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A Citizen's Guide To Solvent Extraction

Technology Innovation Office — **Technology Fact Sheet**

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What Is Solvent Extraction?

Solvent extraction is a treatment technology that uses a solvent (a fluid that can dissolve another substance) to separate or remove hazardous organic contaminants from sludges, sediments, or soil. (Sludge is a mud-like material produced from industrial or sewage waste and sediment is fine-grained rock and mineral fragments which have settled to the bottom of a water body such as a river or lake.) Solvent extraction does not destroy contaminants. It concentrates them so they can be recycled or destroyed. It is used in combination with other technologies to destroy the separated concentrated contaminants.

When the soil enters an extractor (a tank where the contaminated soil is mixed with the solvent), the soil is separated into three components, or fractions: solvent with dissolved contaminants, solids, and water. Contaminants are concentrated into each of these fractions. For example, PCBs (polychlorinated biphenyls) concentrate in the contaminated solvent mixture, while metals are left behind in the solids and water. Each fraction can then be individually treated or disposed of more cost effectively. A simplified drawing of the solvent extraction process is illustrated in Figure 1 on page 2. The solvent extraction process involves five steps:

- Preparation (screening the contaminated material)
- Extraction
- Separation of concentrated contaminants from solvent
- Removal of residual solvent
- Contaminant recovery, recycling, or further treatment.

These are explained in the following paragraphs.

Solvent Extraction Profile

- **Separates contaminants so they may be treated individually.**
- **Is a transportable technology that can be brought to the site.**
- **Reduces volume of contaminated material.**
- **Processes from 24 to over 100 tons of waste per day.**
- **Is designed to operate without air emissions.**

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How Does It Work?

Treatment of contaminated soil will be discussed in this guide, but the method would be essentially the same for treatment of sludges or sediments.

The process begins by digging up the contaminated soil and moving it to a staging area (a place where contaminated material is prepared for treatment). The soil is then sifted to remove debris and large objects, such as rocks. The soil may be processed in either a batch, a semi-batch, or a continuous mode. In the semi-batch mode, the material is cycled through the extraction unit in increments. If the soil is processed continuously, it may need to be made more fluid so it can move easily through the process by pumping. This is accomplished by adding water or, in the case of oily sludges, adding solvents to the material.

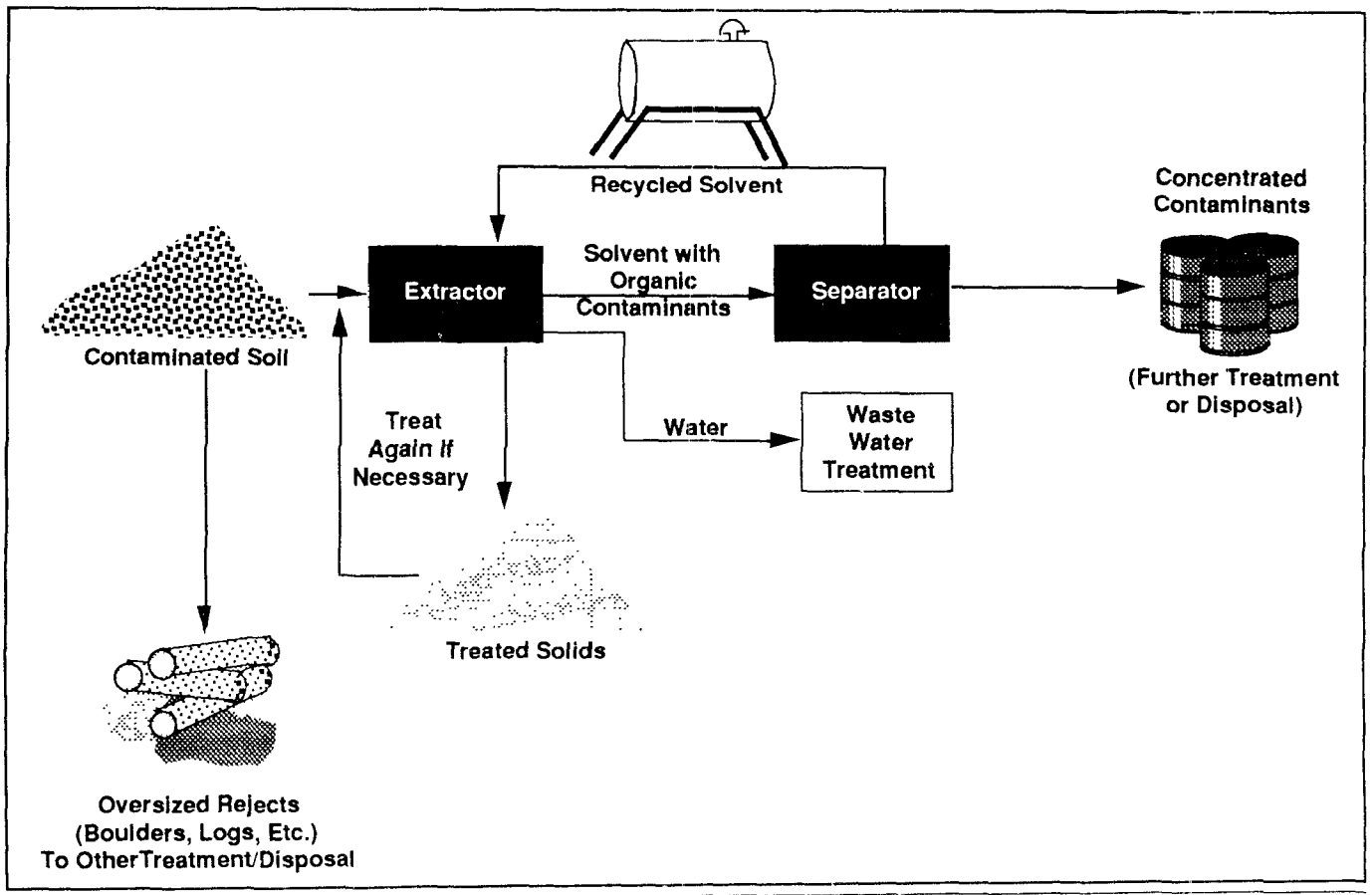
The soil is placed in the extractor. Extractors can vary in size. Some process 24 tons per day while others may treat over 100 tons daily. The larger systems may require a set up area of more than 4,000 square feet. This is about the size of a tennis court. The solvent is poured into the extractor, and the soil and solvent are mixed together. Consequently, the organic contaminants dissolve into the solvent.

A number of factors control the speed with which contaminants are dissolved from the soil. Some of these controlling factors include temperature, moisture content, and the level of contamination. Each is critical to the design of the treatment. Treatability studies performed in a laboratory are required to determine how much solvent is needed and how long the material must remain in the extractor in order to assure maximum effectiveness. Since some solids may contain contaminants that require more than one cycle in the extractor for the solids to become nonhazardous, this step of the process may require repetition.

The extraction process produces three fractions:

- The contaminated solvent mixture, which is removed from the mixing tank and passed to a separation tank;
- The treated soil or sludge (Depending on the concentrations of contaminants present in the solids, the solids may require a repeat cycle or further treatment by some other technique);
- The water, which must be analyzed to determine if further treatment is necessary before discharge to either a publicly-owned treatment plant or other approved discharge area.

Figure 1
Solvent Extraction Process Flow



The separation process occurs next. The contaminated solvent mixture flows to the separation tank. Here, the pressure and temperature are changed, causing the organic contaminants to separate from the solvent or the solvent is extracted with another solvent. At the completion of this step, concentrated contaminants result. Concentrated contaminants are removed from the separation tank, and the solvent is sent to the mixing tank for reuse. These contaminants are then analyzed to determine their suitability for recycle/reuse, or need for further treatment before disposal.

Solvent extraction units are designed to operate without air emissions. However, at some sites volatile air emissions could occur during excavation or preparation of contaminated soil. If air emissions exceed applicable regulatory standards, then waste preparation and handling procedures must be modified to meet the standards.

Why Consider Solvent Extraction?

Solvent extraction is both an effective and cost efficient process for separating hazardous contaminants from non-hazardous materials and concentrating the hazardous materials for further treatment. Because the contaminants are separated, the treatment selected can be targeted to the contaminant. As a result of solvent extraction, many of the contaminants may be recycled or reused in manufacturing, thus minimizing disposal requirements. The process has been effective in removing organic contaminants from paint wastes, synthetic rubber process wastes, coal tar wastes, drilling muds, wood treating wastes, pesticide/ insecticide wastes, and oily wastes.

What Contaminants Can It Treat?

Solvent extraction has been shown to be effective in treating sediments, sludges, and soils containing primarily organic contaminants, such as polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), halogenated solvents (solvents containing halogens, which are bromine, chlorine, or iodine), and petroleum wastes. These contaminants typically come from metal degreasing, printed circuit board cleaning, gasoline, and wood preserving manufacturing processes. Table 1 lists the solvents that are used. This technology is generally not used for removing inorganics (i.e., acids, bases, salts, and heavy metals) as these materials do not readily dissolve in most solvents. Other treatment methods can be applied to these contaminants.

Will It Work At Every Site?

Solvent extraction is effective at separating hazardous organic contaminants from soils, sludges and sediments. It does not reduce the toxicity of the contaminants and, therefore, additional treatment techniques must be used during the clean-up. Some of the limitations of this technology include:

- If the waste contains detergents or strong acids or bases, solvent extraction may not be effective. Their presence can reduce the amount of contamination removed and inhibit the speed with which the contaminants can be removed.
- The presence of lead and other inorganics may interfere with the removal of organic materials.
- Implementation can require complex engineering considerations. For example, some systems include compressed butane and propane, which require strict management to prevent them from vaporizing and becoming flamable.

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.**

Where Is Solvent Extraction Being Selected?

Solvent extraction has been selected as a treatment method at several Superfund sites. Table 2 on page 4 lists some sites, their locations, and the types of facilities. In addition to using this technology at Superfund sites, solvent extraction is also commonly used by manufacturers in their day-to-day operations. Since solvents are expensive raw materials that can be reused, manufacturers, such as the drycleaning and perfume industries, regularly recycle the solvents used in their manufacturing processes.

Table 1
Solvents Used In The Solvent Extraction Process

Liquid Carbon Dioxide
Propane
Butane
Triethylamine
Acetone
Methanol

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Table 2
Site Locations Where Solvent Extraction Has Been Selected*

Site	Location	Type of Facility
Norwood	Massachusetts	Industrial Waste Dumping
O'Connor	Maine	Salvage and Electrical Transformer Recycling
Pinette's Salvage Yard	Maine	Salvage and Vehicle Repair
Ewan Property	New Jersey	Industrial Waste Dumping
General Refining	Georgia	Abandoned Waste Oil Recycling Facility
Traband Warehouse	Oklahoma	Abandoned Storage Management Complex

*All waste types and soil 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 solvent extraction. 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

Other documents may be obtained by contacting:

Center for Environmental Research Information
26 West Martin Luther King Drive
Cincinnati, OH 45268
(513) 569-7562

There may be a charge for these documents.

- **Applications Analysis Report - CF Systems Organic Extraction System, New Bedford, MA, EPA/540/A5-90/002.**
- **Evaluation of BEST Solvent Extraction Sludge Treatment Technology 24 Hour Test, PB88-245907.**
- **Innovative Technology: BEST Solvent Extraction Process, EPA/9200.5-253FS; PB90-274218.**
- **Engineering Bulletin, Solvent Extraction Treatment, September 1990, EPA/540/2-90/013.**

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