



A Citizen's Guide To In Situ Soil Flushing

Technology Innovation Office

Technology Fact Sheet

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What Is In Situ Soil Flushing?

In situ soil flushing is an innovative treatment technology that floods contaminated soils beneath the ground surface with a solution that will flush out the contaminants to an area where they will be extracted. In situ — meaning in place — refers to treating the contaminated soil without excavating and removing it.

The contaminants in the soil determine the type of flushing solution needed in the treatment process. The flushing solution is typically one of three types of fluids: 1) *water only*; 2) water plus additives such as *acids* (low pH), *bases* (high pH) or *surfactants* (like detergents); or 3) organic solvents.

Water is used to treat contaminants that dissolve easily in water. An *acidic solution* is a mixture of water and an acid, such as nitric acid or hydrochloric acid. Acidic solutions are used to remove metals and organic

contaminants, such as those typically found in battery recycling or industrial chrome plating processes. For example, zinc contamination — which can result from plating operations — would be treated with an acidic solution.

A *basic solution* is a mixture of water and a base, such as sodium hydroxide. An example of a base commonly used in households is ammonia. Basic solutions are used to treat phenols and certain metal species.

A *surfactant* is a detergent or emulsifier. Emulsifiers can join substances together which normally do not mix such as oil and water. Surfactant solutions are effective at removing contaminants, such as oil.

Organic solvents are substances that usually dissolve the contaminants water cannot dissolve. Common household products that contain organic solvents are paint strippers and nail polish removers.

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Chicago, IL 60604-3590

In Situ Soil Flushing Profile

- injects a washing solution into unexcavated soils to flush out contaminants.
- is most effective on soils that contain low silt or clay content.
- Requires the drilling of injection and extraction wells on-site.
- is a transportable technology that can be brought to the site after the wells have been installed.

How Does It Work?

Figure 1 on page 2 provides an illustration of one type of an in situ soil flushing process. The process begins by drilling injection wells and extraction wells into the subsurface where the contamination exists. The number, location, and depth of the injection and extraction wells depends on many geological factors and engineering considerations. Wells may be installed either vertically or horizontally. After the wells are in place, the soil flushing equipment and, typically, a wastewater treatment system, are transported to or built on the site.

The soil flushing equipment pumps the selected flushing solution into the injection wells. The solution percolates through the soils, picking up contaminants along its way. The natural flow of this percolation moves the solution toward the extraction wells. The extraction wells collect the subsequent *elutriate* — the flushing solution mixed with the contaminants.

From the extraction wells, the elutriate is pumped to the ground surface. Here, the elutriate is typically treated by a wastewater treatment system to remove the contaminants.

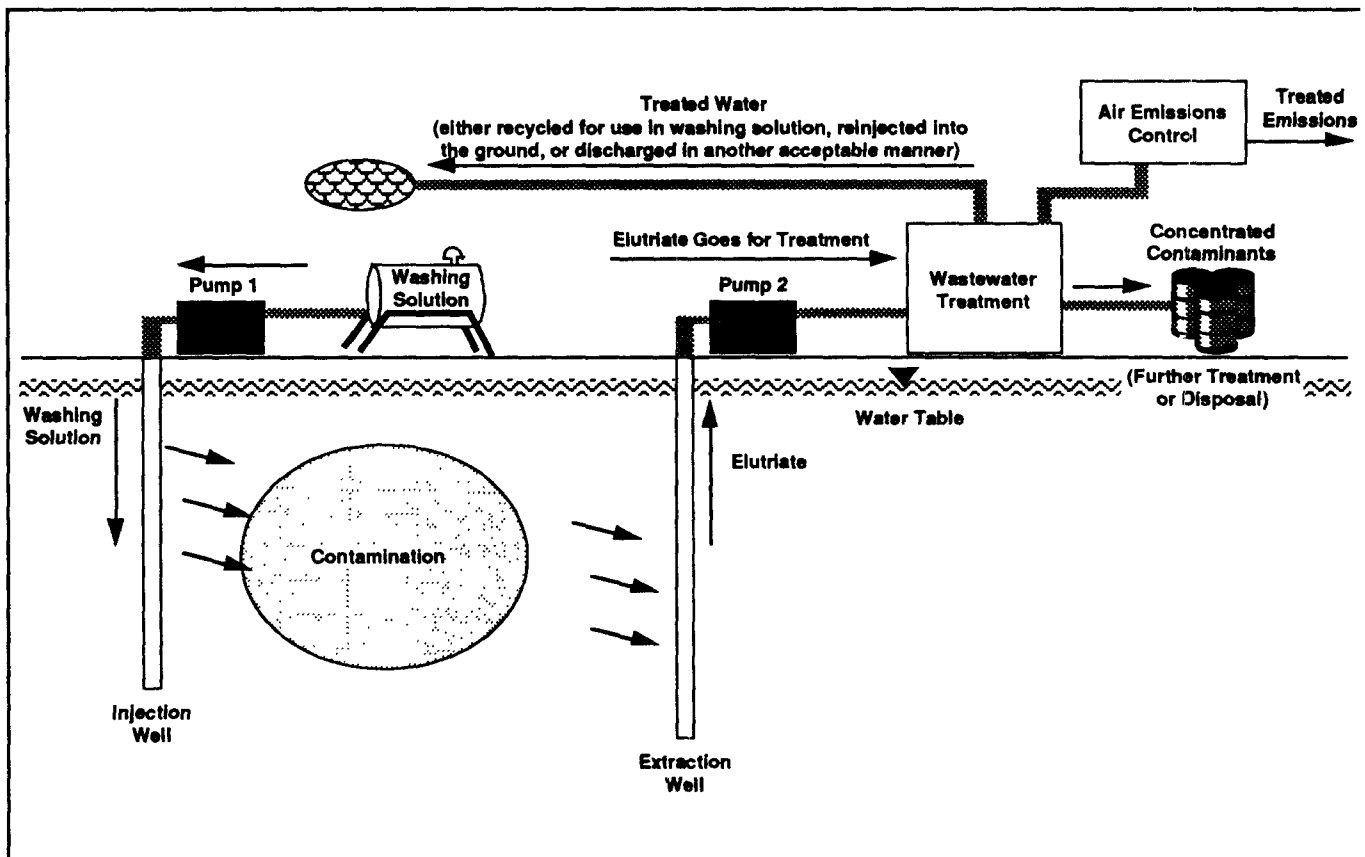
What is An Innovative Treatment Technology?

*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. Technologies 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 are called **innovative** treatment technologies.*

The contaminants are subjected to further treatment or disposal, and the treated water can either be recycled for use in the flushing solution, reinjected into the ground, or discharged in another acceptable manner. It is because of this circular process that in situ soil flushing systems are often referred to as injection/recirculation systems.

In situ soil flushing systems are designed to operate without air emissions. However, volatile air emissions could occur

Figure 1
In Situ Soil Flushing* (Using Vertical Wells)



*This figure shows one type of soil flushing done when saturated soil conditions exist.

during wastewater treatment. If necessary, air emissions will be controlled by collecting and treating the air prior to it being released.

Why Consider In Situ Soil Flushing?

In situ soil flushing is tailored to treat specific contaminants. By adding certain cleaning agents to the flushing solution, for example, the solution can be adjusted to mix more easily with certain soil contaminants. These contaminants, in turn, are carried away with the elutriate. Since in situ soil flushing is tailored to treat specific contaminants, this technology is not highly effective with soils contaminated with a variety of hazardous substances. It would be difficult to prepare a flushing solution that would effectively remove different types of contaminants.

In addition, since soil flushing is conducted in situ, no excavation is required. This reduces the need for excavation, handling, or transportation of the hazardous substances. The process has been most effective in removing the contaminants such as those identified in Figure 2 below. Some of the industries where these contaminants are found are also listed.

Figure 2
Contaminants Considered for Treatment
by In Situ Soil Flushing

Contaminants	Industries Where Found*
• Heavy metals (lead, copper, zinc)	<i>Battery Recycling, Metal Plating</i>
• Halogenated solvents (TCE, trichloroethane)	<i>Drycleaning, Electronics Assembly</i>
• Aromatics (benzene, toluene, cresol, phenol)	<i>Wood Treating</i>
• Gasoline and fuel oils	<i>Petroleum, Automobile</i>
• PCBs and chlorinated phenols	<i>Pesticide, Herbicide, Electric Power</i>

* All waste types and site conditions are not similar. 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.

Will It Work At Every Site?

In situ soil flushing works best with soils that contain very little silt or clay. If the soil has a high percentage of silt or clay, the flushing solution can not easily move through the soil. This limits the overall effectiveness of the soil flushing process. In addition, some flushing fluids contain additives or cleaning agents which may create some ground water contamination since all of it may not be completely removed.

There are additional limitations of this technology. For example:

- Ground water flow must be well-defined in order to design the well system for a given site. Defining the ground water flow can require extensive field investigations.
- In some cases, the chemical reactions of the soil with the flushing solution may decrease the ease with which the contaminants are carried away with the elutriate. To illustrate this, suppose a given site contains soil that is basic and is contaminated with metals. The most appropriate flushing fluid for this site would be an acid solution. The basic soil, however, may neutralize the acid solution, therefore inhibiting the transport of the metals.

Where Is In Situ Soil Flushing Being Selected?

Table 1, on page 4, lists some Superfund sites where in situ soil flushing has been selected as a treatment method. The table shows the sites, their location, and the types of facilities requiring treatment.

How Is Soil Flushing Different From Soil Washing?

With soil flushing, the soil is treated in place using an injection/recirculation process. Soil washing involves excavating the contaminated soil and treating it at the surface in a soil washer.

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Table 1
Site Locations Where In Situ Soil Flushing Has Been Selected

Site	Location	Facility Description*
Byron Barrel & Drum	New York	Uncontrolled dump site and landfill
Goose Farm	New Jersey	Uncontrolled dump site
Lipari Landfill	New Jersey	Commercial dump site
Vineland Chemical	New Jersey	Pesticide manufacturing
L.A. Clarke & Sons	Virginia	Wood preserving
U.S. Titanium	Virginia	Titanium dioxide plant
Jadco-Hughes	North Carolina	Solvent recovery and storage
Ninth Avenue Dump	Indiana	Commercial dump site
U.S. Aviox	Michigan	Chemical packaging
South Cavalcade Street	Texas	Wood preserving and coal tar distillation
Poly-Carb	Nevada	Inactive waste management
United Chrome Products	Oregon	Chrome Plating

** All waste types and site conditions are not similar. 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

EPA prepared this fact sheet to provide basic information on in situ soil flushing. Additional technical reports are listed below. The documents containing a "PB" designation are available by contacting the National Technical Information Service (NTIS) at 1-800-336-4700. Mail orders can be sent to:

**National Technical Information Service
Springfield, VA 22161**

The additional document may be obtained by calling (513) 569-7562 or writing to:

**Center for Environmental Research Information
26 West Martin Luther King Drive
Cincinnati, OH 45268**

There may be a charge for these documents.

- **Handbook on In Situ Treatment of Hazardous Waste-Contaminated Soils, EPA/540/2-90/002; PB90-155607.**
- **Mobile Treatment Technologies for Superfund Wastes, EPA/540/2-86/003; PB89-135859.**
- **A Compendium of Technologies Used in the Treatment of Hazardous Wastes, EPA/625/8-87/014.**

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