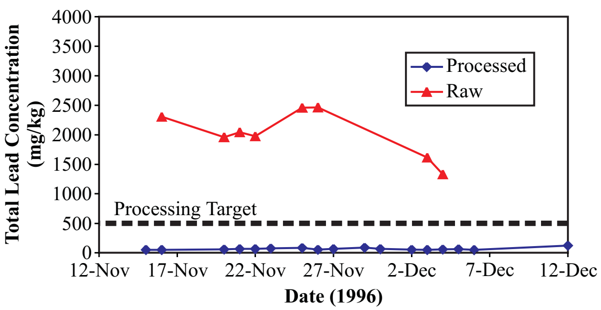
However, process control difficulties led to a gradual buildup of lead in the regenerated leachant, and this caused a progressive decline in the degree of heavy metal removal from the soil.

The hydrochloric acid plant consistently produced a final processed soil that had less than 250 mg/kg of total lead (see Figure 2) and less than 5 mg/L TCLP lead. The plant continuously processed 835 tons of range soil at an average rate of 6.3 tons/hr, with minimal downtime. On average, the processing removed 96% of the lead, 97% of the copper, 89% of the zinc, and 60% of the antimony in the soil.

Figure 3 shows the costs of using this type of separation/leaching technology for range maintenance or remediation, versus using other competing approaches. Although off-site landfilling and on-site stabilization are cheaper, separation/leaching is competitive in cost, especially at larger sites. This technology may be an attractive option for many small-arms range sites, regardless of the quantity of soil requiring processing, because separation/leaching removes lead in a recyclable form from the range soil. This reduces the potential for long-term liability and opens up the site to a wider range of beneficial uses.

Figure 2. Vendor 2 HCl Field Demonstration: Total Lead Concentration for Processed and Raw Soil

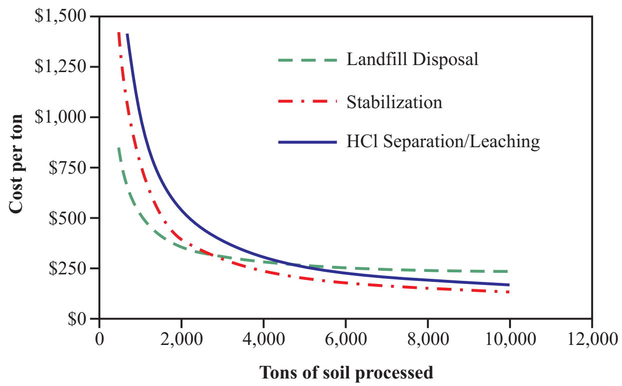


Conclusions

The separation/leaching technology tested at Fort Polk is a technically feasible and cost-effective option for processing small-arms range soils containing heavy metals. As a leachant, acetic acid is less aggressive and more expensive, but it is also less corrosive on plant equipment. Hydrochloric acid is cheaper, more aggressive, and is expected to be effective at most sites. The following factors contribute to a successful field operation:

- A site-specific bench-scale study that evaluates all aspects of the process
- Flexibility in the plant design to handle a highly variable feed material (in terms of soil texture and contaminant concentration)
- Appropriate equipment and procedures to address potential material handling problems
- Adequate plant process control and well-trained operators during field operation

Figure 3. Cost Comparison of Alternative Technologies



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Physical Separation and Acid Leaching

A Demonstration of Small-Arms Range Remediation at Fort Polk, Louisiana

Conducted jointly by

NAVAL FACILITIES ENGINEERING SERVICE CENTER

NFESC

U.S. ARMY ENVIRONMENTAL CENTER
COMPLIANCE • RESTORATION • PREVENTION • CONSERVATION

USAEC

Sponsored by

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ENVIRONMENTAL SECURITY TECHNOLOGY CERTIFICATION PROGRAM

ESTCP

Contractors providing technical support:
Battelle, BDM Engineering Services Co., BESCORP, and ContraCon

Background

An estimated 2,600 Department of Defense (DoD) sites have small-arms range berms that contain lead and other heavy metals, such as copper, zinc, and antimony. Buildup of metals in the berm can cause ricochet problems. Over time, heavy metals could potentially run off into surface waters or infiltrate to the groundwater.

Maintenance or remediation of small-arms ranges currently involves off-site landfilling or on-site stabilization. With either method, the heavy metals remain with the soil and the potential for future liability persists. Physical separation and acid leaching processes are based on mining industry techniques that recover metals from ores. When applied to small-arms range soils, these processes recover particulate and ionic heavy metals from the soil. The recovered metals can often be recycled in an off-site smelter.

Participants

The Naval Facilities Engineering Service Center (NFESC) and US Army Environmental Center (USAEC) were jointly sponsored by the Environmental Security Technology Certification Program (ESTCP) to conduct a demonstration of separation/leaching technologies as part of a maintenance operation at an active range (Range 5) at Fort Polk, Louisiana. The Defense Evaluation Support Activity (DESA) and the US Army Corps of Engineers, Waterways Experiment Station were also partners in the demonstration.

BDM Engineering Services Company, under a contract with DESA, coordinated vendor selection and site support activities for the demonstration. Vendor 1, ContraCon Northwest, demonstrated acetic (weak) acid leaching and Vendor 2, Brice Environmental Services Corporation (BESCORP), demonstrated hydrochloric (strong) acid leaching.

Under contract to NFESC, Battelle conducted an independent evaluation of the two vendors' processes.

Objectives

The main objective of the demonstration was to evaluate the technical performance and cost effectiveness of physical separation and acid leaching for maintenance of active ranges or remediation of inactive ranges.

Although the processing at Fort Polk was conducted as a range maintenance activity, a good faith attempt was made to achieve a RCRA-driven target of 5 mg/L of leachable lead in the processed soil, as measured by the toxicity characteristic leaching procedure (TCLP). A goal of 1,000 mg/kg total lead was established for Vendor 1. For Vendor 2, this goal was reduced to 500 mg/kg to better meet the TCLP target.

Bench-Scale Treatability Testing

Before the field demonstration, both vendors performed bench-scale tests to determine the feasibility of the process and to aid in plant design. The results of these tests were promising.

Site Infrastructure

BDM built an asphalt pad with bermed sides at the site to accomodate each vendor's plant. The pad was graded slightly to allow any runoff to flow into a containment pond built along one of the sides. The water from the containment pond was discharged to the base wastewater treatment plant or hauled off as hazardous waste, depending on its composition. Arrangements were made to supply power (300 kVA) and water to the plant.

Physical Separation and Acid Leaching Plants

The two vendors' plants had the general configuration shown in Figure 1. The main difference in the two plants was the type of acid used in the leaching step.

The raw soil from the berm was first separated into coarse and fine fractions. The coarse fraction was processed by gravity separation to remove particulate heavy metals. Both coarse and fine fractions were contacted with acid to further remove smaller metal particulates and ionic metal species.

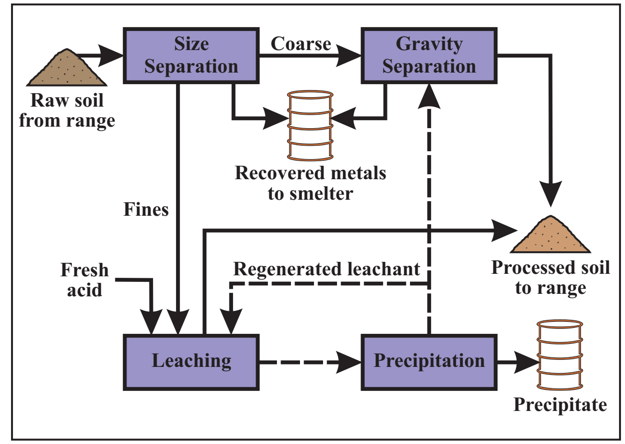

Figure 1.
General Schematic of the Separation/Leaching Plant

The spent leachate was treated by precipitation to remove heavy metals and returned to the process. The recovered metal fragments and the precipitate sludge were sent to a smelter for lead recycling.

Evaluating the Performance of the Technology

Process evaluation included field observation and measurements, sampling and analysis, and discussions with the vendors and site support personnel. Obtaining representative samples and analysis of the heterogeneous process streams was one challenge in the evaluation. Standard EPA methods do not address matrices containing particulate metal contaminants. Based on mining industry experience, Battelle developed special sample collection, preparation, and analysis methods to ensure that meaningful data was obtained from the demonstration. During routine maintenance or remediation at future sites, simplified variations of these sampling and analytical techniques could be used to obtain an accurate and precise verification of total and leachable metal concentrations in the processed soil.

Results

The acetic acid plant removed 93% of the lead on the first day of processing. The processed soil had less than 1,000 mg/kg total lead and less than 5 mg/L TCLP lead, and thus met demonstration criteria.