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A Citizen's Guide to Soil Washing

Technology Innovation Office | Technology Fact Sheet

What is soil washing?

Soil washing is a technology that uses liquids (usually water, sometimes combined with chemical additives) and a mechanical process to scrub soils. This scrubbing removes hazardous contaminants and concentrates them into a smaller volume. Hazardous contaminants tend to bind, chemically or physically, to silt and clay. Silt and clay, in turn, bind to sand and gravel particles. The soil washing process separates the contaminated fine soil (silt and clay) from the coarse soil (sand and gravel). When completed, the smaller volume of soil, which contains the majority of the fine silt and clay particles, can be further treated by other methods (such as incineration or bioremediation) or disposed of according to state and federal regulations. The clean, larger volume of soil is not toxic and can be used as backfill.

How does soil washing work?

A simplified drawing of the soil washing process is illustrated in Figure 1 on page 2. The equipment is transportable so that the process can be conducted at the site. The first step of the process is to dig up the contaminated soil and move it to a staging area where it is prepared for treatment. The soil is then sifted to remove debris and large objects, such as rocks. The remaining material enters a soil scrubbing unit, in which the soil is mixed with a washing solution and agitated. The washing solution may be simply water or may contain additives, like detergent, which remove the contaminants from the soil. This process is very similar to washing laundry. The washwater is drained out of the soil scrubbing unit and the soil is rinsed with clean water. The larger scale soil washing equipment presently in use can process over 100 cubic yards of soil per day.

The heavier sand and gravel particles in the processed soil settle out and are tested for contaminants. If clean, this material can be used on the site or taken elsewhere for backfill. If traces of contaminants are still present, the material may be run through the soil washer again or collected for alternate treatment or off-site disposal. Off-site disposal may be regulated by the Resource Conservation Recovery Act (RCRA) or the Toxic Substance Control Act (TSCA).

A Quick Look at Soil Washing

- Separates fine-grained particles (silt and clay) from coarse-grained particles (sand and gravel).
- Significantly reduces the volume of contaminated soil.
- Is a relatively low-cost alternative for separating waste and minimizing volume required for subsequent treatment.
- Is a transportable technology that can be brought to the site.

The contaminated silt and clay in the washwater settle out and are then separated from the washwater. The washwater, which now also contains contaminants, is treated by wastewater treatment processes so it can be recycled for further use. As mentioned earlier, the washwater may contain additives, some of which may interfere with the wastewater treatment process. If this is the case, the additives must be removed or neutralized by "pretreatment" methods before the washwater goes to wastewater treatment.

Once separated from the washwater, the silt and clay are tested for contaminants. If all the contaminants were transferred to the washwater and the silt and clay are clean, they can be used at the site or taken elsewhere for use as backfill. If still contaminated, the material may be run through the soil washing process again, or collected for alternate treatment or off-site disposal in a permitted RCRA or TSCA landfill.

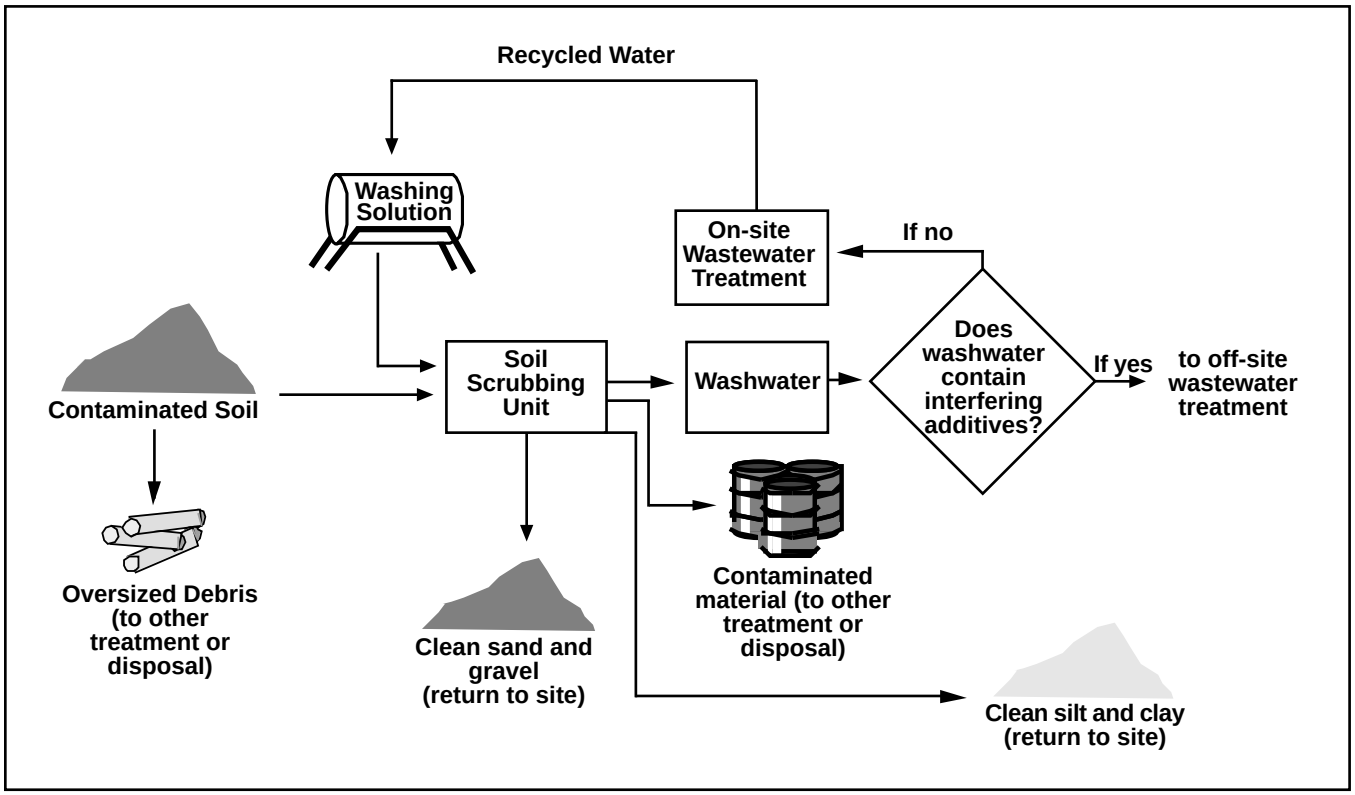
Not All Soil Is Created Equal

Soil is comprised of fine-grained (silt and clay) and coarse-grained (sand and gravel) particles, organic material (decayed plant and animal matter), water, and air. Contaminants tend to readily bind, chemically or physically, to silt, clay, and organic material. Silt, clay, and organic material, in turn, bind physically to sand and gravel. When the soil contains a large amount of clay and organic material, the contaminants attach more easily to the soil and, therefore, are more difficult to remove than when a small amount of clay and organic material is present.

Why consider soil washing?

Soil washing can be used as a technology by itself, but is often used in combination with other treatment technologies. Perhaps the principal use of soil washing is as a *volume reduction* technique in which the contaminants are concentrated in a relatively small mass of material. The larger the percentage of coarse sand and gravel in the material to be processed (which can be cleaned and perhaps returned to the site), the more cost-effective the soil washing application will be.

Figure 1
The Soil Washing Process



Ideally, the soil washing process would lead to a volume reduction of about 90% (which means only 10% of the original volume would require further treatment). Wastes with a high percentage of fine silt and clay will require a larger quantity of material to go on to subsequent, more expensive treatment. These soils may not be good candidates for soil washing.

Soil washing is used to treat a wide range of contaminants, such as metals, gasoline, fuel oils, and pesticides. There are several advantages to using this technology. Soil washing:

- Provides a closed system that remains unaffected by external conditions. This system permits control of the conditions (such as the pH level and temperature) under which the soil particles are treated.

- Allows hazardous wastes to be excavated and treated on-site.

- Has the potential to remove a wide variety of chemical contaminants from soils.

- Is cost-effective because it can be employed as a pre-processing step, significantly reducing the quantity of material that would require further treatment by another technology. It also creates a more uniform material for subsequent treatment technologies.

Will soil washing work at every site?

Soil washing works best when the soil does not contain a large amount of silt or clay. In some cases, soil washing is best applied in combination with other treatment technologies, rather than as a technology by itself.

Removal of contaminants can often be improved during the soil washing process by adding chemical additives to the washwater. However, the presence of these additives may cause some difficulty in the treatment of the used wastewater and the disposal of residuals from the washing process. Costs of handling and managing the additives have to be weighed against the amount of improvements in the performance of the soil washing process.

Where has soil washing been used?

At the King of Prussia site in New Jersey, soil washing was used to remove metal contamination such as chromium, copper, mercury, and lead from 19,000 tons of soil and sludge at a former industrial waste reprocessing facility. The soil washing process was able to clean the materials to meet clean-up goals for eleven metals. For example, chromium levels went from 8,000 milligrams chromium per kilogram of soil (mg/kg) to 480 mg/kg. Table 1 on page 4 lists some of the Superfund sites where soil washing has been selected.

What Is An Innovative Treatment Technology?

Treatment technologies are processes applied to hazardous waste or contaminated materials to permanently alter their condition through chemical, biological, or physical means. Treatment technologies are able to alter, by destroying or changing, contaminated materials so that they are less hazardous or are no longer hazardous. This may be done by reducing the amount of contaminated material, by recovering or removing a component that gives the material its hazardous properties or by immobilizing the waste. *Innovative treatment technologies* are those that have been tested, selected, or used for treatment of hazardous waste or contaminated materials but still lack well-documented cost and performance data under a variety of operating conditions.

Table 1
Examples of Superfund Sites Where Soil Washing Has Been Selected *

Name of Site	Status**	Medium	Contaminants
Myers Property, NJ	In design	Soil, sediment	Metals
Vineland Chemical, NJ	In design	Soil	Metals
GE Wiring Devices, PR	In design	Soil, sludge	Metals
Cabot Carbon/Koppers, FL	In design	Soil	Semi-volatile organic compounds (SVOCs), polyaromatic hydrocarbons (PAHs), metals
Whitehouse Waste Oil Pits	Predesign	Soil, sludge	Volatile organic compounds (VOCs), PCBs, PAHs, metals
Cape Fear Wood Preserving	Design complete	Soil	PAHs, metals
Moss American, WI	Predesign	Soil	PAHs
Arkwood, AR	In design	Soil, sludge	SVOCs, dioxins, PAHs

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 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.

** 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.*

*** As of August 1995*

For More Information

Publications with "EPA" document numbers can be ordered free of charge by either calling 513-489-8190, faxing your request to 513-489-8695, or writing to NCEPI at the address below. If NCEPI is out of stock of a document, you may be directed to other sources.

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Publications with "PB" document numbers are available from the National Technical Information Service (NTIS) at 1-800-553-6847. There is a charge for these documents. Mail orders can be sent to:

National Technical Information Service (NTIS)
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Springfield, VA 22161

- *Selected Alternative and Innovative Treatment Technologies for Corrective Action and Site Remediation: A Bibliography of EPA Information Resources*, EPA 542-B-95-001. **A bibliography of EPA publications about innovative treatment technologies.**
- *Physical/Chemical Treatment Technology Resource Guide*, EPA 542-B-94-008. **A bibliography of publications and other sources of information about soil washing and other innovative treatment technologies.**
- *Engineering Bulletin: Soil Washing Treatment*, PB91-228056/XAB.
- *Abstracts of Remediation Case Studies*, EPA 542-R-95-001.
- WASTECH® Monograph on Soil Washing/Soil Flushing, ISBN #1-883767-03-2. Available for $49.95 from the American Academy of Environmental Engineers, 130 Holiday Court, Annapolis, MD 21401. Telephone 410-266-3311.