Cost and Performance Summary Report: Thermal Desorption at Letterkenny Army Depot Superfund Site, K Areas, OU 1 Chambersburg, Franklin County, Pennsylvania

Summary Information [1,2,3,7]

The Letterkenny Army Depot (Letterkenny) is a 19,243-acre U.S. Army facility located in Chambersburg, Franklin County, Pennsylvania. Since 1942, the Army has used the site to overhaul, rebuild, and test missile systems; store and demilitarize ammunition; and maintain and refurbish equipment and vehicles. Operations at the facility have included degreasing, metal plating, painting and paint stripping, and steam cleaning. Chemicals used in these operations include solvents such as trichloroethene (TCE), 1,1,1-trichloroethane, and freon, and metals such as chromium. From 1957 to 1970, waste handling practices at Letterkenny included disposal of wastes in landfills, trenches, pits, and surface impoundments.

In 1980, a preliminary assessment, conducted as part of the Department of Defense's Installation Restoration Program, identified elevated levels of volatile organic compounds (VOCs) in soil and groundwater in the southeast area of the facility. This area was referred to as the Southeastern (SE) Area and was listed on the National Priorities List in July 1987. The SE area includes the Disposal Area and the Southeast Industrial Area. The Disposal Area includes three areas of soil contamination, also referred to as the K areas. K-1 was a waste disposal lagoon, K-2 was used as a transfer station, and K-3 was an area used to store drums of waste solvent.

An interagency agreement between Letterkenny Army Depot, the U.S. Environmental Protection Agency (EPA), and the State of Pennsylvania was signed in February 1989 to facilitate a cleanup program. The SE Area was divided into three operable units (OU). OU1 addressed contaminated soils in the area of the three surface impoundments (referred to as the K areas), OU2 addressed other areas of soil contamination at the site, and OU3 addressed contaminated groundwater at the site. OU1 is the subject of this report.

Several remedial investigations were conducted in the vicinity of the K areas. A 1992 remedial investigation identified elevated levels of TCE, polychlorinated biphenyls (PCBs), metals, and semivolatile organic compounds (SVOCs) in soils at the site. The concentrations of contaminants varied by K area, with the highest concentrations of TCE found in the K-1 area at levels up to 30,000 milligrams per kilogram (mg/kg). TCE concentrations of up to 1.53 mg/kg were found in the K-2 area and up to 0.61 mg/kg in the K-3 area. PCBs were found in the K-1 area (up to 0.81 mg/kg) and the K-3 area (up to 1.2 mg/kg). Metals, primarily lead, mercury, cadmium, and chromium were found in all three areas. The metals concentrations generally ranged from less than 1 mg/kg to 150 mg/kg, with the exception of lead in the K-1 area, reported at 10,000 mg/kg. The contaminants of concern identified for the K areas were VOCs and lead.

On June 28, 1991, a Record of Decision (ROD) was signed for OU1 and specified excavation of VOC-contaminated soil (levels above 0.225 mg/kg) followed by treatment on-site using low temperature thermal desorption with vapor control and treatment, and backfilling of treated soil on-site. On August 2, 1991, the ROD for OU1 was modified to include solidification/stabilization followed by off-site disposal for any treated soils where the metals concentrations were above the toxicity characteristic leaching procedure (TCLP) levels.

A low temperature thermal desorption system (LTTD), model I.R.V.- 100 designed by McLaren/Hart, was used to treat the contaminated soil from the K areas. The unit operated from September 1993 to October 1994. A total of 13,986 cubic yards of soil were treated during this application, including 2,620 cubic yards of "black stained" soils that were encountered during the excavation of the K-1 and K-3 areas. The black stained soils contained heavy oils, grease, and debris and were stockpiled separately from the "clay soils" for treatment. An estimated 4,000 cubic yards of the treated soil required stabilization prior to off-site disposal.

CERCLIS ID Number:	PA6213820503
Type of Action:	Remedial
Lead:	EPA

Timeline [1]

June 28, 1991	ROD signed
August 2, 1991	ROD modified to add requirement for stabilization and solidification of treated soils with metal concentrations above TCLP

September 8-9, 1993	Initiated Demonstration Test for LTTD system; encountered problems with black stained soils
September 10 - October 25, 1993	Modified the LTTD system to address problems with treating black stained soils
October 26-28, 1993	Performed second Demonstration Test for the LTTD system
November 28, 1993	Began full-scale operation
February 28 - April 6, 1994	Suspended operation of the treatment unit to perform additional emissions testing (see Technology Description section)
April - October 1994	Completed treatment of contaminated soil
November 1994 - September 1995	Completed final cap/site restoration activities

Factors That Affected Cost or Performance of Treatment [1,7]

Listed below are the key matrix characteristics for this technology and the values measured for each during site characterization.

Matrix Characteristics [1,7]

Parameter	Value for Clay Soils	Value for Black Stained Soils
Soil Classification:	Gravel Clay with Sand	Not provided
Clay Content and/or Particle Size Distribution:	15% coarse sand or larger, 70% silt and clay	Not provided
Moisture Content:	24 % (average natural moisture content)	Not provided
Oil and Grease (O&G):	Not measured*	Not measured*
Bulk Density:	1.3 tons per cubic yard	Not provided

* - O&G was not measured; however, it was present in soils and caused problems with the operation of the LTTD (see below).

Treatment Technology Description [1,7]

For this application, McLaren/Hart used the I.R.V.-100, a patented, batch process LTTD system that uses infrared, conductive and convective heat transfer, reduced pressure volatilization, and air stripping to desorb organic contaminants from soil. The 1.2 million BTU/hour system included a total of six carbon steel treatment chambers, each approximately 8 feet (ft) wide, 16 ft long, and 2 ft deep (capacity of 5 cubic yards of soil per chamber). Each chamber was equipped with 16 propane-fired infrared heaters, attached to the top of the chamber, to heat soils to temperatures up to 600°F. The bottom of each chamber contained eight stainless steel well screens, 4 inches in diameter by 15 ft long, which were connected to a manifold outlet which was connected to a vacuum/blower. The system had two vacuum/blowers (one vacuum/blower serviced three chambers). Each had a rated capacity of 25 horsepower and 3,000 cubic feet per minute (cfm) at 13 column inches of water.

The system was operated under a vacuum, ranging from 12 to 20 column inches of water, with a volumetric air flow ranging between 500 and 1,000 cfm per chamber. Air from the bottom of the chamber was directed to the emissions control system which included two cyclones to remove particulates, two air expansion chambers to cool the temperature of the air from about 120° F to about 90°F, and one 4,000 pound activated carbon adsorption unit. Each cyclone and air expansion unit serviced three treatment chambers. Treated soil from the system was stockpiled for sampling and analysis. Particulates from the cyclones were returned to the LTTD unit.

Prior to full-scale operation, the LTTD system was required to pass three test runs performed during a Demonstration Test. The performance requirements for the system included treating soil to a level of 0.05 mg/kg for TCE, to the Land Disposal Restriction treatment standards for 10 other VOCs, and meeting the local emissions standards including standards for opacity. In addition, the Demonstration Test was used to determine residence time. During the initial test, performed September 8-9, 1993, one test was performed on clay soil and two on black stained soils. The test on the clay soil met the performance requirements. However, during the tests on the black stained soils, a heavy white-grey smoke was produced (exceeding the opacity standard) and the treated soil did not meet the TCE level. Oil and grease (sludge layer) of these soils degraded shredded wood that was also present, helping to generate the smoke.

To address the problem with treating black stained soils, McLaren/Hart added an Anderson 2000 dry scrubber unit to the system (between the air expansion units and the carbon adsorption unit) for use when treating black stained soils.

In addition, the total residence time for black stained soils was increased from 60 minutes (for clay soil) to 120 to 150 minutes.

During the second Demonstration Test, conducted in October 1993, performance requirements were met for three tests of clay soils and three tests of black stained soils.

During full-scale operation, the unit was operated according to the original design parameters when treating the clay soils. When treating black stained soils, the unit was operated using the Anderson 2000 dry scrubber and the residence time was increased.

Listed below are the key operating parameters for this technology and the values measured for each.

Operating Parameters [1]

Operating Parameter	Value
Residence Time:	60 minutes (clay soils) 120 to 150 minutes (black stained soils)
System Throughput:	5 cubic yards/unit
Soil Temperature:	150 - 600 °F
Air Flow:	500 - 1000 cfm/chamber

Full-scale operations began in November 1993 and continued until February 1994 when the U.S. Army Corps of Engineers (USACE) suspended treatment operations in order to conduct additional stack testing of emissions from the unit. McLaren/Hart performed an additional demonstration test using black stained soils to monitor levels of PCBs, SVOCs, and VOCs in stack emissions from the unit. The results confirmed that the emissions were within the required limits and operations resumed on April 7, 1994. Soil treatment was completed in October 1994.

Performance Information [1,2,3,5,6,7]

The ROD specified cleanup goal for TCE in treated soil was 0.05 mg/kg. The amended ROD required that treated soils that exceeded the TCLP limits for metals be stabilized and shipped off site for disposal. In addition, because soils excavated from the top 6 feet of the K-1 area and the top 3 feet of the K-2 area were found to contain high levels of both total and TCLP lead after treatment, all soils from these depths were stabilized prior to disposal. In addition, treated soils were required to meet the Land Disposal Restriction treatment standards (40 CFR Part 268.43) for 10 other VOCs (acetone, benzene, carbon tetrachloride, chlorobenzene, o-dichlorobenzene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, tetrachloroethene, ethyl benzene, toluene, and total xylene) and the TCLP regulatory levels for organics and metals (40 CFR Part 261.24). No goals were established for total RCRA metals.

The emissions standards for the unit included an opacity limit of < 10% for 30 minutes, total VOC emissions of < 1 pound/hour, and particulate matter of < 0.08 grains per dry standard cubic foot. Compliance with the emissions standards was determined during the demonstration tests.

Samples of the treated soil were collected from stockpiles generated during each shift and from stockpiles generated during every 24 hours of unit operation. During this application, a total of 13,986 cubic yards of contaminated soil were treated to below the cleanup goals, including 11,366 cubic yards of clay soil and 2,620 cubic yards of black stained soil. Information on the total number of batches treated was not provided. Soil that did not meet the cleanup goals on the first pass through the unit was retreated until the cleanup goals were met. Approximately 10% of the clay soils and 14% of the black stained soils from the K-1 area were retreated.

In addition, a total of about 4,000 cubic yards of treated soils was stabilized prior to off-site disposal. This included treated soil that was above the TCLP metals levels and from the top 6 feet of K-1 area treated soil, top 3 feet of K-2 area. The remaining treated soil was backfilled on-site.

Performance Data Quality [1]

A quality assurance/quality control (QA/QC) engineer performed all the QA/QC activities for this application including inspections of site activities, field testing materials, and completion of written quality control reports. No variations or deviations from the QA/QC requirements were noted.

Cost Information [1,4,7]

The remediation for the thermal treatment of the K areas contaminated soil was procured by the USACE, who provided oversight for the remediation. McLaren/Hart was awarded the contract and provided the patented I.R.V.-100 LTTD system (invented by Therrachem, a division of McLaren/Hart) for the remediation.

The actual costs for this project were provided by the remediation contractor, McLaren/Hart, based on invoiced costs, and by USACE based on estimated funded costs for the project. Table 1 presents the costs for the project, including the capital and operation and maintenance (O&M) costs for the thermal

treatment technology application, other technology-specific costs, and other project costs.

The total cost for the LTTD application for the treatment of the contaminated soils from the K areas was $3,073,031, including $3,051,425 in capital cost and $21,606 in O&M costs. The calculated unit cost for this application was $220 per cubic yard of soil. The total project cost for the remediation of the K areas was $5,402,801. This cost includes $4,647,632 for McLaren/Hart's actual costs, as well as other project costs identified by USACE for design and project remediation ($192,827), design contract costs ($249,320), and construction contract management ($312,320).

McLaren/Hart's actual costs of $4,647,632 include $2,622,470 for five modifications to the contract, which included $1,937,802 to treat the black stained soils found at the site, and costs for additional emissions testing, dewatering of the excavation, and suspension of work during the dewatering operations. Specific costs for each of the modifications are presented in Table 1 (modifications are identified in parentheses and described in footnotes). McLaren/Hart's actual costs also reflect a credit of $165,162 for cost savings resulting from backfilling soil and debris on-site rather than paying for off-site disposal, as proposed in the base contract. Because the disposal had been priced on a unit basis (rather than a lump sum), McLaren/Hart credited the cost savings on the contract to USACE.

USACE did not agree to pay McLaren/Hart the full amount of the modifications. USACE and McLaren/Hart subsequently negotiated a settlement of $1,740,000 for the five modifications. The settlement also reflected the $165,162 credit described above. The result was a total payment to McLaren/Hart of $3,905,256 for the remediation of the K area soils.

Observations and Lessons Learned [1]

Between September 1993 and October 1994, the LTTD system treated 13,986 cubic yards of contaminated soil to the specified cleanup goals. The total amount of soil treated included 11,366 cubic yards of clay soil and 2,620 cubic yards of black stained soil. In addition, a total of 4,000 cubic yards of treated soil were stabilized prior to off-site disposal.

The total project cost for this application was $5,402,801, including $3,073,031 in capital and operating costs directly associated with the LTTD application. These costs represent the actual costs incurred by McLaren/Hart. During the performance of the project, there were five modifications that resulted in additional costs incurred by McLaren/Hart of more than $2.6 million. USACE subsequently reached a settlement that resulted in a net increase to the base contract of about $1.74 million.

According to McLaren/Hart, the presence of the black stained soils had not been anticipated at the time of the original contract. The adverse effects of these soils on the operation of the unit, from the heavy hydrocarbons in the soil, were discovered during the first demonstration test and required modification to the design and operation of the system, including expansion of the emissions controls. This resulted in increased costs and a delay in the schedule over the original plan.

Several delays were encountered during the project that extended the time required to complete the treatment of the contaminated soil from the K areas. These delays included:

- A two-month delay, following the first demonstration test, to modify the system to add a dry scrubber to control emissions during the treatment of black stained soils and a five week delay when operations of the the LTTD system were suspended by USACE in order to perform additional stack testing of emissions from the system.
- Delays caused by an unusually high snow fall that restricted operation of the unit in the winter and, when the snow melted in the spring, increased the moisture content in the soil, which in turn, increased the amount of time required to treat the soil.

According to McLaren/Hart, several cost savings were realized during the project. These included:

- A savings of $456,000 by using the Letterkenny Army Depot wastewater treatment plant to treat wastewater resulting from excavation dewatering activities rather than treating wastewater off-site (based on an assumed unit disposal cost of $0.20 per gallon x 2.28 million gallons).
- A savings of $1.1 million by backfilling treated soil on-site rather than disposing off-site at a "residual waste" landfill (based on 14,000 cubic yards x 1.3 tons per cubic yard x $60 per ton for transportation and disposal).
- A savings of $168,000 by using the treated soil as backfill rather than other material (based on 14,000 cubic yards x $12 per cubic yard).

Table 1 - Actual Project Costs [1,4,7]

Cost Category/Element	Cost (1996 $ Basis)	Cost for Calculating Unit Cost ($)
1. Capital Cost for Technology		
Technology mobilization, setup, and demobilization	Mobilization costs included with startup and testing	
Planning and preparation	See other project costs	
Site work	See other project costs	
Equipment and appurtenances - thermal treatment - Black stained soil treatment (mod 5)	1,053,270 1,937,802	
Startup and testing - mobilization, shakedown, and demonstration of LTTD system - additional stack emissions testing (final demonstration)(mod 1)	30,353 30,000	
Other (Includes nonprocess equipment)	0	
TOTAL CAPITAL COSTS		**3,051,425**
2. O&M for Technology		
Labor	Included in capital costs	
Materials	Included in capital costs	
Utilities and fuel	Included in capital costs	
Equipment ownership, rental, or lease	Included in capital costs	
Performance testing and analysis	Included in capital costs under equipment and appurtenances	
Other - standby time for LTTD system - suspension of work - thermal treatment	21,606	
TOTAL OPERATION AND MAINTENANCE COSTS		**21,606**
3. Other Technology-Specific Costs		
Compliance testing and analysis	0	
Soil, sludge, and debris excavation, collection, and control - excavation of soil - excavation and disposal of various debris - dewatering of excavation (groundwater infiltration) (mod 3) - dewatering of excavation (stormwater intrusion) (mod 4) - suspension of work on excavation for 132 days (mod 2)	 346,780 144,077 (estimated)* 118,641 51,853 484,174	
Disposal of residues - treated soil	88,690 (estimated)*	
Credit for disposal of soil and debris	(165,162)*	
Subtotal for category 3	**1,069,053**	

Table 1 - Actual Project Costs [1,4,7] (continued)

Cost Category/Element	Cost (1996 $ Basis)	Cost for Calculating Unit Cost ($)
4. Other Project Costs		
- mobilization, shakedown, and demonstration of solidification/stabilization equipment	23,210	
- construction of Type III residual waste caps	75,832	
- solidification/stabilization of soil	68,520	
- general site management activities	326,560	
- other general project activities	11,521	
- design and project management	192,827	
- design contract cost	249,827	
- construction contract management S&A	312,420	
Subtotal for category 4	**1,260,717**	
Total cost	**5,402,801**	
Total cost for calculating unit cost		3,073,031
Quantity treated		13,986 cubic yards
Calculated unit cost		220/cubic yard
Basis for quantity treated		quantity of soil treated in LTTD

* - McLaren/Hart's original proposed costs included unit costs for disposal of soil and debris. A cost savings of $165,162 was realized because of savings resulting from being able to backfill material on-site. Since these costs were proposed on a unit cost basis rather than a lump sum basis, the USACE was credited with $165,162.

Modification 1 - Includes costs for additional emissions testing. After the system failed emission testing, the contractor was ordered to perform additional emission testing.

Modification 2 - Includes cost for work suspension for 132 days for excavation activities and for 37 days (2/28 - 4/6/94) for thermal treatment operations.

Modification 3 - Includes cost for dewatering of excavation caused by groundwater infiltration as a result of extended wet weather conditions; dewatering was performed after the groundwater table had dropped.

Modification 4 - Includes costs for dewatering of excavation following a large storm which caused a partial shoring collapse.

Modification 5 - Includes costs to treat black stained soils, including the costs for a scrubber, a second demonstration, and treatment of black stained soil.

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References

The following references were used in the preparation of this report.

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