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A Citizen's Guide to Innovative Treatment Technologies

For Contaminated Soils, Sludges, Sediments, and Debris

Technology Innovation Office | Technology Fact Sheet

What are innovative treatment technologies?

Treatment technologies are chemical, biological, or physical processes applied to hazardous waste or contaminated materials to permanently change their condition. This Citizen's Guide focuses on treatment technologies for soil, sludge, sediment, and debris.

Treatment technologies destroy contaminants or change them so that they are no longer hazardous or, at least, are less hazardous. They may reduce the amount of contaminated material at a site, remove the component of the waste that makes it hazardous, or immobilize the contaminant within the waste.

Innovative treatment technologies are newly invented processes that have been tested and used as treatments for hazardous waste or other contaminated materials, but still lack enough information about their cost and how well they work to predict their performance under a variety of operating conditions.

Why use an innovative technology?

Treatment of contaminated sludges and soils is a field of technology that has developed and grown since Congress passed the "Superfund" law for contaminated waste site cleanup in 1980. An initial approach to eliminate a hazardous waste from a particular location was to move it somewhere else, or cover it with a cap. These methods use *land disposal* as the solution to the problem. With an increasing number of cleanups underway, and the passage of amendments to the Superfund law in 1986 that stated a preference for *treatment*, demand developed for alternatives to land disposal that provided more permanent and less costly solutions for dealing with contaminated materials. Development and use of more suitable treatment technologies has progressed.

As knowledge about the cleanup of contaminated sites increases, new methods for more effective, permanent cleanups will become available. Innovative treatment technologies, which lack a long history of full-scale use, do not have the extensive documentation necessary to make them a standard choice in the engineering/scientific community. However, many innovative technologies have been used successfully at contaminated sites in the United States, Canada, and Europe despite incomplete verification of their utility. Some of the technologies were developed in response to hazardous waste problems and some have been adapted from other industrial uses.

Developing and perfecting treatment technologies is an on-going process, as shown in Figure 1 on page 2. The process begins with a **concept** — an idea of how to treat a particular hazardous waste. The concept usually undergoes a research and evaluation process to prove its feasibility. If the concept is found to be useful, often the next step is to undergo bench-scale testing. During bench-scale testing, a small-scale version of the technology is

Why Use Innovative Treatment Technologies?

- They offer cost-effective, long-term solutions to hazardous waste clean-up problems.
- They provide alternatives to land disposal or incineration.
- They are often more acceptable to surrounding communities than some established treatment technologies.

Are Innovative Treatment Technologies Always the Right Choice?

Although innovative treatment technologies may be less expensive and even more effective than established technologies, science and engineering professionals must determine which technology is most appropriate at a given site.

built and tested in a laboratory. During this testing, it is considered an **emerging** technology. If it is successful during bench-scale testing, it is then demonstrated at small-scale levels at field sites. If successful at the field demonstrations, the technology often will be used full-scale at contaminated waste sites. As the technology is used and evaluated at different sites, it is continuously improved.

Only after a technology has been used at many different types of sites and the results fully documented, is it considered an **established** technology. The majority of technologies in use today are still classified as **innovative**.

What types of treatment technologies are in use?

Established technologies such as incineration and solidification/stabilization have been the most widely used at Superfund sites. By 1990, however, 40 percent of the treatment technologies used were innovative. In 1994 the figure reached almost 60 percent. Table 1 on page 3 describes some of the most frequently used innovative treatment technologies.

How is a treatment technology selected for a site?

Before a treatment technology can be selected for a Superfund site, detailed information about the site conditions and contaminants must be collected. EPA uses this information to determine which of the possible remedies will be capable of meeting the clean-up standards that EPA has set.

A treatability study is often conducted to assess a treatment technology's potential for success. It is conducted on contaminated material from the site, either when the treatment technology is being considered or after selection of the remedy, in order to collect additional operation and performance information.

There are three levels of a treatability study. The level chosen depends on the information available about the site and technology and the nature of information that is needed. The quickest, least expensive treatability study is the **laboratory screening**. It is done to learn more about the characteristics of the waste to determine if it would be treatable by a particular technology. A laboratory screening test takes a matter of days and generally costs from $10,000 to $50,000. Successful laboratory screening may lead to more sophisticated treatability studies.

The next level of a treatability study is the **bench-scale study** which provides greater information on the performance (and, in some cases, the cost) of a technology by simulating the treatment process using a very small quantity of waste. The objective of this type of test is to determine if the technology can meet the clean-up standards set for the site. These tests typically cost between $50,000 and $250,000.

At the highest level, the **pilot-scale treatability study** is usually conducted in the field or the laboratory and requires installation of the treatment technology. This study is used to provide performance, cost, and design objectives for the treatment technology. Due to the cost of this type of study—generally more than $250,000—it is used almost exclusively to fine-tune the design of the technology following other treatability studies.

What happens if a technology does not work?

There is always a possibility that a treatment technology, established or innovative, may not work once it is in full-scale operation in spite of the best engineering design. Site conditions that could not be predicted from the smaller-scale studies are often to blame. Natural conditions are far more complex than laboratory conditions.

Figure 1
Developing Treatment Technologies

Concept	Emerging	Innovative			Established
• Idea • Research • Laboratory Screening	• Bench-Scale Study	• Pilot-Scale Study or Field Demonstration	• Chosen for Cleanup	• Limited Full-Scale Use	• Common Full-Scale Use

Table 1
Descriptions of Some Innovative Treatment Technologies

Soil Vapor Extraction removes contaminant vapors from soil (without having to dig it up) through the use of vacuum extraction wells placed in the ground. Contaminants are collected for further treatment.

Air Sparging injects air into the ground below the contaminated area, forming bubbles that rise and carry trapped and dissolved contaminants to the surface where they are captured by a soil vapor extraction system.

Bioremediation uses microorganisms, such as bacteria in engineered processes, to break down organic contaminants into harmless substances.

Thermal Desorption heats soil at relatively low temperatures to vaporize contaminants with low boiling points. Vaporized contaminants then are captured and removed for further treatment or destruction.

Soil Washing uses water or a washing solution and mechanical processes to scrub excavated soils and remove hazardous contaminants.

Chemical Dehalogenation converts contaminants that contain halogens (chlorine and fluorine, for example) to less toxic substances through controlled chemical reactions that remove or replace halogen atoms.

Solvent Extraction separates hazardous organic contaminants from oily-type wastes, soils, sludges, and sediments, reducing the volume of hazardous waste that must be treated.

In Situ Soil Flushing floods contaminated soils beneath the ground surface with a solution that flushes the contaminants to an area where they can be extracted.

A technology may be adapted or redesigned to treat targeted waste, despite initial failures. In some rare cases a different technology may have to be designed and installed. Experience with and increasing use of innovative treatment technologies will lead to better and faster ways to clean up the environment.

Where are innovative treatment technologies being selected?

Industry is using technologies labeled as “innovative” by EPA for containing and treating the hazardous wastes generated during manufacturing processes. Innovative technologies also are being used under many federal and state clean-up programs to treat hazardous wastes that have been improperly released on the land. For example, innovative technologies are being selected to manage contamination (primarily petroleum) at some leaking underground tank sites. They also are being selected to clean up contamination that resulted from past disposal practices at industrial sites regulated under the Resource Conservation and Recovery Act, and to clean up contamination at uncontrolled hazardous wastes sites, known as Superfund sites. One innovative treatment technology, soil vapor extraction, is now routinely used in federal and state clean-up programs. As more cost and performance data are documented, innovative treatment technologies will be increasingly recognized for their effectiveness.

Why is EPA encouraging the use of innovative treatment technologies?

The Environmental Protection Agency is encouraging the selection of innovative treatment technologies for site remedies because they have the potential to be more cost-effective and to provide better and more efficient cleanups. In addition, they are often more acceptable to surrounding communities than established treatment technologies.

EPA Supports the Use of Innovative Treatment Technologies

The mission of EPA's Technology Innovation Office (TIO) is to increase government and industry use of innovative treatment technologies at contaminated waste sites.

Numerous other efforts to increase the use of innovative technologies are described in the EPA fact sheet entitled *Progress in Reducing Impediments to the Use of Innovative Remediation Technology.* (The document number is EPA 542-F-95-008 and can be ordered from NCEPI at the address given below.)

For More Information

The U.S. EPA's Technology Innovation Office has produced a series of Citizen's Guides, including this one, on topics relating to innovative treatment technologies:

- *A Citizen's Guide to Soil Washing,* EPA 542-F-96-002
- *A Citizen's Guide to Solvent Extraction,* EPA 542-F-96-003
- *A Citizen's Guide to Chemical Dehalogenation,* EPA 542-F-96-004
- *A Citizen's Guide to Thermal Desorption,* EPA 542-F-96-005
- *A Citizen's Guide to In Situ Soil Flushing,* EPA 542-F-96-006
- *A Citizen's Guide to Bioremediation,* EPA 542-F-96-007
- *A Citizen's Guide to Soil Vapor Extraction and Air Sparging,* EPA 542-F-96-008
- *A Citizen's Guide to Phytoremediation, EPA 542-F-96-014*
- *A Citizen's Guide to Natural Attenuation, EPA 542-F-96-015*
- *A Citizen's Guide to Treatment Walls, EPA 542-F-96-016*

Some other publications of interest include:

- *Selected Alternative and Innovative Treatment Technologies for Corrective Action and Site Remediation: A Bibliography of EPA Resources*, EPA 542-B-95-001. **A bibliography of EPA publications about innovative treatment technologies.**
- *Innovative Treatment Technologies: Annual Status Report (7th Ed.)*, EPA 542-R-95-008. **A description of sites at which innovative treatment technologies have been used or selected for use.**
- *Innovative Treatment Technologies: Annual Status Report Database*. **An automated computer database of descriptions of sites at which innovative treatment technologies have been used or selected for use.** The database can be downloaded free of charge from EPA's Cleanup Information bulletin board (CLU-IN). Call CLU-IN at 301-589-8366 (modem). CLU-IN's help line is 301-589-8368. The database also is available for purchase on diskettes. Contact NCEPI for details.

Copies of the items listed above are available from:

National Center for Environmental Publications and Information (NCEPI)
P.O. Box 42419
Cincinnati, OH 45242
Fax your order request to 513-489-8695 or call 513-489-8190

If these documents are out of stock, you may be directed to other sources. In this case, there may be a charge for some of these documents.