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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Contents

Page

Acknowledgments iii
Appendices x
Figures xi
Tables xiii

1. Introduction 1
   1.1 PROJECT BACKGROUND 1
   1.2 OFFICIAL DOD REQUIREMENT STATEMENT(S) 2
   1.3 OBJECTIVES OF THE DEMONSTRATION 2
   1.4 TECHNOLOGY DESCRIPTION 4
   1.5 REGULATORY ISSUES 4
   1.6 PREVIOUS TESTING OF THE TECHNOLOGY 5

2. Physical Separation and Acid Leaching Principles 6
   2.1 PHYSICAL SEPARATION PROCESSES DESCRIPTIONS 6
      2.1.1 Size Separation 7
         2.1.1.1 Dry Screening 7
         2.1.1.2 Wet Screening 7
      2.1.2 Hydrodynamic Separation (Classification) 8
         2.1.2.1 Elutriator 8
         2.1.2.2 Mechanical Classifier 8
         2.1.2.3 Hydrocyclone 9
         2.1.2.4 Attrition Scrubbing 10
      2.1.3 Density (or Gravity) Separation 10
         2.1.3.1 Jig 11
         2.1.3.2 Spiral Concentrator 11
         2.1.3.3 Shaking Table 12
         2.1.3.4 Bartles-Mozley Table 13
      2.1.4 Froth Flotation 13
      2.1.5 Magnetic Separation 14
      2.1.6 Dewatering 14
         2.1.6.1 Filtration and Expression 14
         2.1.6.2 Sedimentation 14
         2.1.6.3 Centrifugation 15
   2.2 APPLICATION OF PHYSICAL SEPARATION PROCESSESTO SMALL-ARMS RANGE SOILS 15
   2.3 ACID LEACHING PROCESS DESCRIPTION 18
      2.3.1 Acid Leaching and Contaminant Chemistry 19
      2.3.2 Acid Leaching Process Configuration 20

Contents
(Continued)

Page

2.4 ACETIC ACID VERSUS HYDROCHLORIC ACID FOR SMALL-ARMS RANGE SOILS 22
2.4.1 Acid Activity Effect on Leaching Rate 23
2.4.2 Relative Lead Ion Complexation (Solubilization) Chemistry of Acetic and Hydrochloric Acids 24
2.4.2.1 Acetic Acid 25
2.4.2.2 Hydrochloric Acid 25
2.4.3 Aggressive Leach Conditions 26
2.4.4 Catalysis of Oxidation 26
2.5 FACTORS AFFECTING COST AND PERFORMANCE OF PHYSICAL SEPARATION AND ACID LEACHING 27

3. Site Description and Berm Soil Characteristics 29
3.1 SITE BACKGROUND 29
3.2 DEMONSTRATION FACILITY CHARACTERISTICS 30
3.3 BERM CHARACTERISTICS 30
3.3.1 Characteristics of the Range Soil 34
3.3.2 Contaminant Species 38
3.3.3 Other Soil Characteristics 38
3.3.4 Excavation and Homogenization of Range 5 Soil for Processing 39

4. Objectives and Approach 40
4.1 PERFORMANCE OBJECTIVES 40
4.2 APPROACH AND ACTIVITIES 40

5. Description of the Process Plants Used at Fort Polk 42
5.1 ACETIC ACID PROCESS 42
5.1.1 Physical Separation Module 42
5.1.1.1 Size Separation 42
5.1.1.2 Density Separation 45
5.1.2 Leaching Module 47
5.1.2.1 Acid Leaching of Fines 47
5.1.2.2 Precipitation Process 49
5.2 HYDROCHLORIC ACID PROCESS 49
5.2.1 Physical Separation Module 51
5.2.1.1 Size Separation 51
5.2.1.2 Density Separation 53
5.2.2 Leaching Module 53
5.2.2.1 Acid Leaching of Fine Soils 53
5.2.2.2 Precipitation and Regeneration of Leachant 55

Contents
(Continued)

Page

6. Evaluation Methodology Used for the Demonstration 56
   6.1 OBJECTIVES OF SAMPLING AND ANALYSIS 56
   6.2 PROCESS STREAMS SAMPLED 56
   6.3 ENSURING THE REPRESENTATIVENESS OF SAMPLES 57
      6.3.1 Collecting the Composite 60
      6.3.2 Field Sample Preparation to Reduce the Composite 60
      6.3.3 Off-Site Laboratory Sample Preparation to Reduce 1-L Samples 61
   6.4 ANALYTICAL METHODS 61
   6.5 ALTERNATIVE SAMPLING AND ANALYSIS SCHEME 62
   6.6 ON-SITE XRF ANALYSIS 63

7. Demonstration Results 65
   7.1 PERFORMANCE OF VENDOR 1 AND THE ACETIC ACID PLANT 65
      7.1.1 Lead Removal by Vendor 1 Process 65
      7.1.2 Vendor 1 Process Residuals 68
      7.1.3 Vendor 1 Plant Reliability 69
      7.1.4 Removal of Other Metals 72
      7.1.5 Reusability of the Processed Soil 72
   7.2 PERFORMANCE OF VENDOR 2 AND THE HYDROCHLORIC ACID PLANT 72
      7.2.1 Lead Removal by Vendor 2 Process 72
      7.2.2 Vendor 2 Process Residuals 76
      7.2.3 Vendor 2 Plant Reliability 77
      7.2.4 Removal of Other Metals 79
      7.2.5 Reusability of the Processed Soil 79
   7.3 QUALITY ASSURANCE (QA) 81
      7.3.1 Field Sample Collection 81
      7.3.2 Sample Preparation and Analysis 81
         7.3.2.1 Sample Preparation and Analytical Precision 82
         7.3.2.2 Field Blanks 84
         7.3.2.3 Accuracy of the Analysis 84
         7.3.2.4 Calibration Checks and Method Blanks 86
   7.4 COST PERFORMANCE 86
      7.4.1 Vendor 1 Process Cost 86
      7.4.2 Vendor 2 Process Cost 90

8. Comparison with Competing Technologies 94
   8.1 TECHNOLOGY REVIEW AND PRESCREENING 94
      8.1.1 Secure Landfill Disposal 94
      8.1.2 Ex Situ Solidification/Stabilization (done on site) 95
      8.1.3 Technology Prescreening 95

Contents
(Continued)

Page

8.2 DETAILED COMPARISON OF ALTERNATIVES 96
8.2.1 General Applicability of Alternative Technologies to Small Arms Ranges 96
8.2.1.1 Landfill Disposal 96
8.2.1.2 Ex Situ Solidification/Stabilization 97
8.2.2 Evaluation of Short-Term Effectiveness of Alternative Technologies 97
8.2.3 Comparison of Long-Term Effectiveness of Alternative Technologies 98
8.2.4 Comparison of Toxicity, Mobility, and Volume Reduction of Alternative Technologies 98
8.2.5 Comparison of Short-Term Effectiveness of Alternative Technologies 99
8.2.6 Comparison of Implementability of Alternative Technologies 99
8.2.7 Comparison of Costs of Alternative Technologies 100

9. Regulatory Issues 103
9.1 REGULATORY ISSUES AT SMALL-ARMS RANGES 103
9.1.1 National Environmental Policy Act (NEPA) 105
9.1.2 Resource Conservation and Recovery Act (RCRA) 105
9.1.3 Emergency Planning and Community Right-to-Know Act (EPCRA) 106
9.1.4 Clean Water Act (CWA) 106
9.1.5 Clean Air Act Amendment (CAAA) and Occupational Safety and Health Act (OSHA) 107
9.2 REGULATORY ISSUES ADDRESSED AT FORT POLK 108
9.2.1 National Environmental Policy Act (NEPA) 108
9.2.2 Resource Conservation and Recovery Act (RCRA), the EPA Military Munitions Rule, and the DoD Military Range Rule 108
9.2.3 Emergency Planning and Community Right-to-Know Act (EPCRA) 108
9.2.4 Clean Water Act (CWA) 109
9.2.5 Clean Air Act Amendment (CAAA) and Occupational Safety and Health Act (OSHA) 109
9.3 COMMUNICATING WITH THE PUBLIC AND OTHER DoD SITES 109

10. Application at Future Sites and Technology Transfer 110
10.1 CHARACTERISTICS OF DoD SMALL-ARMS RANGES 110
10.2 PHYSICAL SEPARATION/ACID LEACHING FEASIBILITY AT OTHER DoD SITES 111
10.3 TECHNOLOGY TRANSFER/IMPLEMENTATION 112
10.3.1 Status of Acetic Acid Process Vs. Hydrochloric Acid Process 112
10.3.2 Technology Transfer Vehicles 112
10.3.3 Guidance for Vendor Selection and Evaluation 113

Contents
(Continued)

Page

11. Conclusions and Recommendations 115
    11.1 SUMMARY OF CONCLUSIONS FROM THE FORT POLK DEMONSTRATION 115
        11.1.1 Site Preparation and Support 115
        11.1.2 Vendor 1 and the Acetic Acid Process 116
        11.1.3 Vendor 2 and the Hydrochloric Acid Process 119
        11.1.4 Acetic Acid and Hydrochloric Acid as Leachants 122
    11.2 RECOMMENDATIONS FOR USE OF THE SEPARATION/LEACHING TECHNOLOGY AT SMALL-ARMS RANGES 122
        11.2.1 Regulatory Setting 122
        11.2.2 Characterization of Range Soils and Contaminants 123
        11.2.3 Vendor Contracting 124
        11.2.4 Bench-Scale Testing and Plant Design 124
        11.2.5 Site Preparation 126
        11.2.6 Plant Operation 126
        11.2.7 Process Verification 127
    11.2.8 Costs 128

12 References 130

Appendices

Appendix A: Points of Contact A-1
Appendix B: Data Archiving and Demonstration Plan B-1
Appendix C: Site Characterization Data C-1
Appendix D: Bench-Scale Tests D-1
Appendix E: Comparison of Alternative Technologies E-1
Appendix F: Vendor 1 (Acetic Acid) Data F-1
Appendix G: Vendor 2 (Hydrochloric Acid) Data G-1
Appendix H: XRF Data H-1
Appendix I: Cost Data I-1

Contents
(Continued)

Page

Figures

Figure 1-1. Overall Project Organization....3
Figure 2-1. Schematic of a Spiral Classifier or "Sand Screw"....9
Figure 2-2. Hydrocyclone....9
Figure 2-3. Basic Jig Construction....11
Figure 2-4. Cross Section of a Spiral Channel in a Spiral Concentrator....12
Figure 2-5. Schematic of Shaking Table....13
Figure 2-6. Pb Solubility Diagram: Calculations Made Assuming Solid Phase Always to be Present, with Total Chemical Component Concentrations [e.g., Pb_T, $(SO_4)_T$, $(PO_4)_T$, C_T] Varying Depending on Amount of Solid Phase that was Dissolved....19
Figure 2-7. Continuous Leaching Process Flow....21
Figure 2-8. Precipitation of Heavy Metals as Hydroxides....22
Figure 3-1. Location of Fort Polk, Louisiana....29
Figure 3-2. General Site Map Showing the Demonstration Site (Gravel Parking Lot)....31
Figure 3-3. Layout of the Demonstration Site....32
Figure 3-4. New Asphalt Pad with Overflow Containment Features Built by BDM for the Demonstration....33
Figure 3-5. Range 5 Site Map....34
Figure 3-6. Lead Distribution Across Various Fractions of Raw Soil....37
Figure 5-1. Overview of the Acetic Acid Process....43
Figure 5-2. Initial Schematic of the Acetic Acid Process....44
Figure 5-3. Final Schematic of the Acetic Acid Process....45
Figure 5-4. Physical Separation Process (Acetic Acid Process)....46
Figure 5-5. Leaching Circuit (Acetic Acid Process)....48
Figure 5-6. Photographic Image of the Hydrochloric Acid Process....50
Figure 5-7. Final Schematic of the Hydrochloric Acid Process....51
Figure 5-8. Physical Separation Process (Hydrochloric Acid Process)....52
Figure 5-9. Leaching Circuit (Hydrochloric Acid Process)....54
Figure 6-1. Schematic of Acetic Acid Process Showing Input and Output Streams....57
Figure 6-2. Sampling Methodology for Each Primary Process System....58
Figure 6-3. Comparison of XRF and ICP Analyses of Lead in the Processed Soil Using (a) Acetic Acid and (b) Hydrochloric Acid....64
Figure 7-1. Precision Evaluation for Total Lead Analysis....83
Figure 7-2. Precision Evaluation for TCLP Lead Analysis....85
Figure 7-3. Accuracy Evaluation of Lead Analysis of Processed Soil....87
Figure 7-4. Method Blanks Analyzed for the Fort Polk Demonstration....88
Figure 8-1. Cost Comparison of Competitive Technologies....102
Figure 11-1. Total Metals Removal During the Acetic Acid Demonstration at Fort Polk....117

Contents
(Continued)

Page

Figure 11-2. TCLP Performance During the Acetic Acid Demonstration at Fort Polk.....118
Figure 11-3. Total Metals Removed During the Hydrochloric Acid Demonstration at Fort Polk.....120
Figure 11-4. TCLP Performance During the Hydrochloric Acid Demonstration at Fort Polk.....121
Figure 11-5. Cost Comparison of Alternative Technologies.....128

Tables

Table 2-1. Key Attributes of Common Particle Separation Techniques.....6
Table 2-2. Key Attributes of Common Dewatering Techniques.....15
Table 2-3. Particle-Size Range for Application of Separation Techniques.....16
Table 2-4. Illustration of Calculated Concentration Criteria for Gravity Concentration.....17
Table 2-5. Molecular and Ionized Forms of Acetic Acid Dependence on pH.....24
Table 2-6. Estimates of H^+ Activity vs. Total Acetic Acid Concentrations Using Equation 2-2.....24
Table 2-7. Complexation Reactions Involving Lead.....25
Table 2-8. Factors Affecting Performance and Costs of Separation/Acid Leaching Technologies.....28
Table 3-1. Vendor Wet Sieve Analyses of the Raw Range Soil.....35
Table 3-2. Battelle Wet Sieve Analyses of the Raw Range Soil.....35
Table 3-3. Particle Size Analysis of the Raw Range Soil.....36
Table 3-4. Other Small-Arms Range Raw Soil Characteristics Measured by Battelle.....39
Table 6-1. Mass (in Pounds) of Composite Required to Obtain Representative Samples.....59
Table 6-2. Comparison of the Analytical Data of Large and Grab Samples.....62
Table 7-1. Overall Removal of Total and Leachable Lead with the Acetic Acid Process.....66
Table 7-2. Distribution of Lead in Acetic Acid Process.....67
Table 7-3. TCLP Results of Water Washing and pH Adjustment on Processed Soil.....68
Table 7-4. Residuals Disposal for the Vendor 1 Demonstration.....68
Table 7-5. Removal of Metals of Concern by the Vendor 1 Process.....73
Table 7-6. Overall Removal of Total and Leachable Lead with the Hydrochloric Acid Process.....74
Table 7-7. Stream Assays of Lead in the Hydrochloric Acid Process.....74
Table 7-8. Mass Distribution of Lead in Various Process Streams for Vendor 2.....75
Table 7-9. Residuals Disposal for the Vendor 2 Demonstration.....76

Contents
(Continued)

Page

Table 7-10. Removal of Metals of Concern by the Vendor 2 Process....79
Table 7-11. Field Blanks Processed During the Soil Washing Demonstrations....86
Table 7-12. Costs Incurred During the Acetic Acid Demonstration....89
Table 7-13. Incurred and Routine Costs of the Hydrochloric Acid Demonstration....91
Table 7-14. Scale-up Costs of the Hydrochloric Acid Process....93
Table 8-1. Cost Comparison of Alternative Technologies....101
Table 9-1. List of Inorganic Persistent and Bioaccumulative Toxic Substances and Their Soluble Threshold Limit Concentration (STLC) and Total Threshold Limit Concentration (TTLC) Values....104
Table 9-2. Leachable Lead Concentrations....104
Table 10-1. Summary of Small-Arms Range Dimensions Data....111
Table 11-1. Strengths of Various Molar Concentrations of Acetic and Hydrochloric Acid....122

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.

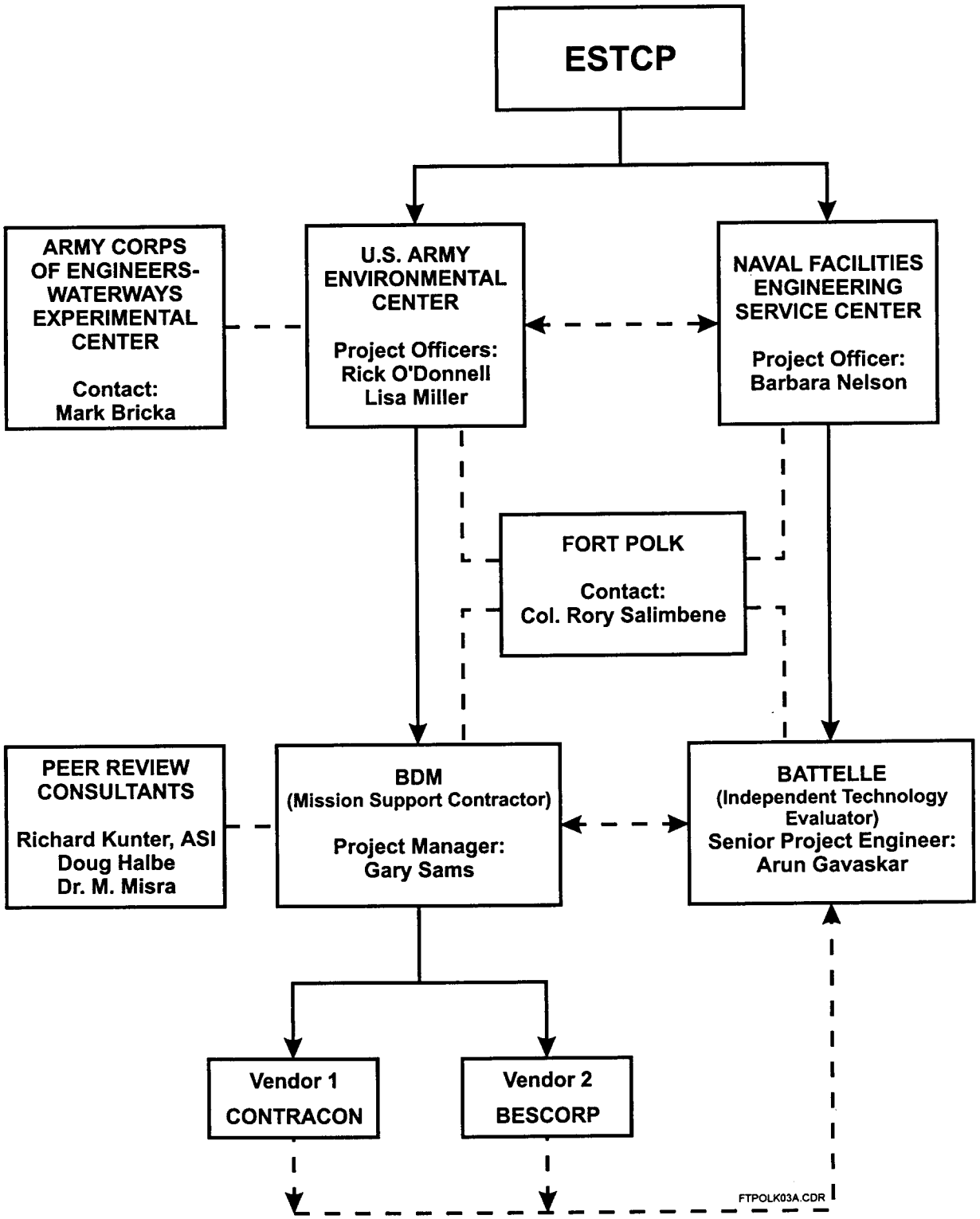

Figure 1-1. Overall Project Organization

- ❒ 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.