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Preface

Soil washing is a water-based process for scrubbing soils ex situ. It removes contaminants from soils by either dissolving or suspending them in the wash solution or concentrating them into a smaller volume of soil through particle size separation, gravity separation, and attrition scrubbing. Soil washing systems that use most of the removal techniques have the greatest potential for treating soils containing a wide variety of heavy metal, radionuclide, and organic contaminants.

The concept of reducing soil contamination by particle size separation is based on the knowledge that most organic and inorganic contaminants tend to bind, either chemically or physically, to clay, silt, and organic soil particles. The silt and clay particles are attached to sand and gravel particles by physical processes such as compaction and adhesion. By separating the fine (small) clay and silt particles from the coarser sand and gravel particles, soil washing processes effectively separate and concentrate the contaminants into a smaller volume of soil that can be further treated or disposed of. The clean, larger volume of soil is normally not toxic and can be used as backfill.

Soil washing can be used as a technology by itself but it is usually used in combination with other treatment technologies. This is because soil washing reduces the volume of the contaminated material but it does not reduce the toxicity of the contaminants. However, this toxicity can be reduced if soil washing is combined with other treatment technologies such as bioremediation, incineration, and solidification/stabilization.

Generally speaking, soil washing is most effective on soils that contain sand and gravel and do not contain large amounts of silt and clay. The target contaminant groups for soil washing are semi-volatile organic compounds, fuels, and inorganics. However, it can also be used on selected volatile organic compounds, pesticides, and radionuclides.

As a remedial technology, soil washing offers several advantages. First of all, it utilizes a closed system that remains unaffected by external conditions. This system allows for control of the conditions surrounding the soil particles such as pH and temperature. Soil washing also makes it possible for hazardous wastes to be excavated and treated on-site and can significantly reduce the volume of the contaminated soil that requires additional treatment. In addition, it has the potential to remove a wide variety of chemical contaminants from soils. Finally, soil washing is cost-effective because it can be used as a pre-processing step to reduce the quantity of material to be treated by subsequent treatment technologies and can generate a more uniform material for these technologies.

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Nevertheless, soil washing does have some limitations due to several factors that may limit its application and effectiveness. First of all, fine soil particles such as clay and silt may require the addition of a polymer to remove them from the washing solution. Such a polymer, as well as other chemical additives in the washing solution, may also cause some difficulty in the disposal of these particles. In addition, complex waste mixtures such as metals combined with organics can make the selection of the appropriate washing solution difficult. Furthermore, a high humic content in the soil may require pretreatment. Finally, the washing solution will require treatment that could be costly depending on the chemical additives used to remove the soil contaminants.

Soil washing has been used at waste sites in Europe, especially in Germany, the Netherlands, and Belgium. In the USA, it has been used as the selected source control remedy at several Superfund sites. The types of operations at these sites included wood preserving, pesticide manufacturing, refining, and lead battery recycling. The average cost for the use of soil washing, including excavation, is about $130 to $220 per metric ton ($120 to $200 per ton), depending on the target waste amount and concentration.

This issue of the *Journal of Hazardous Materials* focuses on a number of recent developments in and applications of soil washing. Hopefully, the issue will foster more dialogue between the developers and users of this remedial technology.

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