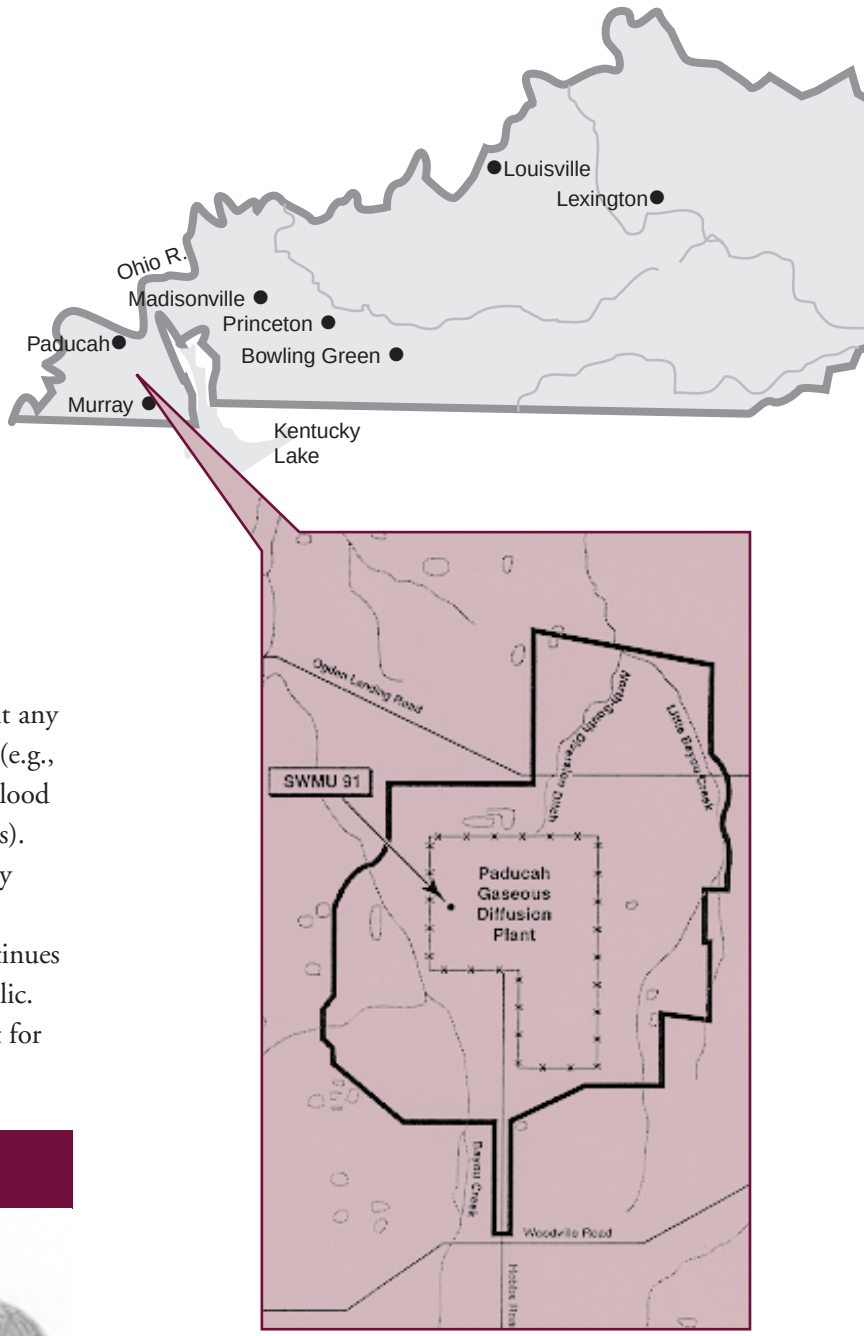
Photo courtesy of DOE.
A worker explains Lasagna™ to visitors.

At the Paducah Gaseous Diffusion Plant, a U.S. Department of Energy (DOE) facility in western Kentucky, a partnership of federal agencies, private industry, and the Commonwealth of Kentucky tested Lasagna™ in dense, clayey soil. This innovative technology was used to help eliminate source contamination of TCE from the soils and to prevent associated underlying groundwater contamination. Lasagna™ represents an outstanding achievement by business and government in joint pursuit of solutions to one of the nation's most complex cleanup problems.

"We see this as an innovative technology that can knock out contamination. That's why we're excited about it," says Carl Froede, Remedial Project Manager for the Environmental Protection Agency's Region 4. "Using Lasagna™ makes it possible to remediate a site in two to four years as opposed to potentially hundreds of years with conventional technologies."

Problematic Ingredients

Since 1952, the Paducah plant has enriched uranium, a step in making fuel for commercial nuclear reactors. Located a few miles south of the Ohio River, an extensive wildlife management area buffers the plant from the surrounding community. When tests showed TCE contamination in four private wells outside the plant boundary in August 1988, response was immediate. The discovery of TCE-contaminated groundwater outside plant boundaries revealed that TCE, dissolved in groundwater, had migrated to some nearby residents' water wells.



DOE acted swiftly to address the situation and halt any potential health concerns linked to TCE exposure (e.g., speech and hearing impairments, kidney disease, blood disorders, strokes, anemia, diabetes, and skin rashes). Without delay, DOE installed water lines to nearby residences and businesses to provide an alternative drinking water supply, and the Paducah plant continues to provide drinking water to the affected local public. Working with EPA and the Kentucky Department for Environmental Protection (KDEP), DOE began a comprehensive facility-wide search for the sources of TCE contamination.

Sampling of activated carbon socks measures removal of TCE from contaminated soil.

Photo courtesy of DOE.

One area at the plant where TCE contamination is a problem is Solid Waste Management Unit 91 (SWMU 91). In the mid 1960s and late 1970s, transportation accidents had been simulated to test the structural integrity of steel containers used to transport uranium material. DOE tested tanks at SWMU 91, dropping

Photo courtesy of DOE.

Drilling a well point at the Lasagna™ test site.

cylinders chilled in dry ice and TCE onto concrete pads. It has since been determined that the TCE not only splashed across this area, but also that the original concrete in-ground pit contained a hole that allowed TCE to leak into the underlying soil. In addition, Paducah plant workers used TCE extensively at other locations as a cleaning solvent for mechanical parts, a typical industrial practice at that time. This contamination resulted in the Paducah plant's placement on the National Priorities List in 1994.

Combine Partnerships With Innovation

The Paducah plant, faced with TCE-contaminated soil and the need to protect the underlying groundwater aquifers, exemplified the need for creative solutions. Cleanup procedures needed to address both soil contamination as a source of TCE and groundwater contamination resulting from dissolved TCE. Removing TCE from the soil, as a first step, would help alleviate contamination of groundwater by eliminating its source. To clean the clayey soils, however, DOE needed a valid technology that could remove the TCE. One traditional option was to dig up contaminated soil and burn away the TCE. Another was to haul the soil to a remote location. DOE, EPA, and KDEP sought a more innovative solution that would address sitewide contamination in ways that reduced toxicity, mobility, and the volume of waste. Unfortunately, available proven technologies for treating TCE-contaminated soils were limited in scope and effectiveness.

In the private sector, corporations also faced the reality of contamination at their industrial sites. A few corporations with sufficient resources initiated independent research on new technologies for environmental cleanup. At the same time, government regulators determined many cleanup operations were charting new territory and existing procedures did not always address the complex problems of contaminated sites. The number of cleanup projects nationwide provided an impetus to compare findings among industry and government researchers to determine the least expensive and most effective solutions. Both industry and government stood to benefit from better, faster, and less costly solutions. A 1992 initiative by the Monsanto Company led the way. Three U.S. corporations—Monsanto, Dupont, and General Electric—created a research consortium and allied with DOE, KDEP, and EPA to test Lasagna™ at the SWMU 91 site.

All in Good Measure

The Lasagna™ process targeted the challenge officials faced at Paducah: removal of TCE from dense, clayey soil more effectively and more economically than traditional technologies. Determining remediation for a site requires

that managers identify and review cleanup alternatives, prepare a feasibility study that analyzes each option, and determine site-specific applicability of the technologies. For cleanup at Paducah, Lasagna™ showed promise but, as an emerging technology, lacked cost and performance data for onsite remediation of soil contamination. DOE chose to fund field testing of Lasagna™ at the Paducah plant in 1995 to determine Lasagna's effectiveness under actual conditions.

In a joint effort, representatives from DOE, EPA Region 4, KDEP, and industry (led by Monsanto) agreed to use Lasagna™ in a phased approach to determine if it might prove successful. This technology uses an electric current to drive groundwater through treatment zones of activated carbon and iron-filings for the destruction and removal of TCE from soil. The electric field is reversed to flush the area with water and remove TCE bound within clayey soil.

Initial tests began in 1995 at a 150-square-foot area at SWMU 91. The testing during Phase I lasted for 120 days and yielded impressive results—approximately 98 percent of the total volume of TCE was removed from the soil. On the basis of that success, year-long testing was initiated to evaluate performance and costs at an expanded site. Completed in July 1997, the expanded field testing, Phase IIA, which occupied a 20-by-30-foot area to a depth of 45 feet, showed 75 percent of total volume of TCE removed from the soil.

A Community Is Served

With outstanding results from the field tests, decision-makers at the Paducah plant ruled out other more costly and time-consuming cleanup options for SWMU 91. Lasagna™'s effectiveness and comparatively modest cost estimates established the technology as workable and appropriate for remedial action at SWMU 91. With approval from the Commonwealth of Kentucky and the Site-Specific Advisory Board, EPA and DOE signed a Record of Decision in August 1998, documenting Lasagna™ as a viable technology for removal of TCE from clayey soil.

The success of Lasagna™ shows great promise in remediating the SWMU 91 site in a better, faster, and cheaper manner. The full-scale use of this technology at SWMU 91 will ultimately save more than a million dollars compared to conventional technology. As cost and performance projections for full-scale implementation are verified, Lasagna™ technology moves one step closer to acceptance as an established treatment for soil remediation. When established, Lasagna™ can be readily applied wherever TCE-type chlorinated solvents necessitate cleanup in clay or silt soils.

The Paducah experiment demonstrates success on several fronts. Lasagna™'s test results show that the new technology destroys TCE bound within the clayey soils of the test site. The partnership's collaboration in treating soil contaminated with TCE demonstrates that government and industry can work together effectively in finding solutions for the remediation of environmental pollution. The Lasagna™ demonstration also is an opportunity for the public and private sectors to develop lasting partnerships with an enormous potential for meeting future environmental challenges.

Solid Waste Management Unit 91, where the Lasagna™ technology will be applied at full scale.

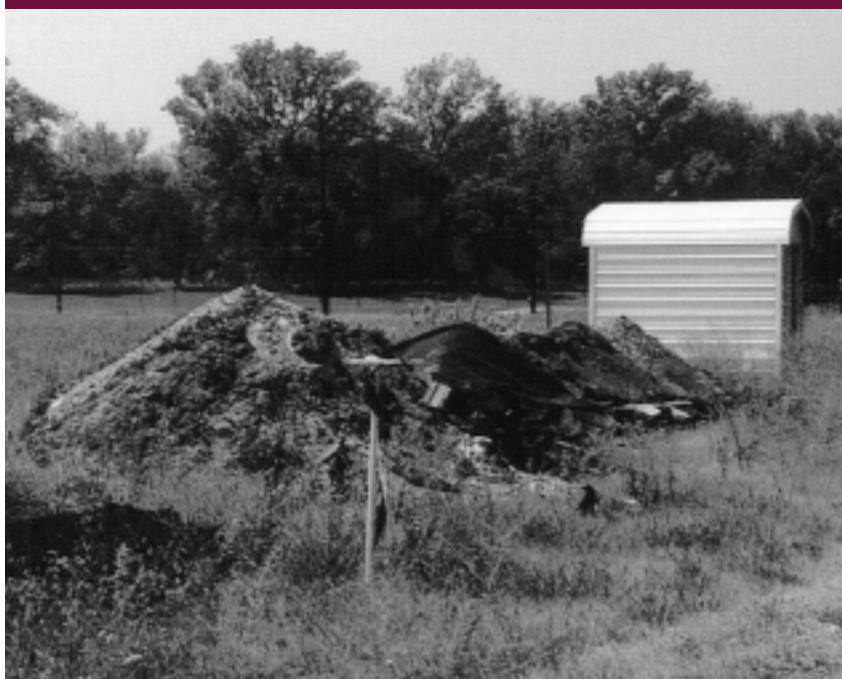


Photo courtesy of DOE.

LASAGNA™ SOIL REMEDIATION TECHNOLOGY

Photo courtesy of DOE.

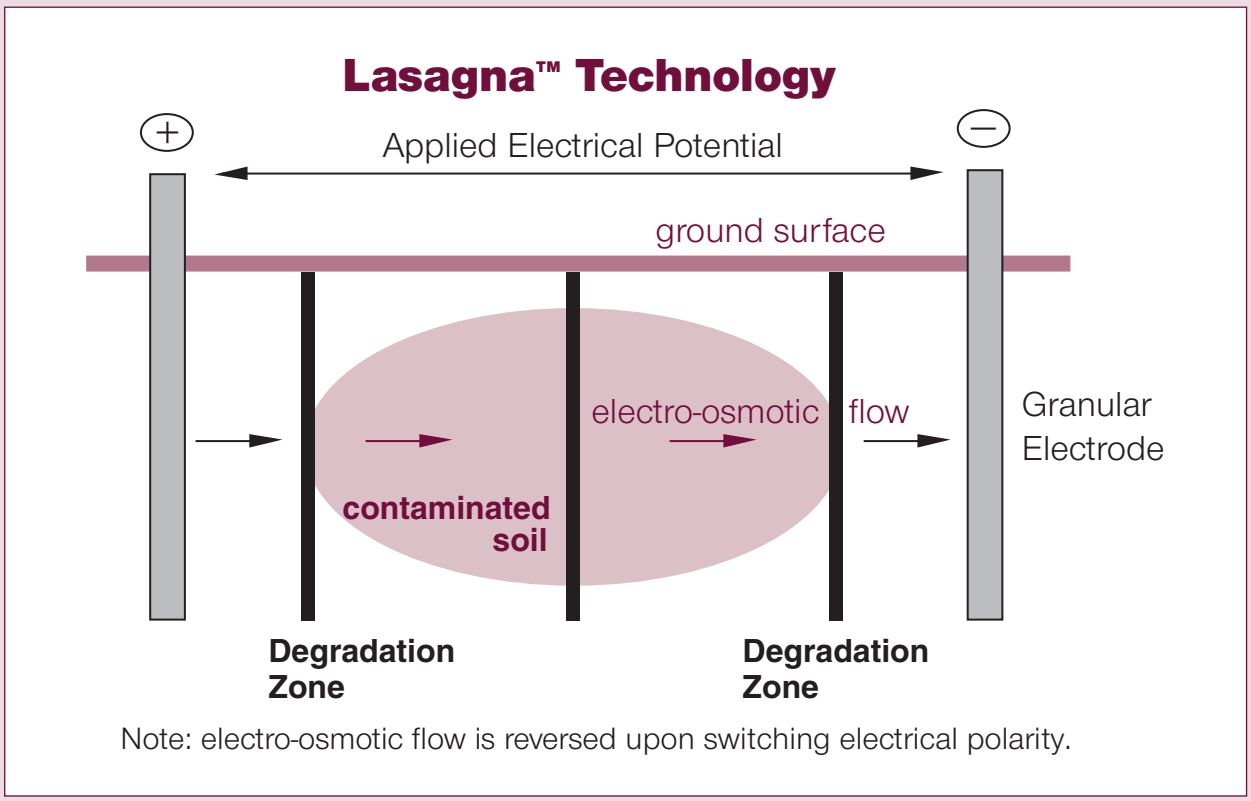
View of Lasagna™ System in operation.

The Lasagna™ process uses low-voltage electric current to clean TCE (a soluble chlorinated solvent) from soil by flushing contaminated groundwater from the pore spaces within the silt and clay soils where it may be trapped. Its capacity to remove contaminants without excavating, soil washing, or incinerating the soil is a critical factor in saving time and money.

Lasagna™ takes its name from the layering of sands, silts, and clays, which resembles lasagna in cross-section. Treatment layers of kaolin and iron filings are interspersed within the contaminated soil. Selected wells surrounding the project area are filled with carbon or graphite and are used to conduct electricity and generate the electric field.

When electricity is applied to the carbon or graphite zones, they act as electrodes, creating an electric field. Within the field, water in the soil flows toward an electrical charge, pulling soluble contaminants into treatment zones, where they are neutralized or destroyed. A water management system recycles and returns water that accumulates at the negative pole back to the positive pole for acid-base neutralization.

The cost of cleaning a cubic yard of soil in this way is estimated to be $80 to $190, considerably less than alternatives that require removal of soil or water. Costs can be reduced by at least 30 percent, for example, compared with deep soil mixing at $290 per cubic yard.



Note: electro-osmotic flow is reversed upon switching electrical polarity.

For more information about Lasagna™ technology and cleanup at the Paducah Gaseous Diffusion Plant, contact:

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