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A Citizen's Guide to Treatment Walls

Technology Innovation Office
Technology Fact Sheet

What are treatment walls?

Treatment walls are structures installed underground to treat contaminated ground water found at hazardous waste sites. Treatment walls, also called *passive treatment walls* or *permeable barriers,* are put in place by constructing a giant trench across the flow path of contaminated ground water and filling it with one of a variety of materials (reactive fillings) carefully selected for the ability to clean up specific types of contaminants. As the contaminated ground water passes through the treatment wall, the contaminants are either trapped by the treatment wall or transformed into harmless substances that flow out of the wall (Figure 1).

How do they work?

The reactive filling of a treatment wall is often mixed with sand or some other porous material to make it less dense than the soil around it. This encourages ground water to flow through the wall because it provides the "path of least resistance." At some sites, an underground funnel system is added to direct the contaminated ground water to the wall.

The specific filling chosen for a wall is based on the types of contaminants found at the site. Different fillings do their job through different chemical processes: *sorption, precipitation*, and *degradation*.

Sorption barriers contain fillings that remove contaminants from ground water by physically "grabbing" contaminants out of the ground water and holding them on the barrier surface (Figure 2a). Examples of these adsorbents are *zeolites*—tiny cage-like particles that trap molecules of contaminants inside them—and activated carbon which has a very rough surface that contaminant molecules stick to as they pass.

Precipitation barriers contain fillings that react with contaminants in ground water as they seep through the wall (Figure 2b). The reaction causes the contaminants dissolved in the ground water to change so they are no longer dissolved and "precipitate" out. These "insoluble" products are left trapped in the barrier and clean ground water flows out the other side. For example, lead is a common contaminant at industrial sites where careless recycling of automobile batteries has taken place. The lead-saturated battery acid that seeped into the ground water at these sites is difficult to trap and treat. A precipitation barrier filled with limestone placed across the path of the acidic, lead-contaminated ground water neutralizes the acid. This causes the lead to change to a

A Quick Look at Treatment Walls

- Are passive systems that require no mechanical equipment or energy source.
- Allow the site to be put to productive use while being cleaned up.
- Can be modified to treat different types of contaminants.
- Completely break down some organic contaminants.

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What Is An Innovative Treatment Technology?

Treatment technologies are processes applied to the treatment of hazardous waste or contaminated materials to permanently alter their condition through chemical, biological, or physical means.

Innovative treatment technologies are those that have been tested, selected or used for treatment of hazardous waste or contaminated materials but lack well-documented cost and performance data under a variety of operating conditions.

solid form that is trapped in the barrier. Highly toxic chromium (VI), a by-product of metal-plating operations, is treated by precipitation barriers in a similar way. It is changed to immobile chromium (III) which is trapped in the barrier.

Degradation barriers cause reactions that break down or "degrade" the contaminants in the ground water into harmless products (Figure 2c). For example, fillings of iron granules degrade certain volatile organic compounds. Walls also may be filled with a mixture of nutrients and oxygen sources which stimulate the activity of the microorganisms found in the ground water. Healthy microorganisms are important because they are responsible for the *biodegradation* of contaminants. Biodegradation is the process that naturally occurring microorganisms (yeast, fungi, or bacteria) use to break down, or *degrade*, hazardous substances into less toxic or nontoxic substances. Microorganisms, just like humans, eat and digest organic substances for nutrition and energy. (In chemical terms, "organic" compounds are those that contain carbon and hydrogen atoms.) Certain microorganisms can digest organic substances such as fuels or solvents that are hazardous to humans. The fact sheet entitled *A Citizen's Guide to Bioremediation* describes the process in detail (see page 4).

Much research and testing has been done on the use of iron for the treatment of chlorinated contaminants. The reaction that occurs when contaminants come in contact with iron granules puts to beneficial use the common chemical reaction called *oxidation* that causes iron to rust. As the iron is oxidized, the toxic component of the contaminant (usually a chlorine atom) is removed from the compound. The iron granules are dissolved by the process, but the metal disappears so

Figure 1. Schematic Diagram of a Treatment Wall

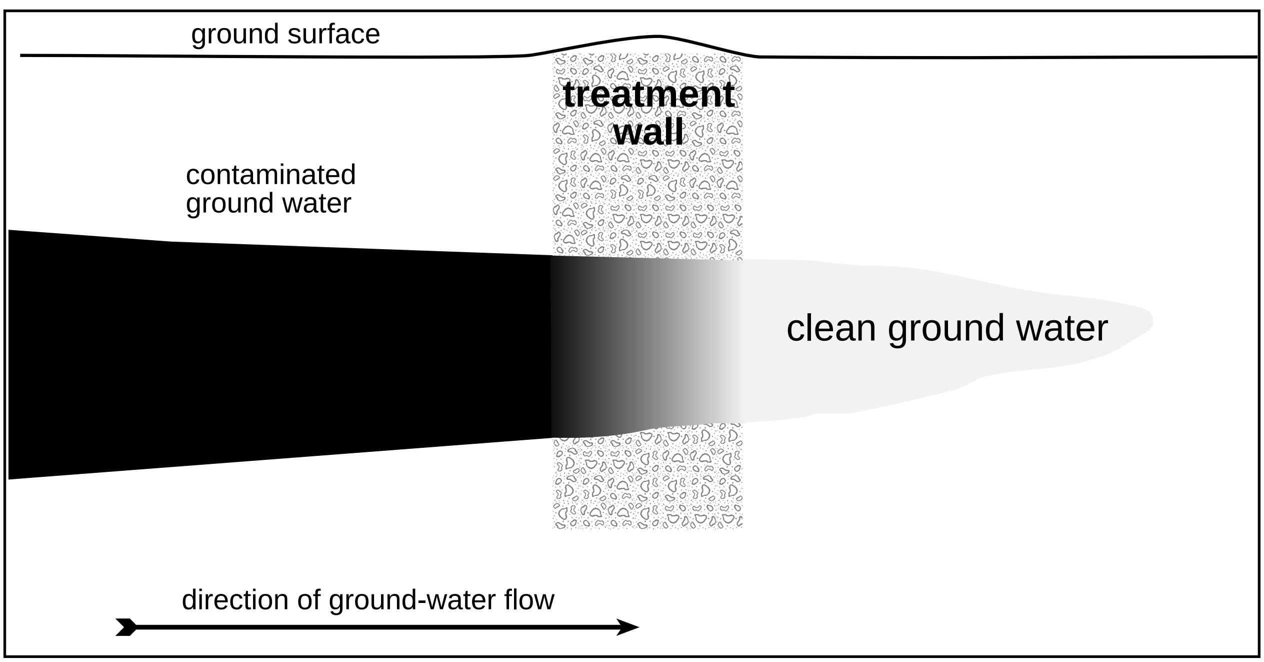
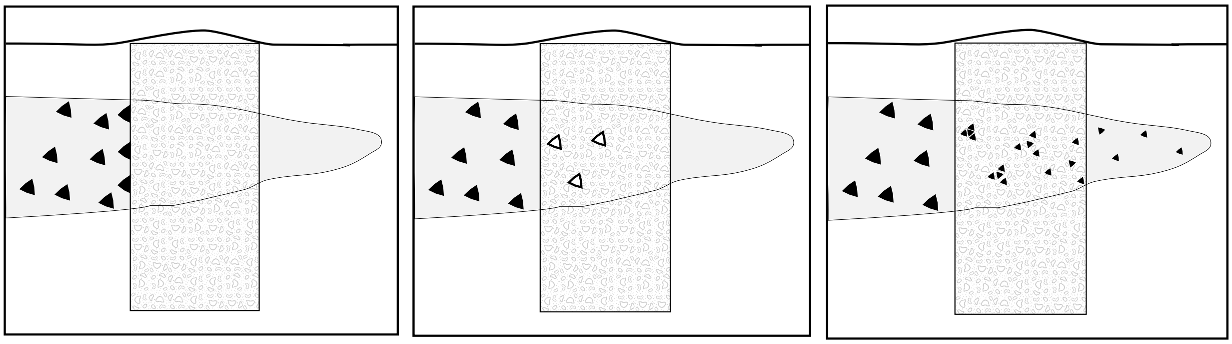


Figure 2. Sorption, Precipitation, and Degradation Treatment Walls



2a. SORPTION
Contaminants are pulled, unchanged, from ground water and held by the wall surface.

2b. PRECIPITATION
Contaminants are changed into solid forms that remain in the wall.

2c. DEGRADATION
Contaminants are broken down into harmless products that flow through the wall.

slowly that remediation barriers, engineers predict, will remain effective for many years, even decades. These iron granules are a by-product of manufacturing processes so their use as a barrier wall material has the added benefit of recycling this material.

Iron can be used to degrade many common chlorinated organic compounds such as trichloroethylene (TCE), tetrachloroethylene (PCE), dichloroethene (DCE) and 1,1,1-trichloroethane (TCA). Mixing palladium, another metal, with the iron granules enables the wall to treat contaminants that iron alone cannot treat.

Why use treatment walls?

The major advantage of treatment walls over traditional treatment methods such as pump-and-treat is that they are passive systems that treat the contaminants in place. There is no need to dig up contaminated soil or pump out contaminated water, there are no parts to break, no need for electricity, and, since there is no equipment on the surface, the property can be put to productive use while it is being cleaned up. Engineers estimate at least a 50% cost savings using treatment walls instead of pumping out contaminated ground water.

Will they work at every site?

The ideal site for a treatment wall is one having porous sandy soil, contamination no deeper than about 50 feet below ground, and a good, solid flow of ground water.

There are an estimated 5,000 Department of Defense, Department of Energy, and Superfund sites contaminated with chlorinated solvents. Probably 10 to 20 percent of these have the right conditions to use treatment walls. Treatment walls also are useful at sites contaminated with metals and radioactive contaminants.

The successful application of a treatment wall requires careful study of the underground environment and an understanding of the contaminant and ground-water flow.

In lab studies, some clogging of wall materials has been observed. So far, clogging has not occurred in the field, but walls have only been in place for a few years.

Where have they been used?

At a former semiconductor manufacturing site in Sunnyvale, California, 220 tons of iron shavings were used to fill a reactive treatment wall that has been breaking down TCE since December 1994. The above-ground equipment that was part of a previously installed pump-and-treat system was removed and the site has been leased to another company that uses it as a parking lot. Some Superfund sites that have chosen treatment walls as a cleanup method are listed in Table 1 on page 4.

Table 1. Some Superfund Sites that Plan to Use Treatment Walls*

Name of Site	Type of Wall/Filling	Contaminants	Site Use
Brown's Battery Breaking Site, PA	Precipitation/Limestone	Lead	Battery recycling & disposal
Tonolli Corporation, PA	Precipitation/Limestone	Lead	Battery recycling & disposal
Somersworth Sanitary Landfill, NH	Degradation/Iron	Organics	Municipal & industrial landfill

For a listing of Superfund sites at which innovative treatment technologies have been used or selected for use, contact NCEPI at the address in the box below for a copy of the document entitled ***Innovative Treatment Technologies: Annual Status Report (7th Ed.)***, **EPA 542-R-95-008.** Additional information about the sites listed in the Annual Status Report is available in database format. The database can be downloaded free of charge from EPA's Cleanup Information (CLU-IN) World Wide Web site (http://clu-in.com) or electronic bulletin board (301-589-8366). The CLU-IN help line number is 301-589-8368. The database also is available for purchase on diskettes. Contact NCEPI for details.

** Not all waste types and site conditions are comparable. Each site must be individually investigated and tested. Engineering and scientific judgment must be used to determine if a technology is appropriate for a site.*

For More Information

The publications listed below can be ordered free of charge by faxing your request to NCEPI at 513-489-8695. If NCEPI is out of stock of a document, you may be directed to other sources. You may write to NCEPI at:

National Center for Environmental Publications and Information (NCEPI)
P.O. Box 42419
Cincinnati, OH 45242

- *A Citizen's Guide to Bioremediation,* April 1996, EPA 542-F-96-007.
- "Metal-Enhanced Abiotic Degradation of VOCs," *Ground Water Currents* (newsletter), July 1995, EPA 542-N-95-004.
- "Funnel and Gate System Directs Plume," *Ground Water Currents* (newsletter), June 1993, EPA 542-N-93-006.
- "*In Situ* Degradation of Halogenated Organics by Permeable Reaction Wall," *Ground Water Currents* (newsletter), March 1993, EPA 542-N-93-003.
- *Permeable Barriers Action Team,* April 1996, EPA 542-F-96-010c.
- *In Situ Remediation Technology Status Report: Treatment Walls*, April 1995, EPA 542-K-4-004.
- "Zero-Valent Metals Provide Possible Solution to Groundwater Problems" by Elizabeth K. Wilson in *Chemical and Engineering News,* July 23, 1995, pages 19-22.
- "When Toxics Meet Metal" by Virginia Fairweather in *Civil Engineering,* May 1996, pages 44-48.

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