Final Technology Evaluation Report
Volume I

Physical Separation and Acid Leaching: A Demonstration of Small-Arms Range Remediation at Fort Polk, Louisiana

Prepared for

Naval Facilities Engineering Service Center *and* **U.S. Army Environmental Center**

by

Battelle
. . . Putting Technology To Work

Columbus,Ohio

September 22, 1997

Sponsored by

ESTCP

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Volume 1: Main Report

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Physical Separation and Acid Leaching: A Demonstration of Small-Arms Range Remediation at Fort Polk, Louisiana

by

Battelle Columbus Operations

September 22, 1997

1. Introduction

1.1 PROJECT BACKGROUND

Approximately 2,600 United States Department of Defense (DoD) installations have small-arms training ranges which contain soil contaminated with heavy metals, particularly lead. These metals may accumulate in the range soils to the extent that the site encounters ricochet problems or a potential for migration of heavy metals to surface waters or groundwater. Maintenance or remediation of these sites currently involves contaminant stabilization and/or landfilling. These methods minimize the hazards due to contaminant migration and exposure to humans and the environment, but the contamination and the liability for it remain. In addition, processes such as stabilization can significantly increase the volume of the final waste form.

New processes are needed that are cost competitive with the stabilization/landfilling processes, result in removal of the heavy metal contaminants, and provide substantial net waste volume reduction. Moreover, processes that remove lead from the soil are also required in order to support the reuse of the site for beneficial purposes. Physical separation and acid leaching are

processes developed partly by the mining industry for recovery of metal values from ores. The application of these processes for the removal of heavy metals from small-arms range soils has recently been explored in bench- and pilot-scale studies. The attractiveness of this approach stems from the fact that metals of concern are removed from the range soils and may even be recycled off site. The site can be restored to a wider range of beneficial uses.

1.2 OFFICIAL DOD REQUIREMENT STATEMENT(S)

The Environmental Security Technology Certification Program (ESTCP) sponsored the U.S. Army Environmental Center (USAEC) and the Naval Facilities Engineering Service Center (NFESC) to conduct a joint demonstration of small-arms range remediation at Fort Polk. Figure 1-1 shows the various participants and their roles. The main requirement of this demonstration was to evaluate and document the performance and cost of two physical separation/acid leaching processes that can be used to process small-arms range soils at DoD sites. Battelle was contracted by the Naval Facilities Engineering Service Center (NFESC) to conduct an independent evaluation of the two processes and their implementation at Fort Polk. The methodology for the evaluation is documented in the Environmental Security Technology Certification Program (ESTCP)-approved Technology Demonstration Plan prepared by Battelle (1996).

1.3 OBJECTIVES OF THE DEMONSTRATION

The primary goal for the demonstration was to evaluate the technical and economic performance of physical separation and acid leaching for the removal of lead from small-arms range soils. Two vendors demonstrated their variations of physical separation and acid leaching on Range 5 berm soils at Fort Polk to remove the heavy metal contamination. Vendor 1's leaching process was based on acetic (weak) acid chemistry. Vendor 2's process was based on hydrochloric (strong) acid chemistry for the leaching process. The goal was not to compare the two vendors, but to evaluate the suitability of the two acids for processing of small-arms range soils.

The following performance objectives were specified for each vendor:

- ❒ Process 1,000 tons of Range 5 berm soils during the demonstration. Complete the mobilization, operation, and demobilization phases of the demonstration within a 3-month period. (Each vendor was expected to keep the plant operational for a period of 15 days.)
- ❒ Demonstrate the technology at a continuous processing rate of 5 to 10 tons per hour.
- ❒ Meet the total lead criterion of 1,000 mg/kg or less in the processed soil. This criterion was changed to 500 mg/kg for Vendor 2 to better meet the Toxicity Characteristic Leaching Procedure (TCLP) criterion.
- ❒ Make a good faith attempt to meet the TCLP lead soil criterion of 5 mg/L for the processed soil.

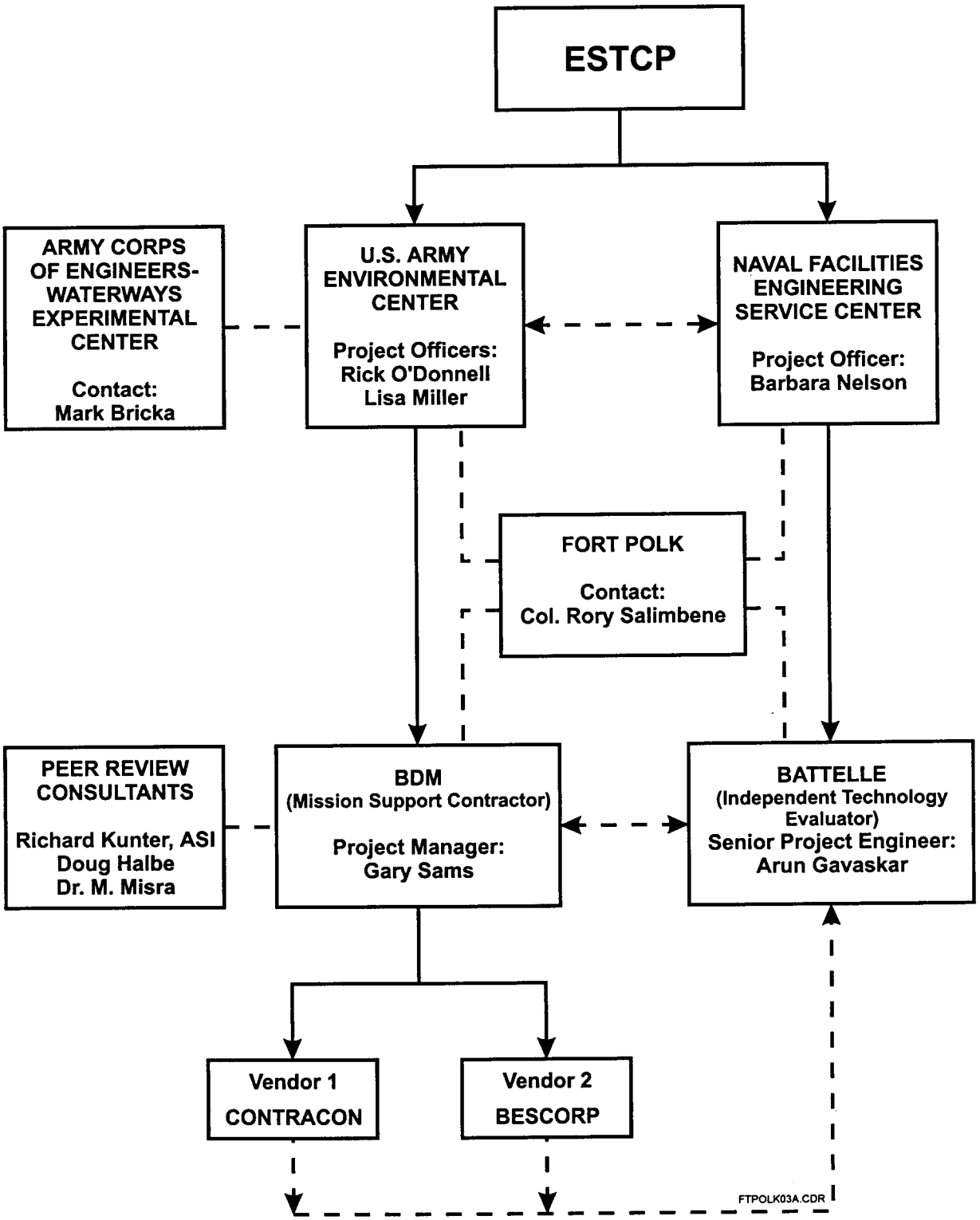

Figure 1-1. Overall Project Organization

- ❒ Ensure that the processed soil is otherwise acceptable (physically and chemically) for returning Range 5 to its former useful condition.

- ❒ Minimize residuals requiring off-site disposal. Ensure acceptability for off-site recycling of lead concentrates.

Battelle evaluated the performance of the technology and its implementation at Fort Polk through preparation of a Technology Demonstration Plan (Battelle, 1996), on-site observation and sampling during the field operation, discussions with vendors and site support personnel, off-site laboratory analysis of samples from various process streams, and evaluation of field and laboratory data.

1.4 TECHNOLOGY DESCRIPTION

The combination of physical separation and acid leaching is an innovative remedial alternative that has received increasing interest (van Benschoten et al., 1997). Physical separation is a technique for dividing soil into different size or density fractions. Physical separation rarely produces material that is sufficiently clean to allow reuse or disposal directly, but works well as a pretreatment so that the volume of soil requiring leaching is reduced. When particulate contaminants are present, physical separation reduces the contaminant load on the leaching process. Section 2 provides a detailed description of various physical separation and leaching techniques.

Physical separation and acid leaching are particularly useful at sites where metallic contaminants are present as particulates, e.g., small-arms ranges or battery recycling sites. First, oversize debris, such as rocks, that typically have low concentrations of metals is removed. This debris fraction can usually be cleaned easily by washing or leaching with a dilute acid solution. Metal fragments are then separated from the bulk soil based on particle size and density. The separated metals stream may be suitable for off-site recycling. The lighter smaller soil that remains consists of sands, silts, and clay and may also contain very fine metal particulates and bound molecular or ionic metals. The soil particles and associated heavy metal contaminants can be effectively treated with acid leaching. Different extractants may be used depending on the physical and chemical form of the heavy metals and the matrix characteristics.

1.5 REGULATORY ISSUES

The following regulations need to be addressed for the application of physical separation/acid leaching technologies to small-arms range maintenance or remediation activities:

- ❒ National Environmental Policy Act (NEPA)

- ❒ Resource Conservation and Recovery Act (RCRA)

- ❒ U.S. Environmental Protection Agency's (EPA's) Military Munitions Rule and the DoD's Military Range Rule

- ❒ Emergency Planning and Community Right-to-Know Act (EPCRA)
- ❒ Clean Water Act (CWA)
- ❒ Clean Air Act Amendment (CAAA)
- ❒ Occupational Safety and Health Act (OSHA)
- ❒ State and local regulations (e.g., Title 22, California Code of Regulations).

These regulations and their application are discussed in Section 9. In general, removal of heavy metals is expected to be conducted as a maintenance activity at active ranges and as a remediation activity at inactive ranges.

1.6 PREVIOUS TESTING OF THE TECHNOLOGY

Appendix E-2 describes previous bench-scale, pilot-scale, and commercial applications of physical separation and acid leaching.