APPENDIX B
EXAMPLE REMEDIAL ACTION REPORT – EX SITU SOIL REMEDIATION

NOTE:

The following example remedial action report is based on an actual Superfund site, but some information has been altered to illustrate the concepts of the guide. In addition, names have been changed to avoid confusion with the actual site.

Content and format of actual RA reports may vary from this example due to considerations such as project lead and support roles, availability of information, and site-specific conditions. The information presented in this example report (e.g., costs) should not necessarily be used as a technical basis for completing remedial action at an actual site (e.g., as a source of cost information).

FINAL
REMEDIAL ACTION REPORT

SLIPPERY CHEMICAL SUPERFUND SITE, OPERABLE UNIT 3
GREASE, TEXAS

September 2000

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Abstract

Operable Unit 3
On-Site Thermal Treatment
Slippery Chemical Superfund Site, Grease, Texas

Site Name and Operable Unit:	Slippery Chemical Superfund Site, Operable Unit 3
Location:	Grease, Texas
Regulatory Oversight:	U.S. Environmental Protection Agency Region VI Texas Natural Resources Conservation Commission
Contractor Oversight:	U.S. Army Corps of Engineers, Ft. Worth District
Remedial Action Contractor:	H&S Consultants, Grease, TX
Waste Source:	Two lined and two unlined waste management lagoons; disposal of drums of chemical waste, chemical sludge and demolition debris on the ground surface and in the shallow subsurface
Contaminants:	Organic Compounds • 470 to 1,500,000 µg/kg ß-Naphthylamine • 3.8 to 8,200 µg/kg Fenac • Halogenated and non-halogenated VOCs and SVOCs detected in soil
Technology:	On-Site Incineration • The incineration system consisted of a co-current, rotary kiln and a secondary combustion chamber (SCC). • The kiln operated at an exit gas temperature above 1599°F and the SCC operated above 1801°F. • Hot gases exiting the SCC passed through an evaporative cooler, a baghouse, a Venturi quench unit, and a caustic scrubber. • Excavated soil was dried and screened to remove oversized organic and inorganic debris. • Excavated soil and shredded combustible material were fed to the incinerator. • Treated soil and fly ash were stockpiled for compliance sampling. • Treated soil and fly ash that met treatment standards were used as fill material at the site.
Cleanup Type:	Full-Scale
Purpose/Significance Of Application:	Remediation designed to provide permanent destruction of soil contaminants; no long-term waste management requirements following on-site backfill of incinerator ash.
Type/Quantity of Media Treated:	295,087 tons (194,520 cubic yards) of contaminated soil Moisture content: 17.6% average, range of 10 to 25.5% BTU value: 274 Btu/lb
Period of Operation:	Trial burn: 1/25/97 to 2/4/97 Full-scale operation: 3/4/98 to 4/22/99

Abstract

Operable Unit 3, cont.
On-Site Thermal Treatment
Slippery Chemical Superfund Site, Grease, Texas

Regulatory Requirements/ Cleanup Goals:

Destruction and removal efficiency (DRE) of 99.99% for POHC.
Treated soil objectives were 55 mg/kg for b-Naphthylamine and 1,000 mg/kg for Fenac.
Treated soil and fly ash with TCLP concentrations in excess 25 times the drinking water standard for any one of eight metals were stabilized.
Air emission requirements included control of metals, hydrogen chloride, total dioxins and furans, carbon monoxide, nitrous oxides, and particulate matter in the stack gas.

Results:

Sampling of treated soil indicated that the cleanup goals were met. Three percent of the soil required re-treatment to achieve cleanup levels.
Two batches of fly ash required stabilization prior to on-site backfill.
Emissions data from the trial burn and full-scale operations indicated that all emissions standards were met.

Costs:

The total cost for this project was $134,622,950, with RA capital costs of $64,676,100, RA operating costs of $69,890,000, and RA periodic costs of $56,850. The total technology-specific cost was $109,190,500. Therefore, using a quantity of 194,520 cubic yards, the technology-specific unit cost was calculated at $478 per cubic yard.

Description:

The SCS Site included a chemical manufacturing facility that operated from 1951 to 1982, producing chemical intermediates used in dye, cosmetic, textile, pharmaceutical, pesticide and herbicide manufacturing. Two lined wastewater treatment lagoons, a dry unlined sludge lagoon, and an unlined leachate lagoon were constructed at the site during the late 1950s, probably for use as waste impoundments. Drums of chemical waste, chemical sludge, and demolition debris were disposed on the ground surface and in the shallow subsurface at the site.

Site soil and chemical sludge were contaminated with VOCs, SVOCs including b-naphthylamine, the herbicide Fenac, and metals. These compounds were detected throughout the site regardless of sampling depth. A ROD was signed in September 1988, specifying on-site incineration as the remedial technology for addressing soil contamination at the site. Contaminated soil/sludge/sediment and groundwater were identified as Operable Unit (OU) 3.

Site work for construction of the incinerator commenced in April 1995. Incinerator shake down and a clean burn were conducted in January 1996. The incinerator was then shut down until September 1996 due to a lawsuit filed to stop the remediation project. System optimization and preliminary testing were conducted in the Fall of 1996. The trial burn and risk burns were conducted in January and February 1997. Following approval of the test results, the incinerator was put into full-scale operation in March 1998. All site soil was excavated down to the water table (about 15 feet below ground surface) and treated. The total area of the SCS Site is 9.6 acres. The incineration system consisted of a co-current, rotary kiln followed by a SCC. After confirming that treated soil and fly ash met the cleanup criteria, the materials were backfilled at the site. Treatment was completed in April 1999.

SITE DESCRIPTION

The Slippery Chemical Superfund (SCS) Site is located in Slick County, Texas, in the city of Grease. The site was a chemical manufacturing facility that operated from 1951 to 1982. During its operation, the Slippery Chemical Company produced chemical intermediates used in dye, cosmetic, textile, pharmaceutical, pesticide and herbicide manufacturing. The total area of the site is 9.6 acres and includes the previous location of the Slippery Chemical Company and the adjacent Oily Chemical Company property. Figure 1 shows the general layout of the site.

The Slippery Chemical plant included several major buildings, two lined wastewater treatment lagoons, a dry unlined sludge lagoon, and an unlined leachate lagoon. The lagoons were constructed during the late 1950s, probably for use as waste impoundments. The leachate lagoon was constructed in the lowest portion of the site, and is assumed to be the collection point for all surface runoff at the site. Approximately 60 process tanks and reactors were located inside and surrounding the process buildings. Approximately 10 additional larger tanks were staged outside of the buildings for bulk storage of acids, bases, and fuel oils.

The area surrounding the site includes the Oily Chemical Company to the west, Rough Paper Company to the southwest, Wet Creek to the south, the west branch of the Roaring River to the north, and an apartment complex and shopping center to the east.

GEOLOGY AND STRATIGRAPHY

The general lithology of the upper 15 feet of overburden material at the SCS Site consists of sandy clay floodplain deposits with various lenses of clay dispersed throughout. Below approximately 15 feet, the alluvial sediments increase in grain size with increasing depth to sand and gravel and then to sand with gravel and cobble-sized sandstone fragments. The bedrock is a soft gray to shaley claystone and medium hard limestone ranging from less than 1 foot to 31 feet in thickness, and occurs at approximately 110 feet bgs.

Groundwater at the SCS Site flows to the north, east and south. Local groundwater flows to the south and southeast toward Wet Creek. Groundwater is typically encountered at 12 to 15 feet bgs.

RELEVANT OPERATIONS AND WASTE MANAGEMENT PRACTICES

From the late 1950s through the early 1980s, four waste management lagoons (waste impoundments) were operated at the SCS Site. The two wastewater lagoons were lined, but the sludge lagoon and leachate lagoon were unlined. Additionally, drums of chemical waste, chemical sludge, and demolition debris were disposed on the ground surface and in the shallow subsurface at the site.

REGULATORY HISTORY

Slippery Chemical was cited many times by state and federal agencies for violating environmental and health and safety regulations. In 1982, after Slippery Chemical failed to respond to the U.S. Environmental Protection Agency's (USEPA's) request to clean up the site, the USEPA initiated an emergency removal action during which drums, surface sludges, and storage tanks were removed. During this removal action, USEPA removed 1,700 exposed drums and drained and neutralized approximately 10 large tanks used for bulk storage of acids, bases, and fuel oil. Access to the site was controlled using an 8-foot fence, and warning signs were posted.

A Superfund remedial investigation and feasibility study (RI/FS) was initiated in 1983. The first two phases of the RI/FS led to interim remedial actions, specifically: Operable Unit (OU) -1 – the remediation of a leachate stream that was discharging to an off-site area; and OU-2 – the removal of the two lined wastewater treatment lagoons and the on-site structures. Phase I was completed in 1987. Phase II was completed in 1988.

The September 1988 Record of Decision (ROD) addressed both soil/sludge/sediment contamination and groundwater contamination at the SCS site; however, OU-3, the subject of this report, only addresses soil/sludge/sediment.

The Phase III RI/FS was initiated in January 1987. During Phase III field investigations, samples of soil, groundwater, surface water and sediment were collected. Forty-one test pits were excavated to characterize contaminated soil and sludge at the site. Each test pit was excavated to the water table or to a depth of 15 feet below ground surface (bgs), whichever was more shallow.

NATURE AND EXTENT OF CONTAMINATION

During the Phase III RI/FS, soil, groundwater, surface water, and sediment contamination was observed throughout the site. OU-3 addressed all of these contaminated media. The degree of contamination varied throughout the study area. In general, the frequency of occurrence and concentrations of contaminants were greatest on the Slippery Chemical property and immediately off-site, particularly on the Oily Chemical property, which is located immediately north of the Slippery Chemical property. Based on local groundwater patterns, the Oily Chemical property is considered to be down gradient of the Slippery Chemical Property.

Chemical sludge and contaminated soil were observed in all of the open area on the SCS Site. The soil and sludge were contaminated with volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), Fenac, β-naphthylamine, and metals. Organic contaminants (i.e., Fenac) were consistently observed in samples collected throughout the site. Field screening revealed that the vadose zone at the site was contaminated to varying concentrations with chlorinated solvents and benzene, toluene, ethylbenzene, and xylenes (BTEX). Substituted chlorinated phenols and alkyl phenols were also present. These compounds occurred throughout the site regardless of sampling depth; therefore, no one particular area of the Slippery Chemical property or the adjacent Oily Chemical property could have been considered the most likely source of contamination. Metals were also detected in soil samples; however, it is not clear whether activities at the Slippery Chemical plant were the source of metals contamination.

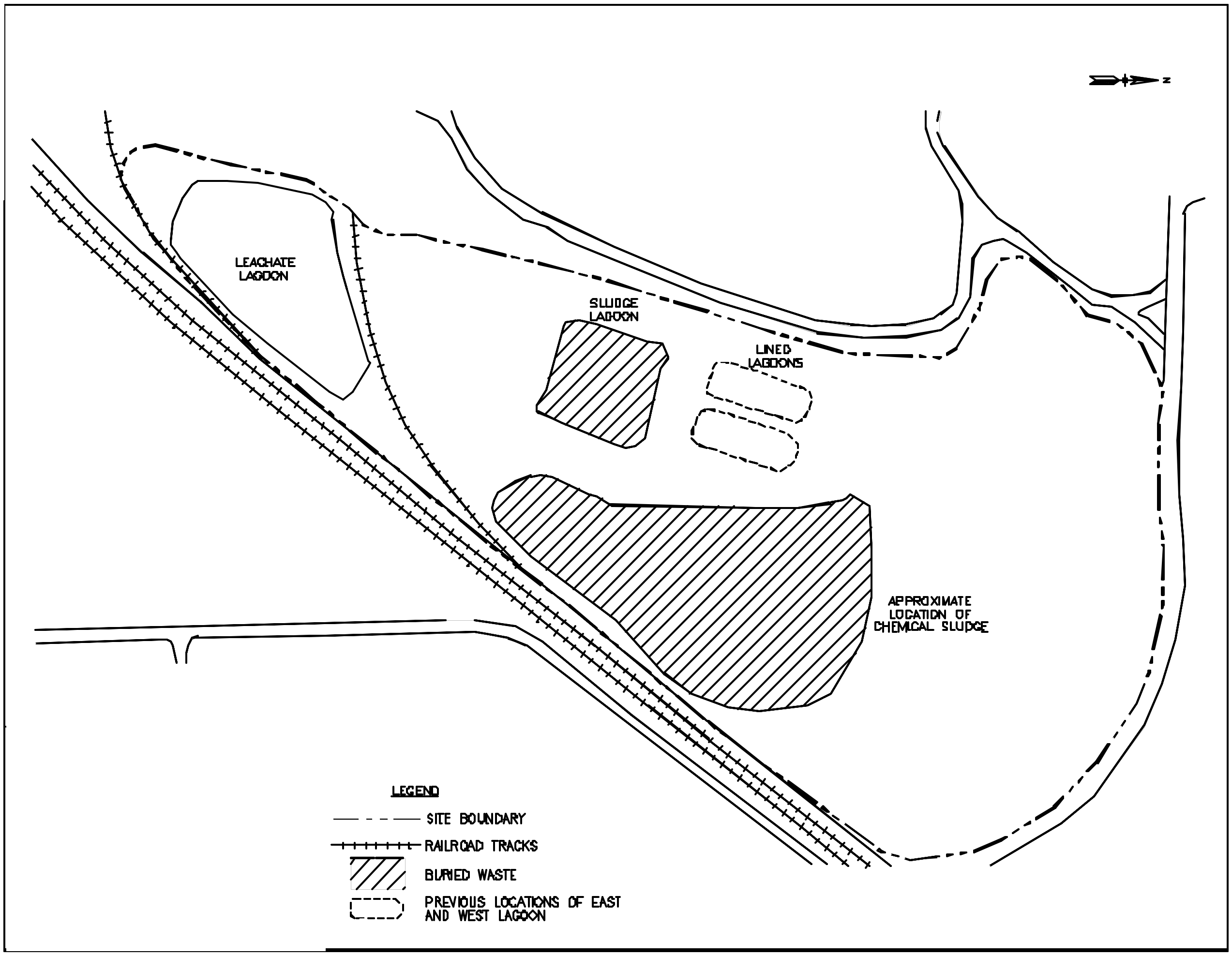

FIGURE 1
SLIPPERY CHEMICAL SUPERFUND SITE

REMEDY SELECTION

Based upon CERCLA requirements and a detailed analysis of the alternatives, USEPA and the Texas Natural Resources Conservation Commission (TNRCC) recommended incineration of all soil and buried waste within the SCS Site boundary down to the groundwater table. The selected remedy was deemed:

- To be protective of human health and the environment,
- To meet all applicable or relevant and appropriate federal and state requirements (ARARs), and
- To be cost-effective.

This remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility or volume as a principal element and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

The selected remedy for the SCS Site included:

- Excavation of approximately 252,000 cubic yards (CY) of contaminated sludge, soil, and sediments,
- Treatment of excavated materials in an on-site mobile rotary kiln incinerator,
- Backfilling all excavations (potentially with incinerator ash), and
- Installation of a vegetative cover.

CLEANUP GOALS/STANDARDS

The following table lists the remediation objectives for soil treated in the incinerator operated at the SCS Site. These objectives were established in the September 1988 ROD to meet TNRCC requirements.

Treated Soil Objectives

Contaminant	Cleanup Level (mg/kg)
Volatile Organics	
Benzene	100
Chlorobenzene	10,000
1,2-Dichloroethene	7,000
Ethylbenzene	70,000
Tetrachloroethane	2,000
Toluene	100,000
Trichloroethene	2,000

Contaminant	Cleanup Level (mg/kg)
Total Xylenes	5,000
Semivolatile Organics	
Benzo(a)anthracene	6,000
Benzo(b)fluoranthene	6,000
Benzo(k)fluoranthene	60,000
Benzoic Acid	3,300
Benzo(a)pyrene	660
Chrysene	300,000
1,2-Dichlorobenzene	7,000
1,4-Dichlorobenzene	8,000
Fluoranthene	400,000
Naphthalene	8,000
Pentachlorophenol	40,000
Phenanthrene	80,000
Phenol	400,000
Pyrene	300,000
1,2,4-Trichlorobenzene	20,000
β-Naphthylamine	55
Chlorinated Herbicide	
Fenac	1,000

CONSTRUCTION AND IMPLEMENTATION OF THE TREATMENT REMEDY

A background air monitoring study was performed prior to on-site construction activities. The study was conducted from October 10 through December 5, 1994. The perimeter air monitoring program was initiated in March 1995, and excavation began in April 1995. In order to support the vertical excavation at the site boundaries, a sheet pile excavation support system was installed to allow "straight cut" excavations. Soil excavation was the first step in incinerator construction, and the unit was sited on imported clean fill placed after the initial excavation. Construction of the incineration system was completed in December 1995. System shakedown and a clean burn were conducted on January 13, 1996. The incinerator was then shut down until September 23, 1996 due to a lawsuit that was filed by a local opposition group against the USEPA to stop the remediation project. Approval to continue the project was issued on August 14, 1996.

A mobile, on-site incineration system was used to decontaminate soil, sludge, and sediment at the SCS Site. The incineration system consisted of a rotary kiln, a secondary combustion chamber (SCC), and an air pollution control system (APCS). Rotary kiln incinerators are able to process a wide variety of waste feed compositions and handle oversized wastes with minimal processing pre-treatment. The rotary kiln portion of the system is used to volatilize and destroy the majority of the organic contaminants. The remaining organic contaminants exit the kiln with the hot gases into the SCC where additional destruction occurs. The APCS is used to provide particulate matter and acid gas control. Figure 2 shows a schematic of the on-site incineration system.

Site characteristics, operating limits, and operating parameters of the incineration system are presented in Appendix A. The system was operated using the following steps:

- Contaminated soil was excavated down to the water table over the entire site and was dried by adding cement kiln dust or lime. Soil was then transported to the debris separation building. Material greater than 4 inches in diameter was removed from the soil by rotating barrel screens and underwent manual segregation into organic and inorganic debris. Organic debris (e.g., wood) was shredded. Inorganic debris was either landfilled (e.g., plastic), recycled (e.g., steel) or cleaned for backfill (e.g., rocks). Material less than 4 inches in diameter was stockpiled in the feed preparation building after ferrous material was electromagnetically removed.

- Soil was blended with shredded brush, roots, trees, and other combustible material. The soil was fed onto a variable-speed, apron conveyor, a weigh belt conveyor, and into the kiln feed hopper. Feed material was delivered from the hopper to the kiln via dual, water-cooled, feed screws. The feed material was sampled and analyzed for metals, SVOCs (including β-naphthylamine), VOCs, Fenac, and physical/chemical parameters (e.g., BTU, moisture, ash, and chlorine).

- The rotary kiln was 60 feet long and had an inside diameter of 11 feet. The kiln was operated concurrently with the waste feed located at the same end as the oxygen-natural gas burners.

Contaminated soil traveled through the kiln via gravity. The kiln was operated at a minimum exit gas temperature of 1599°F.

- The kiln discharge chamber was sized to reduce the flue gas velocity and remove large particulate matter in the exit gas stream. The hot gas cyclone subsequently removed additional particulate matter in the flue gas prior to entering the SCC. The SCC was operated at a minimum temperature of 1801°F and a minimum gas retention time of 2 seconds.

- Exhaust gases from the SCC were cooled to 400°F using air-atomized, water spray nozzles in an evaporative cooler. The cooled flue gases then passed through a baghouse for removal of particulate matter. The baghouse was designed with a 3-to-1 air-to-cloth ratio.

- The baghouse gas discharged to an induced draft (ID) fan, which drew gases through the entire system and discharged them through the wet scrubber system to the discharge stack. The fan produced negative pressure throughout the incineration system to eliminate fugitive emissions.

- Exhaust gases from the baghouse were cooled from approximately 350°F to 185°F with water sprays in the Venturi quench unit. A mildly caustic scrubber water solution neutralized dissolved acid gases in one of two countercurrent, packed-bed absorbers, which were operated in parallel. The pH of the scrubber water was maintained between 6.5 and 9 by addition of a sodium hydroxide solution. The cleaned gas passed through a high-efficiency, multi-pass mist eliminator for removal of entrained water droplets.

- Cleaned flue gas was exhausted through a 150-foot tall stack equipped with continuous emission monitors (CEMs) that analyzed the gas for oxygen (O_2), carbon monoxide (CO), carbon dioxide (CO_2), total hydrocarbons (THC), and nitrogen oxides (NO_x).

- Bottom ash and fly ash were segregated prior to disposal. Bottom ash consisted of treated soil from the kiln and ash collected by the cyclone and SCC. Fly ash consisted of ash from the evaporative cooler and baghouse. Each ash stream was cooled and wetted by spraying with excess scrubber system water, after which it was conveyed to the ash storage area. A 10,000 cubic feet per minute (cfm) scrubber and Lamella clarifier system captured steam issuing from the wet ash drag conveyor to prevent off-site migration of particulate matter.

- Fly was were tested for TCLP metals as each storage bin was filled. Each day’s production of bottom ash was separated for testing of TCLP metals, Fenac, SVOCs (including b-naphthylamine), and VOCs. Ash failing the cleanup criteria was retreated. Ash meeting the cleanup criteria was backfilled on-site. Ash with TCLP concentrations greater than 25 times any of the drinking water standards was stabilized prior to backfill.

In addition to the incineration system, a 100-gallon per minute (gpm) wastewater treatment plant (WWTP) was installed and operated at the site to remove metals and organic compounds from various water streams generated during the project. Treated wastewater was discharged to Wet Creek. Wastewater treated at the WWTP included: incineration system pad cleaning water; ash handling pad cleaning water; wash water from equipment and personnel decontamination activities; water collected from the leachate lagoon; water collected from the soil excavation cavities; and potentially-contaminated storm water. The WWTP included the following treatment technologies:

- Primary settling;
- Wastewater equalization tanks;
- Metals removal through chemical addition, flocculation, and clarification;
- Neutralization;
- Sand filtration for suspended solids removal;
- Air stripping with activated carbon columns for treating organics transferred to the air stream;
- Bag filtration for removal of small-diameter suspended solids;
- Activated carbon adsorption for removal of residual organics; and
- Sludge dewatering with a filter press.

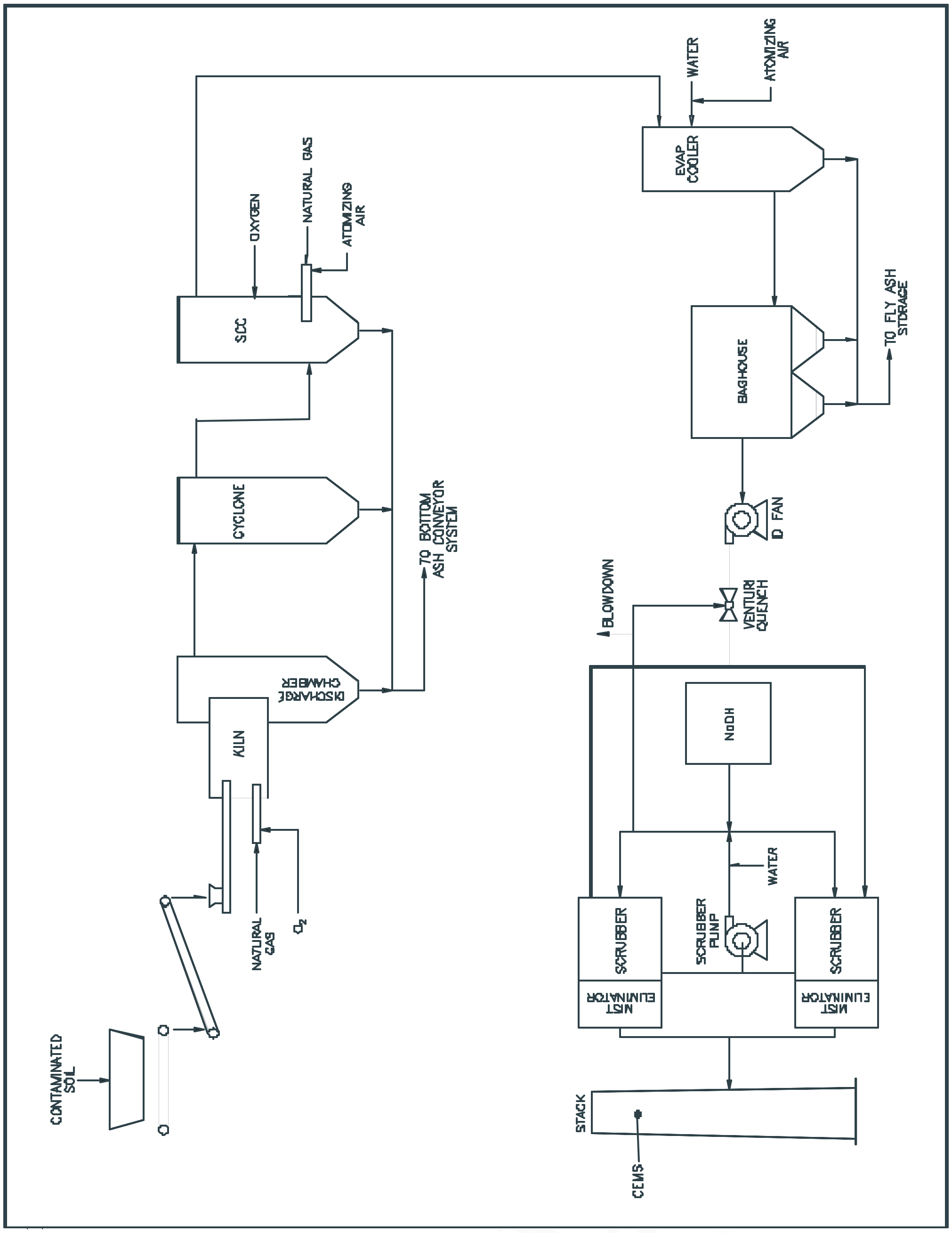

FIGURE 2
SCHEMATIC DIAGRAM OF THE SITE INCINERATOR

The following table includes the dates of the most significant events in the operation of the incinerator system and WWTP at the SCS site.

Date	Activity
September 29, 1988	Phase III ROD signed by the U.S. EPA and the Army
Spring 1989	Phase II remediation completed
October 1990 – August 1991	Incineration feasibility study conducted
September 30, 1993	Contract awarded
November 15, 1993	Notice to proceed issued
November 14, 1994	Mobilization to the site
May 13, 1995	WWTP put into operation
January 3, 1996	Construction of incinerator and supporting facilities complete
January 13, 1996	Shakedown and clean burn complete
January 14, 1996 – August 14, 1996	Stop work in effect due to lawsuit
September 19, 1996	Public meeting held on the revised trial burn risk assessment protocol
January 20 – 22, 1997	Risk Burn No. 1 conducted
January 25 – February 4, 1997	Trial Burn conducted
February 7 – 9, 1997	Risk Burn No. 2 conducted
February 10, 1997 – March 4, 1998	Project shutdown for risk and trial burn data review
February 10, 1998	Public meeting held on the risk assessment
March 9, 1998	Full-scale operations started
April 22, 1999	Soil incineration completed
November 23, 1999	Project completion

PERFORMANCE STANDARDS

The following table provides the performance objectives that were established for the SCS Site incinerator in the September 1988 ROD:

Incinerator Performance Objectives

Parameter	Performance Criteria
Principal Organic Hazardous Constituent (POHC) destruction removal efficiency (DRE)	≥ 99.99%
Particulate Matter (PM) Emissions	≤0.01 grains/dry standard cubic foot (gr/dscf) @ 7% O_2
Hydrochloric Acid (HCl) Emissions	≤4 lb/hr or 99% reduction
Total Dioxins and Furans Emissions	≤30 nanograms/dry standard cubic meter (ng/dscm) @ 7% O_2
NO_x Emissions	≤300 parts per million – volume (ppmv) @ 7% O_2 (daily average)
CO Emissions	≤100 ppmv @ 7% O_2 (hourly rolling average)
Metal Emissions As Be Cd Cr^{+6} Cr Pb	 <0.11 g/sec <0.20 g/sec <0.27 g/sec <0.04 g/sec <0.12 g/sec <1,384 g/sec

Fly ash and bottom ash were analyzed for metals using the toxicity characteristic leaching procedure (TCLP). The results were compared to the Texas drinking water standards listed in the table below. Ash meeting these standards could be backfilled on-site without restriction. Ash failing these standards, but with TCLP concentrations less than 25 times the drinking water standards, could be returned to the site as fill material but could not be placed below 553 feet mean sea level (8 feet above the average water table). As specified in the 1988 ROD, treated soil with TCLP concentrations greater than 25 times the drinking water standard required stabilization prior to backfill.

Ash TCLP Concentration Objectives

Metal	Drinking Water Standard (mg/L)	25 x Standard (mg/L)
Arsenic	0.05	1.25
Barium	1.0	25
Cadmium	0.01	0.25
Chromium	0.05	1.25
Lead	0.05	1.25
Mercury	0.002	0.05
Selenium	0.01	0.25
Silver	0.05	1.25

As discussed previously, perimeter air monitoring was routinely performed at the site. Three VOCs were selected as key indicator compounds to be monitored by the HNu if the average NMOC reading exceeded 1 parts per million (ppm). Perimeter action levels were set at 10% of the OSHA permissible exposure limits (PELs) for each of the three selected contaminants. The perimeter action levels were:

- 9.146 ppm for toluene
- 7.777 ppm for chlorobenzene
- 2.511 ppm for tetrachloroethene

The table below provides the discharge limitations for the WWTP at the SCS Site as specified in the September 1988 ROD. Weekly samples of the WWTP effluent were required whenever the WWTP was in operation.

Wastewater Discharge Limitations

Parameter	Monthly Average (mg/L)	Daily Maximum (mg/L)
β-Naphthylamine	0.012	0.024
Fenac	0.100	0.200
Toluene	0.010	0.020
Chlorobenzene	0.010	0.020
1,2-Dichlorobenzene	0.010	0.020
1,4-Dichlorobenzene	0.010	0.020
1,2-Dichloroethane	0.010	0.020
Trichloroethene	0.005	0.010
Total Arsenic	0.100	0.200
Total Barium	2.000	4.000
Total Cadmium	0.060	0.120
Total Nickel	0.200	0.400
Total Chromium	0.150	0.300
Total Lead	1.000	2.000
pH	6 to 9 standard units	6 to 9 standard units

QUALITY ASSURANCE AND QUALITY CONTROL

Data Assessment

An incineration feasibility study was conducted between October 1990 and August 1991. All test runs met the cleanup criteria established for the SCS Site. The pilot-scale rotary kiln incinerator achieved 99.99% destruction removal efficiency (DRE) of Principal Organic Hazardous Constituents (POHCs), which were spiked into the soil. The leachable metal concentrations in the ash from the pilot study were either non-detect or were below TCLP limits for characteristic hazardous waste, so no fixation or stabilization was required prior to backfilling incinerator ash on site. Some fly ash had TCLP metal concentrations above the drinking water standards.

A risk assessment concluded that full-scale operation of the incinerator at the SCS Site would not pose a threat to public health. All of the estimated risks were within the range that is considered acceptable for cleanup activities performed under the Superfund hazardous waste program.

The results from the trial burn demonstrated that the incinerator met the RCRA performance standards of 40 CFR 264 and other regulatory and contractual requirements while burning site soils spiked with POHCs and metals.

During full-scale operations, all treated soil batches met the cleanup criteria for Fenac after the first pass; eight treated soil batches did not initially meet the cleanup goal for β-naphthylamine. Of the total mass of soil treated, less than 3% required additional thermal treatment after the first pass. Soil not meeting the cleanup criteria was sent back to the feed preparation building where it was blended with the other soil, and then conveyed to the incinerator.

TCLP metals results for 2 batches of fly ash were greater than 25 times the drinking water standard (once during a metals spiking test and the other time during full-scale operation). The fly ash from these batches was stabilized prior to backfill.

Stack testing, perimeter air monitoring and ambient air monitoring performed in the community near the project site met all specified objectives.

Data Quality

All trial burn testing was conducted in accordance with the source test sampling and analysis protocols specified in the quality assurance plan for the trial burn. All data gathered during the trial burn were found to be of acceptable quality to demonstrate that the incinerator met the performance standards. The quality assurance/quality control (QA/QC) results were compared to the data quality objectives specified in the Project Quality Assurance Plan contained in the Trial Burn Plan. This comparison showed that greater than 90% of the accuracy, precision, and method performance objectives were met.

The perimeter air sampling and off-site ambient air sampling were conducted in accordance with the SCS Site Perimeter Air Sampling Plan, including the calibration, sampling and analytical procedures. Other sampling and analysis activities during full-scale operations (e.g., soil and ash tests) were conducted according to the protocols in the Chemical Quality Management Sampling Plan.

INSPECTIONS

The project utilized the U.S. Army Corps of Engineers (USACE) Three Phase Inspection Program which included the Preparatory Inspection – prior to the start of work, Initial Inspection – as soon as representative portion of the work was complete, and Follow Up Inspection – daily until the work is complete. Prior to site mobilization a list of the Definable Features of Work was generated. The Definable Features of Work list was a guideline for initiating the Three Phase Inspection Program on individual work tasks. The Definable Features of Work list was updated monthly and forwarded to the USACE for information only.

CERTIFICATIONS

As part of the submittal process data, drawings, instructions, schedules, statements, reports, certificates, samples, and records were transmitted to the USACE for either review and action or for information only. Each individual submittal was given a unique transmittal number. Submittals were forwarded to the USACE on Government Form SF4025 and to other reviewers such as the USACE Architectural Engineer, USEPA, and TNRCC on Government Form SF4026. Submittals were tracked in the Complete Submittal Register that was updated on a monthly basis. A copy of all submittals was kept on file at the project site.

The Quality Control Department was responsible for generating a Daily Contractors Quality Control Report (DCQCR). Starting with mobilization, through the contract completion date, a DCQCR was generated and issued for each contract day. The report included the following information: date, report number corresponding to the number of contract days, general weather information, work performed by H&S Consultants, attachment reports, work performed by subcontractors, inspections performed, testing performed, verbal instructions received from Government personnel, verbal instructions received from Government personnel on construction deficiencies, safety violations observed, remarks, and worker hours and equipment use. Two copies of the report (one with the original H&S Consultants QC signature) were forwarded to the USACE QA Field Office.

Data Quality Objectives (DQOs) were established prior to the start of the project and were updated throughout the project. Individual programs such as the Perimeter Air Sampling Program and the Chemical Quality Management/Sampling Program defined DQOs. Objectives included precision, accuracy, representativeness, comparability, and completeness. In 1997, a process to consolidate the DQOs was performed. The result was a document that defined DQOs for all chemical data generated on the project. The DQOs were summarized using a seven step process outlined in EPA's "Guidance for the Data Quality Objectives Process" (1994).

HEALTH AND SAFETY

A Permea-Tec® pad was used to verify that beta-napthylamine (BNA) had not permeated gloves and protective clothing during usage. To use this method as a field verification of chemical protective gloves, a worker wore a pad on the back of the hand over the top of the inner glove and beneath the outer glove for approximately two hours. After wear, the outer glove was removed and the Permea-Tec® pad was retrieved. The analysis of the pad was activated with tap water. A positive indication of breakthrough of 2-naphthlylamine (2-NA) through the personal protective equipment (PPE) would result in a predominately red color change of the pad. During the course of the project, no positive results were found with the 780 separate pad tests collected.

A Surface Swype® pad was also used to determine surface contamination of aromatic amine compounds. A monthly wipe sampling program using these pads was implemented to confirm that support areas were not becoming contaminated during site activities. During the course of the project, no positive results were found from the 627 Surface Swype® samples collected in trailers and support facilities.

Surface Swype® pads were also used to confirm that equipment, which had entered the exclusion zone, was decontaminated of aromatic amines prior to release from the exclusion zone. During the equipment decontamination program, only three of the 2,864 pads showed the characteristic color change indicating the presence of aromatic amines. Of the three positive samples, one was found to be a false positive through additional testing and research, and the other two were equipment which were re-cleaned using a decontamination solution formulated to remove aromatic amine compounds. After re-cleaning with the decontamination solution, the equipment Surface Swype® was repeated and no color change was indicated.

Another type of pad utilized was a Skin Swype® pad. The Skin Swype® pad was used to determine that no inadvertent skin contamination with 2-NA had occurred. When a worker exited the exclusion zone, the worker's skin was wiped with a Skin Swype® pad prior to washing, the pad was placed in a small cup containing developing solution, the developing solution was allowed to wick through the pad. If a strip near the top of the pad changed color, it was considered to be positive for an aromatic amine. None of the 770 Skin Swype® pads showed a positive result.

The Risk Assessment Report and associated risk analysis were complete in January 1998, at which time the USACE notified H&S Consultants to prepare for the operation phase. In late February 1998, a clean burn demonstration was performed to ensure that the thermal destruction facility (TDF) was mechanically capable of performing during the Operations Phase. On March 4th, with the clean burn successfully complete, and with concurrence from USEPA and USACE, the Operation Phase commenced.

With-in several days of the Operation Phase concerns were raised over whether dust was entrained in the steam generated from the thermal process and whether, if entrained, it was leaving the site boundary. Several members of the project team including USEPA, TNRCC, USACE, and H&S Consultants inspected the process and determined that there was no dust leaving the site boundary, but that modifications could be made to help alleviate the dust concern. The first effort was to install a hood equipped with mist spray nozzles on the ash-receiving bin. The use of mist nozzles in the ash-receiving bin knocked out dust that was entrained in the steam. The second effort was to partially enclose the fly ash building. This allowed additional residence time in the building for steam to settle. The first two efforts were implemented immediately. The third effort included locating a steam scrubber that could be installed as final precaution to scrub the steam of any entrained dust. By the end of April 1998, a steam scrubber was mobilized to the site, modified for the site-specific application, and installed in the ash-receiving bin.

In early April 1998, after preliminary kiln refractory brick repairs failed, a decision was made to re-line the kiln with a castable refractory. Installation of the new refractory took place during the last three weeks of April and the first week of May. The Operation Phase resumed during the first week of May 1998.

As per the TNRCC Air Equivalency Document and the Trial Burn Plan, Operation Phase Stack Testing was performed. Once per month for the first three months of operations stack testing was performed for dioxin and Furan analysis. Once per quarter for the duration of the project stack testing was performed for particulate and metals analysis.

During the Operation Phase several statistical operating goals were established. A “utilization percentage” was calculated to illustrate performance of the TDF as compared to a benchmark operating rate of 47 tons per hour. A “utilization average” was calculated to summarize the performance of the TDF. An “availability percentage” was calculated to illustrate the time the TDF was physically available to operate. An “availability average daily tons” was calculated to summarize the TDF production during available operating hours. An “availability TPH” was calculated to summarize the TDF production rate during available operating hours. The percentage of ash requiring additional thermal treatment was calculated and compared to a project goal. The following table summarizes the Operation Phase performance versus established goals.

Operation Phase Performance

Parameter	Goal	Achieved
Utilization %	86.0%	75.0%
Utilization Avg. TPH	40.4 TPH	35.3 TPH
Availability %	71.0%	78.1%
Availability Avg. Daily Tons	688.8 Tons	660.7
Availability TPH	28.7 TPH	27.53 TPH
Ash Req. Add. Thermal Treat	5%	2.7%

The Operation Phase was complete on April 22nd, 1999 when the final soil to be incinerated was fed to the TDF. Final bottom ash analytical results were received on April 23, at which time the TDF burners were shut off and the Demobilization Phase started.

PROCUREMENT PROCESS

USACE awarded the contract to perform the soil remediation at OU-3 to Remedial Services International on September 30, 1993, with remediation activities performed by Remedial Services International. Remedial Services International was subsequently acquired by H&S Consultants, which was later acquired by ABC Corporation. The contract was awarded using a firm fixed-price cost structure. On September 23, 1996, the contract was converted to a cost plus fixed fee contract.

TREATMENT SYSTEM COST

The table below summarizes total project costs for the RA at OU 3. Appendix B provides a breakdown of these costs.

Cost Item	Adjusted ROD Estimate	Actual Cost[1]	Difference[2]
RA Capital Costs (1994-1999)	$78,150,000	$64,676,100	- 17 %
RA Operating Costs (1998-1999)[3]	$45,800,000	69,890,000	+ 53 %
RA Periodic Costs (1999)	$45,000	56,850	+ 26 %
Total Costs Incurred, Years 0-5 (Actual $$)	$123,995,000	$134,622,950	+ 9 %

1 Costs are based on the respective years that the costs were incurred. The ROD estimates were adjusted from 1988 dollars to the appropriate year's dollar basis using ENR building cost index factors.

2 Differences between the actual RA operating costs and the adjusted ROD estimate are largely attributable to the waiting phase associated with a project shutdown pending the outcome of a lawsuit filed by a citizens group ($14,268,000). Costs were saved during site restoration by using clean, excavated rock as backfill and by eliminating the need for vegetative cover (see Section 9 for additional information).

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COST-RELATED

Costs on similar future projects could be reduced by taking preliminary steps to minimize the chances for shutdowns caused by legal actions. Millions of dollars in costs were incurred while the incinerator was shutdown pending the outcome of a lawsuit brought by an opposition group.

A significant cost savings was realized due to a change incorporated into the contract specifications allowing for the cleaning and backfilling of excavated rock. The reuse of rock eliminated costs associated with importing stone from an outside source.

The initial remedial design included laying cover material capable of supporting vegetation over treated soil depleted of organic material. Two studies demonstrated that the addition of compost and fertilizer to the treated soil would be sufficient to allow sustained growth of a vegetative cover. The amended design resulted in elimination of costs associated with importing fill materials and topsoil.

PERFORMANCE-RELATED

Project managers of future similar projects should perform a thorough review of the proposed equipment layout plans. Equipment locations are particularly important to consider with material handling systems. Bins and buildings to store and/or stabilize ash should be located in close proximity to ash sources to minimize the amount of high wear/severe duty equipment (e.g., screw augers and drag conveyors) necessary.

The feed preparation area should be as large as physically possible to allow sufficient room for any additional equipment, which may become necessary for trash separation, drum handling operations, pre-drying and similar operations.

Dust suppression is an important aspect of managing soil and ash on-site. When possible, soil and ash management operations should be conducted within an enclosed structure such as a building under slight negative pressure or using enclosed equipment.

During the preliminary site investigation and incinerator conceptual design, the moisture content of site soil should be characterized. Worst case moisture content should be included in the RFP so the contractor design engineers can size the kiln and burners accordingly. Soil moisture will greatly affect the allowable throughput rate and the ability of the system to remove contaminants from the soil. A heat transfer specialist should do a thorough review of the assumptions and calculations used to size the incineration equipment.

The temperature of the treated soil exiting the kiln is a primary indicator of whether the soil will meet the treatment requirements. The contractor should measure the kiln exit soil temperatures to obtain a real-time indication of the kiln efficiency, rather than waiting 72 hours for the analytical results of the treated soil samples.

Due to the severe environments under which they operate, the ash conveyance system may be particularly susceptible to mechanical failure. A thorough review of the contractor's proposed system should be performed. The review should draw upon the vast quantity of material handling information and experience available within the combustion industry.

Whenever cost and space allow, redundant systems should be implemented in order to keep the incinerator operational. The incinerator cannot physically operate without certain systems online (e.g., drag conveyors or pumps) and the incinerator must not be allowed to operate if certain equipment is not operational per permit requirements (e.g., Continuous Emission Monitors [CEMs]). Incinerator downtime can be costly because site personnel must be paid and equipment rental fees are incurred whether the incinerator is operating or not.

Performing a clean burn prior to feeding hazardous waste to the incinerator can have the following benefits:

- Serves as a mechanical shakedown of the system;
- Provides an opportunity to do performance testing on the CEMs; and
- Provides an opportunity to debug any programming or control systems without the risk of any sort of a release or labor-intensive decontamination prior to correcting any problems.

During the incinerator optimization stage and the trial burn tests, the incinerator should be operated under a wide range of operating conditions (e.g., varied feed rate, kiln rotation speed, and combustion temperature) to ensure that the permit limits allow the desired level of operating flexibility.

OTHER LESSONS LEARNED

The USACE and the state regulatory agency were involved with a proactive, USEPA-lead public relations effort that was implemented from the beginning of the project. This was achieved by developing a public relations plan in conjunction with the local community.

Ninety to one hundred twenty days was allowed for state review of permit equivalency documents, including the Trial Burn Plan.

The RFP specifications delineated which activities were construction-related and which activities were service-related. Difficulties can arise when personnel working side-by-side on the same equipment are paid different wages.

Staffing requirements for an incineration project are greater than the typical USACE construction project. Required staff included an on-site project chemist, thermal incineration experts, office engineers, project engineers, quality assurance staff, and an on-site authorized contracting officer's representative. In addition, the contracting officer's representative was given more authority to process changes so the changes could be incorporated in a timely manner.

A Construction Management Plan was developed that included the roles and responsibilities of the participating organizations and individuals.

The project manager prepared for the worst weather possible at the site. Freezing pipes, power outages, late deliveries, inability to move equipment and excavations filling with water are examples of weather-related problems. These occurrences, if not anticipated, could have delayed the project and been a source of additional costs.

Local emergency responders were involved with emergency response planning and drills. They were provided with the required training and the necessary response equipment if they were not already prepared for incinerator-related emergencies.

All pertinent federal and state regulations and guidance documents identified in the project specifications were available on-site for reference.

Due to the large volume of information gathered and shared with outside agencies, a computer-based information and issue tracking system was used for this project. The system contained complete descriptions of the issues, responsible individuals, inception dates, and anticipated resolution dates. The system was reviewed on a regular basis to track the status of outstanding issues.

Before initiating site work, a cost-benefit analysis was performed to determine if a backup to the primary laboratory should be selected. Selection of a backup laboratory at the beginning of the project eliminated time spent for laboratory validation and approval, which could have impacted the project in progress if a laboratory had not been selected prior to start of work.

An active safety incentive program increased worker safety awareness and reduced injuries and accidents.

Remedial Action Contractor:

Primary Contact Name and Title:	Mr. Frederick Stanley, President
Company Name:	H&S Consultants
Address:	630 Hilton Street, Grease, TX 99990
Phone Number:	(555) 555-4102

RA Oversight Contractor:

Company Name:	RJB Consultants	*Contract Number:*	9999-8888-5555RT
Address:	999 What Street, Sometown, TX 99994	*Work Assignment Number:*	44444-66-22222XJ
Phone Number:	(555) 555-4444		

Analytical Laboratory:

For the USACE:

Company Name:	Eastern Laboratories, Inc.
Address:	101 South 16th Street, Padre Island, TX 99998
Phone Number:	(555) 555-4455

Project Management:

For the USACE:

Name:	Joe Civil
Company Name:	U.S. Army Corps of Engineers
Address:	Ft. Worth District
Phone Number:	(888) 555-1234
Email:	civil@usace.army.mil

For the EPA:

Name:	Alice Jones
U.S. EPA Region:	VI
Address:	1445 Ross Avenue, Suite 1200, Dallas, TX 75202
Phone Number:	(214) 665-1212
Email:	jones@epa.gov

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19. Stan Bopp, USACE, Final Cost Report, Slippery Chemical Superfund Site, April 21, 2000.

The table below lists selected characteristics for the soil at the SCS Site. Except where noted, data provided are average values for pre-treatment soil samples collected during the 1997 trial burns.

Site Characteristics

Characteristic	Value	Measurement Procedure
Soil Classification[1]	SM (silty sands and silt-sand mixtures)	USCS
Clay Content[1]	3.8 to 8.8%	ASTM D422
Moisture Content	16%[2]	ASTM D-3173
Total Petroleum Hydrocarbon (TPH) Content	181 to 6,569 mg/kg	EPA 418.1
Bulk Density	99.8 to 109.6 lbs/ft^3	ASTM D 4253 and 4254
BTU Value	274 BTU/lb	ASTM D 2015
Halogen Content	260 mg/kg Chlorine	ASTM E 442 or D 808/D 4327
Metal Content Arsenic Beryllium Cadmium Chromium Lead	 7.65 mg/kg 0.67 mg/kg 0.16 mg/kg 24.5 mg/kg 41.6 mg/kg	 ICP ICP ICP, GFAA ICP ICP

[1] These data correspond to treated soil samples. Data was not available for untreated soil.

[2] During full-scale operations, the soil moisture content ranged from 10.0 to 25.5% and averaged 17.6%.

The following table lists the operating limits for the incineration system that were approved by the USEPA and TNRCC prior to full-scale operation of the system. These operating limits were developed based on the results of the trial burns and risk burns.

Operating Limits

Parameter	Value
Waste Feed Rate, Maximum Allowable	47.3 tons/hr rolling average
Kiln Hood Pressure, Maximum Allowable	0 inches water column (wc) instantaneous -0.1 inches wc for 10 seconds or more
Kiln Exit Temperature, Minimum Allowable	1599ºF hourly average 1000ºF instantaneous
Kiln Exit Temperature, Maximum Allowable	2200ºF
Kiln Rotation, Minimum Allowable	0.4 revolutions per minute (rpm)
SCC Temperature, Minimum Allowable	1801ºF
SCC Temperature, Maximum Allowable	2600ºF
SCC Residence Time, Minimum Allowable	2 seconds
Baghouse Inlet Temperature, Maximum Allowable	500ºF
Baghouse Air-to-Cloth ratio, Maximum Allowable	3.6 to 1
Bag House Pressure Drop, Minimum Allowable	1.0 inches wc for more than 5 minutes

Parameter	Value
Bag House Pressure Drop, Maximum Allowable	6 inches wc for more than 5 minutes
Scrubber Inlet Temperature, Maximum Allowable	250ºF
Scrubber Liquid pH, Minimum Allowable	6.5
Scrubber Liquid Feed Rate, Minimum Allowable	450 gallons per minute (gpm) hourly average
CO Emissions, Maximum Allowable	200 parts per million by volume (ppmv) instantaneous 100 ppmv hourly rolling average
NO_x Emissions, Maximum Allowable	300 ppmv daily average
Stack Gas Velocity, Maximum Allowable	46.2 ft/sec hourly average

The table below lists values for selected parameters observed during incineration operations at OU-3. Observed values are compared to design values for each parameter. The parameters were selected for this report based on USACE guidance. Data provided are based on average conditions during full-scale operation of the incinerator system.

Operating Parameters

System Parameter	Design Value	Actual Value
Residence Time (Air in SCC)	>2 seconds	1.7 to 4.6 seconds
Residence Time (Soil in Kiln)	30 minutes	24.6 to 44.3 minutes
System Throughput	60 ton/hr	40.4 tons/hr (average)
Flue Gas Temperature	Information not available Information not available	>1599 °F (kiln) >1801 °F (SCC)

The following tables present a breakdown of actual costs incurred for the project and calculation of technology-specific unit cost for incineration. HCAS data entry sheets are also attached to this appendix.

ACTUAL COSTS (1 of 2)

Site: Slippery Chemical Site
Location: Grease, Texas
Phase: Final RA Report (OU-3)
Date: June 7, 1999

Description: The selected treatment consisted of a mobile rotary kiln incinerator used to treat excavated sludge, soil and sediments onsite. In addition, a waste water treatment plant (WWTP) used granular activated carbon (GAC) to treat all water produced from the excavation and incineration processes.

RA CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL (1994 $$)	NOTES
331XX HTRW Remedial Action					
.01 Mobilization and Preparatory Work					
.02 Mob of Personnel	1	EA	$3,171,000	$3,171,000	
.03 Submittals/ Implementation Plans	1	EA	$2,683,000	$2,683,000	
.04 Setup/Construct Temporary Facilities	1	EA	$2,665,000	$2,665,000	Fence, roads/parking, signs, trailers
.05 Construct Temporary Utilities	1	EA	$122,000	$122,000	
SUBTOTAL				$8,641,000	
.03 Sitework					
.08 Water/Sewer Relocation	2,425	LF	$378	$916,000	
.06 Groundwater Collection					
.05 Earthwork - Sheet Piling	87,204	SF	$55	$4,809,000	
.08 Solids Collection and Containment					
.01 Contaminated Soil Excavation	194,520	CY	$15	$2,856,000	
.10 Drums/Tanks/Struct/Misc Removal					
.01 Drum Handling and Removal	185	EA	$1,157	$214,000	
.07 Debris Removal	8	AC	$39,375	$315,000	
SUBTOTAL				$529,000	
.13 Physical Treatment					
.20 Carbon Adsorption - Liquids					WWTP
.05 Mobilize/Setup/Relocate Plant	1	EA	$811,000	$811,000	
.07 Demobilize Plant	1	EA	$71,000	$71,000	
SUBTOTAL				$882,000	
.14 Thermal Treatment					
.01 Incineration					
.04 Pads/Foundations/Spill Control	39,875	SF	$48	$1,914,000	
.05 Mobilize/Setup Plant	1	EA	$4,420,000	$4,420,000	
.06 Startup/Readiness Test/Trial Burn	1	EA	$12,910,000	$12,910,000	
.07 Demobilize Plant	1	EA	$2,248,000	$2,248,000	
SUBTOTAL				$21,492,000	
.18 Disposal (Other than Commercial)					
.21 Transport to Storage/Disposal Facility	275,467	TON	$14	$3,762,000	Load/Haul/Unload
.19 Disposal (Commercial)					
.21 Transport to Storage/Disposal Facility	2,200	TON	$275	$604,000	Load/Haul/Unload
.20 Site Restoration					
.01.03 Earthwork - Backfill	194,520	CY	$13	$2,544,000	
.01.04 Earthwork - Borrow	12,376	CY	$16	$195,000	
.01.90 Grading & Topsoil	1	EA	$378,000	$378,000	
.03.90 Storm Drainage	1	EA	$245,000	$245,000	
.04 Revegetation and Planting	8	AC	$10,750	$86,000	Seeding/mulch/fertilizer
SUBTOTAL				$3,448,000	
.21 Demobilization					
.01 Removal of Temporary Facilities	1	EA	$408,000	$408,000	Fence, roads/parking, signs, trailers
.02 Removal of Temporary Utilities	1	EA	$99,000	$99,000	
.03 Final Decontamination	1	EA	$812,000	$812,000	
.04 Demobilization of Construction Equipment	1	EA	$318,000	$318,000	Excavator, etc.
SUBTOTAL				$1,637,000	
SUBTOTAL				$49,576,000	
Project Management				3,544,500	
Remedial Design				5,915,600	
Construction Management				5,640,000	
TOTAL RA CAPITAL COSTS				**$64,676,100**	

ACTUAL COSTS (2 of 2)

RA OPERATING COSTS[1]:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL (Actual $$)	NOTES
331XX HTRW Remedial Action					
.02 Monitoring, Sampling, Testing, and Analysis					
.03 Air Monitoring and Sampling (17.3 mo)	1	EA	$5,574,000	$5,574,000	HNu, Summa Cannisters, CEMs
.13 On Site Laboratory Facilities	1	EA	$211,000	$211,000	GC, MS
.14 Off Site Waste Water Analysis (17.3 mo)	1	EA	$268,000	$268,000	NPDES Compliance
SUBTOTAL				$6,053,000	
.13 Physical Treatment					
.20 Carbon Adsorption - Liquids (21,000 MGA)					WWTP
.08 Plant Operation	17.3	MO	$127,399	$2,204,000	
.14 Thermal Treatment					
.01 Incineration (194,520 CY)					
.01 Solids Preparation and Handling	194,520	CY	$17	$3,380,000	Drying, blending, feeding
.08 Ownership Plant / Plant Operation	14.2	MO	$1,027,715	$14,594,000	
.10 Performance Testing	1	EA	$11,542,000	$11,542,000	
.90 Utilities	14.2	MO	$742,324	$10,541,000	Electricity + fuel
.91 Waiting Phase	7	MO	$2,038,286	$14,268,000	
SUBTOTAL				$54,325,000	
.15 Stabilization/Fixation					
.04 Pozzolan Process	3,054	CY	$73	$223,000	
SUBTOTAL				$62,805,000	
Project Management				2,289,000	
Technical Support				4,796,000	
TOTAL RA OPERATING COSTS				**$69,890,000**	

[1] Actual costs based on the respective year the costs were incurred (i.e., 1998 and 1999).

RA PERIODIC COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL (1999 $$)	NOTES
Remedial Action Report	1	EA	$56,850	$56,850	1 report upon project completion
TOTAL RA PERIODIC COSTS				**$56,850**	

TOTAL ACTUAL RA COSTS INCURRED	**$134,622,950**

INCINERATION TECHNOLOGY-SPECIFIC UNIT COST CALCULATION	
RA CAPITAL COSTS:	
Solids Collection and Containment'	$2,856,000
Drums/Tanks/Struct/Misc Removal	$529,000
Physical Treatment	$882,000
Thermal Treatment	$21,492,000
Disposal (Other than Commercial)	$3,762,000
Disposal (Commercial)	$604,000
SUBTOTAL	$30,125,000
RA OPERATING COSTS:	
Monitoring, Sampling, Testing, and Analysis	$6,053,000
Physical Treatment	$2,204,000
Thermal Treatment	$54,325,000
Stabilization/Fixation	$223,000
SUBTOTAL	$62,805,000
TOTAL TECHNOLOGY-SPECIFIC COST	$92,930,000
Volume of Media Treated (Cubic Yards)	194,520
TECHNOLOGY-SPECIFIC UNIT COST (Per Cubic Yard)	**$478**

Historical Cost Analysis System (HCAS)
Project Data Entry Form (Sheet 1)

Project Information

Project Name: Slippery Chemical Operable Unit 3

Project Number: ______

Project Phase (Select one)

- Studies and Design ______
- Remedial Action ✓
- Operations and Maintenance ______

Project Note (Describe the project)

Incineration treatment technology was utilized to remediate 194,520 cy of soil contaminated with VOCs, SVOCs, Fenac, Naphthylamine, etc.

Contract Information

Contract Number: DACW63-93-C-0200

Managing Organization: U.S. Army Corps of Engineers

Organization Name: Ft. Worth District

Site Owner: Private Party

Other ID Number: ______

Prime Contractor: H&S Consultants

Contract Type (Select one)

- Cost + Award Fee ______
- Cost + Base + Award Fee ______
- Cost + Fixed Fee ✓
- Cost + Incentive Award ______
- Fixed Price ______
- Not Availiable ______
- Other ______

Procurement Type (Select one)

- Two Step Sealed Bid ______
- Sealed Bid (IFB) ______
- Competitive Negotiation (RFP) ✓
- Sole Source (SSC) ______
- Other ______

Historical Cost Analysis System (HCAS)
Project Data Entry Form (Sheet 2)

Site Information

State/Country	Texas/USA
Installation	
Site Name	Grease, TX
Site Number	
EPA Region	VI

Current Use (Select one)

Installation Operation	
Industry Operation	
Residential	
Recreational	
Wildlife Refuge	
Waste Disposal	✓
Administrative Office	
Commercial	
Other	
Unknown	

Future Use (Select one)

Installation Operation	
Industry Operation	
Residential	
Recreational	
Wildlife Refuge	
Waste Disposal	
Administrative Office	
Commercial	
Other	
Unknown	✓

Point of Contact

	Data Entry Person	POC#2	POC#3
Title/Role	Contractor Estimator		
Organization	H&S Consultants		
Name	John Jones		
Address	630 Hilton St.		
City, State	Grease, TX		
Zip	99990		
Telephone	555-555-4102		
Fax	555-555-4103		
Email	jjones@h&s.com		

Enter up to 3 POC's.

Historical Cost Analysis System (HCAS)
Project Data Entry Form (Sheet 3)

Profile - General Characteristics

Regulatory Class			Public Concern		
	CERCLA	✓		Low	
	RCRA			High	✓
	Other		Historical/Archoelogical		
	Unknown			Yes	
National Priority List				No	✓
	Yes	✓	Innovative Technology		
	No			Yes	
Wetland				No	✓
	Yes		Size of Exclusion Zone (Acres)		9.6
	No	✓	Size of Area (Acres)		9.6
Flood Plain					
	Yes				
	No	✓			

Profile - Contaminants/Technical Approach

Site Type	**Media**	**Contaminant**	**Technical Approach**
AG Storage Tanks	Air	Nonhal VOC's	CWM/OEW Remvl
UG Storage Tanks	Equipment/Mach	Halogenated VOC's	Surf Water Control
Drums/Cont <250 GA	Groundwater	Nonhal Semi VOC's	Grnd Water Control
Unauth Disposl Area	Liquid	Halogen Semi VOC's	Air/Gas Control
Facil/Bldgs	Surface Water	Fuels	Solids Contain
Fire Train/Open Burn	Sediment	Inorganics	Liq/Sed/Sludge Cntrl
Firing Rnge/Open Det	Sludge	Low Lev Rad Waste	Drums/Tanks Remvl
Pit/Trench	Soil	High Lev Rad Waste	Biological Treatment
Surf Impnd/Lagoons	Solid/Debris	Low Rad Mixed Wst	Chemical Treatment
Lakes/Ponds/Swamp	Struct Bldg Matls	TRU Waste	Physical Treatment
Landfill	Other	CWM/OEW	Thermal Treatment
Ocean		Asbestos	Stab/Fix/Encap
Rivers/Streams		Unknown	Decon & Decommish
Spill/Emerg Resp		Other	Disposal (Not Comm)
Waste Pile			Disposal Commercial
Other			Other

Pick as many Profile combinations as necessary:

Surf Impnd/Lagoons	Soil	Nonhal VOCs	Thermal Treatment
Surf Impnd/Lagoons	Soil	Halogenated VOCs	Thermal Treatment
Surf Impnd/Lagoons	Soil	Nonhal SVOCs	Thermal Treatment
Surf Impnd/Lagoons	Soil	Halogenated SVOCs	Thermal Treatment

Historical Cost Analysis System (HCAS)
Project Data Entry Form (Sheet 4)

Cost

Start Date	9/30/1993
End Date	11/23/1999
Number of Mods	0
Reasons for Mods (Select those applicable)	
Administrative	
Changes for Time or Cost	
Changes Requested by Government Authority	
Design Deficiency	
Differing Site Conditions	
Funding Level Change	
New Federal Regulation	
Other Changes	
Suspension or Termination of Work	
Value Engineering Change	
Variations in Estimated Quantities	
Variations Not Readily Identifiable During Design	
Cost	
Award Amount	$99,000,000
Actual Amount	$112,381,000
Cost Variance	+13,381,000

Cost Breakdown

See next sheets.

The HCAS Cost Breakdown is structured in accordance with the February 1996 "HTRW Remedial Action Work Breakdown Structure (RA WBS)" and "HTRW O&M Work Breakdown Structure (O&M WBS)".

The next sheets show the RA WBS and O&M WBS to the Third Level as required for the HCAS cost report portion of the "RA Report".

The costs reported shall be "Burdened Costs", meaning that contractor markups, general requirements, overhead, and profit shall be included in the costs.

The complete RA WBS and O&M WBS to the Fourth Level is at:
http://www.FRTR.gov/cost/ec2/wbs1.html

The HCAS 3.1 software can be downloaded from:
http://www.FRTR.gov/cost/ec2/index.html

WBS Number				DESCRIPTION	QTY	UOM	UNIT COST	COST $
33XXX				**HTRW CONSTRUCTION ACTIVITIES**				
331XX				**HTRW REMEDIAL ACTION (Capital and Operating)**				
	01			**MOBILIZATION AND PREPARATORY WORK**				
	01	01		Mobilization of Construction Equipment and Facilities		EA		
	01	02		Mobilization of Personnel	1	EA	3,171,000	3,171,000
	01	03		Submittals/Implementation Plans	1	EA	2,683,000	2,683,000
	01	04		Setup/Construct Temporary Facilities	1	EA	2,665,000	2,665,000
	01	05		Construct Temporary Utilities	1	EA	122,000	122,000
	01	06		Temporary Relocations of Roads/Structures/Utilities		EA		
	01	07		Construction Plant Erection		EA		
	01	08		Institutional Controls		EA		
	01	09		Alternate Water Supply		EA		
	01	10		Population Relocation		EA		
	01	9X		Other (Use Numbers 90-99)				
	02			**MONITORING, SAMPLING, TESTING, AND ANALYSIS**				
	02	01		Meteorological Monitoring		EA		
	02	02		Radiation Monitoring		EA		
	02	03		Air Monitoring and Sampling	1	EA	5,574,000	5,574,000
	02	04		Monitoring Wells		EA		
	02	05		Sampling Surface Water/Groundwater/Liquid Waste		EA		
	02	06		Sampling Soil and Sediment		EA		
	02	07		Sampling Asbestos		EA		
	02	08		Sampling Radioactive Contaminated Media		EA		
	02	09		Laboratory Chemical Analysis		EA		
	02	10		Radioactive Waste Analysis		EA		
	02	11		Geotechnical Testing		EA		
	02	12		Geotechnical Instrumentation		EA		
	02	13		On-Site Laboratory Facilities	1	EA	211,000	211,000
	02	14		Off-Site Laboratory Facilities	1	EA	268,000	268,000
	02	9X		Other (Use Numbers 90-99)				
	03			**SITEWORK**				
	03	01		Demolition		SY		
	03	02		Clearing and Grubbing		ACR		
	03	03		Earthwork		CY		
	03	04		Roads/Parking/Curbs/Walks		SY		
	03	05		Fencing		LF		
	03	06		Electrical Distribution		LF		
	03	07		Telephone/Communication Distribution		LF		
	03	08		Water/Sewer/Gas Distribution	2,425	LF	378	916,000
	03	09		Steam and Condensate Distribution		LF		
	03	10		Fuel Line Distribution		LF		
	03	11		Storm Drainage/Subdrainage		LF		
	03	12		Permanent Cover Structure Over Containment Area		SF		
	03	13		Development of Borrow Pit/Haul Roads		ACR		

WBS Number				DESCRIPTION	QTY	UOM	UNIT COST	COST $
331XX	03	14		Fuel Storage Tanks (New)		EA		
	03	9X		Other (Use Numbers 90-99)				
	04			**ORDNANCE AND EXPLOSIVE - CHEMICAL WARFARE**				
	04	01		Ordnance Removal and Destruction		ACR		
	04	9x		Other (Use Numbers 90-99)				
	05			**SURFACE WATER COLLECTION AND CONTROL**				
	05	01		Berms/Dikes		LF		
	05	02		Floodwalls		SF		
	05	03		Levees		LF		
	05	04		Terraces and Benches		LF		
	05	05		Channels/Waterways (Soil/Rock)		LF		
	05	06		Chutes or Flumes		LF		
	05	07		Sediment Barriers		LF		
	05	08		Storm Drainage		LF		
	05	09		Lagoons/Basins/Tanks/Dikes/Pump System		ACR		
	05	10		Pumping/Draining/Collection		MGA		
	05	11		Transport to Treatment Plant		MGA		
	05	12		Earthwork		CY		
	05	13		Erosion Control		ACR		
	05	14		Development of Borrow Pit/Haul Roads		ACR		
	05	9X		Other (Use Numbers 90-99)				
	06			**GROUNDWATER COLLECTION AND CONTROL**				
	06	01		Extraction and Injection Wells		EA		
	06	02		Subsurface Drainage/Collection		LF		
	06	03		Slurry Walls		SF		
	06	04		Grout Curtain		SF		
	06	05		Sheet Piling	87,204	SF	55	4,809,000
	06	06		Lagoons/Basins/Tanks/Dikes/Pump System		ACR		
	06	07		Pumping/Collection		MGA		
	06	08		Transport to Treatment Plant		MGA		
	06	09		Development of Borrow Pit/Haul Roads		ACR		
	06	9x		Other (Use Numbers 90-99)				
	07			**AIR POLLUTION/GAS COLLECTION AND CONTROL**				
	07	01		Gas/Vapor Collection Trench System		LF		
	07	02		Gas/Vapor Collection Well System		EA		
	07	03		Gas/Vapor Collection at Lagoon Cover		SY		
	07	04		Fugitive Dust/Vapor/Gas Emissions Control		ACR		
	07	9x		Other (Use Numbers 90-99)				
	08			**SOLIDS COLLECTION AND CONTAINMENT**				
	08	01		Contaminated Soil Collection	194,520	CY	15	2,856,000
	08	02		Waste Containment, Portable (Furnish/Fill)		CY		
	08	03		Transport to Treatment Plant		CY		

WBS Number				DESCRIPTION	QTY	UOM	UNIT COST	COST $
331XX	08	04		Radioactive Specific Waste Containment (Furnish/Fill)		CY		
	08	05		Capping of Contaminated Area/Waste Pile (Soil/Asphalt		ACR		
	08	06		Nuclear Waste Densification (Dynamic Compaction)		CY		
	08	07		Development of Borrow Pit/Haul Roads		ACR		
	08	9x		Other (Use Numbers 90-99)				
	09			**LIQUIDS/SEDIMENTS/SLUDGES COLLECTION AND**				
	09	01		Dredging/Excavating		CY		
	09	02		Industrial Vacuuming		CY		
	09	03		Waste Containment, Portable (Furnish/Fill)		MGA		
	09	04		Transport to Treatment Plant		MGA		
	09	05		Radioactive Specific Waste Containment (Furnish/Fill)		MGA		
	09	06		Pumping/Draining/Collection		MGA		
	09	07		Lagoons/Basins/Tanks/Pump System		ACR		
	09	08		Development of Borrow Pit/Haul Roads		ACR		
	09	9x		Other (Use Numbers 90-99)				
	10			**DRUMS/TANKS/STRUCTURES/MISCELLANEOUS**				
	10	01		Drum Removal	185	EA	1,157	214,000
	10	02		Tank Removal		EA		
	10	03		Structure Removal		SF		
	10	04		Asbestos Abatement		SF		
	10	05		Piping and Pipeline Removal		LF		
	10	06		Radioactive Specific Waste Containment (Furnish/Fill)		CY		
	10	07		Miscellaneous Items	8	ACR	39,375	315,000
	10	08		Contaminated Paint Removal		SF		
	10	9x		Other (Use Numbers 90-99)				
	11			**BIOLOGICAL TREATMENT**				
	11	01		Activated Sludge (Sequencing Batch Reactors)		MGA		
	11	02		Rotating Biological Contactors		MGA		
	11	03		Land Treatment/Farming (Solid Phase Biodegradation)		CY		
	11	04		In-Situ Biodegradation/Bioreclamation		CY		
	11	05		Trickling Filters		MGA		
	11	06		Biological Lagoons		MGA		
	11	07		Composting		CY		
	11	08		Sludge Stabilization - Aerobic		CY		
	11	09		Sludge Stabilization - Anaerobic		CY		
	11	10		Genetically Engineered Organisms (White Rot Fungus)		CY		
	11	11		Slurry Biodegradation		CY		
	11	12		Bioventing		SF		
	11	13		Bioslurping		SF		
	11	14		Biopile (Heap Pile Remediation)		CY		
	11	50		Construction of Permanent Plant Facility		EA		
	11	9x		Other (Use Numbers 90-99)				

WBS Number				DESCRIPTION	QTY	UOM	UNIT COST	COST $
331XX	**12**			**CHEMICAL TREATMENT**				
	12	01		Oxidation/Reduction (Catalytic Oxidation, UV Ozone,		MGA		
	12	02		Solvent Extraction		MGA		
	12	03		Chlorination		MGA		
	12	04		Ozonation		MGA		
	12	05		Ion Exchange		MGA		
	12	06		Neutralization		MGA		
	12	07		Chemical Hydrolysis		MGA		
	12	08		Ultraviolet Photolysis		MGA		
	12	09		Dehalogenation (Catalytic Dechlorination)		CY		
	12	10		Alkali Metal Dechlorination		CY		
	12	11		Alkali Metal/Polyethylene Glycol (A/PEG)		CY		
	12	12		Base-Catalyzed Decomposition Process (BCDP)		CY		
	12	13		Electrolysis		MGA		
	12	14		Vapor Recovery/Reuse (Internal Combustion Engine)		CF		
	12	50		Construction of Permanent Plant Facility		EA		
	12	9x		Other (Use Numbers 90-99)				
	13			**PHYSICAL TREATMENT**				
	13	01		Filtration/Ultrafiltration		MGA		
	13	02		Sedimentation		MGA		
	13	03		Straining		MGA		
	13	04		Coagulation/Flocculation/Precipitation		MGA		
	13	05		Equalization		MGA		
	13	06		Evaporation		MGA		
	13	07		Air Stripping		MGA		
	13	08		Steam Stripping		MGA		
	13	09		Soil Washing (Surfactant/Solvent)		CY		
	13	10		Soil Flushing (Surfactant/Solvent)		CY		
	13	11		Solids Dewatering		CY		
	13	12		Oil/Water Separation		MGA		
	13	13		Dissolved Air Floatation		MGA		
	13	14		Heavy Media Separation		CY		
	13	15		Distillation		MGA		
	13	16		Chelation		MGA		
	13	17		Solvent Extraction		MGA		
	13	18		Supercritical Extraction		MGA		
	13	19		Carbon Adsorption - Gases		CF		
	13	20		Carbon Adsorption - Liquids	21,000	MGA	146.95	3,086,000
	13	21		Membrane Separation - Reverse Osmosis		MGA		
	13	22		Membrane Separation - Electrodialysis		MGA		
	13	23		Soil Vapor Extraction		CY		
	13	24		Shredding		CY		
	13	25		Aeration		CY		
	13	26		Advanced Electrical Reactor		CY		
	13	27		Low Level Waste (LLW) Compaction		CY		
	13	28		Agglomeration		CY		

WBS Number				DESCRIPTION	QTY	UOM	UNIT COST	COST $
331XX	13	29		In-Situ Steam Extraction		MGA		
	13	30		Filter Presses		MGA		
	13	31		Lignin Adsorption/Sorptive Clays		CY		
	13	32		Air Sparging		MGA		
	13	50		Construction of Permanent Plant Facility		EA		
	13	9x		Other (Use Numbers 90-99)				
	14			**THERMAL TREATMENT**				
	14	01		Incineration	194,520	CY	389.76	75,817,000
	14	02		Low Temperature Thermal Desorption		CY		
	14	03		Supercritical Water Oxidation		MGA		
	14	04		Molten Salt Destruction		CY		
	14	05		Radio Frequency Heating		CY		
	14	06		Solar Detoxification		CY		
	14	07		High Temperature Thermal Desorption		CY		
	14	50		Construction of Permanent Plant Facility		EA		
	14	9x		Other (Use Numbers 90-99)				
	15			**STABILIZATION/FIXATION/ENCAPSULATION**				
	15	01		Molten Glass		CY		
	15	02		In-Situ Vitrification		CY		
	15	03		In-Situ Pozzolan Process (Lime/Portland Cement)		CY		
	15	04		Pozzolan Process (Lime/Portland Cement)	3,054	CY	73	223,000
	15	05		Asphalt-Based Encapsulation		CY		
	15	06		Radioactive Waste Solidification (Grouting/Other)		CY		
	15	07		Sludge Stabilization (Aggregate/Rock/Slag)		CY		
	15	50		Construction of Permanent Plant Facility		EA		
	15	9x		Other (Use Numbers 90-99)				
	16			**RESERVED FOR FUTURE USE**				
	17			**DECONTAMINATION AND DECOMMISSIONING (D&D)**				
	17	01		Pre-Decommissioning Operations		SF		
	17	02		Facility Shutdown Activities		SF		
	17	03		Procurement of Equipment and Material		SF		
	17	04		Dismantling Activities		SF		
	17	05		Research and Development (R&D)		SF		
	17	06		Spent Fuel Handling		SF		
	17	07		Hot Cell Cleanup		SF		
	17	9x		Other (Use Numbers 90-99)				
	18			**DISPOSAL (OTHER THAN COMMERCIAL)**				
	18	01		Landfill/Burial Ground/Trench/Pits		CY		
	18	02		Above-Ground Vault		CY		
	18	03		Underground Vault		CY		
	18	04		Underground Mine/Shaft		CY		
	18	05		Tanks		MGA		

WBS Number				DESCRIPTION	QTY	UOM	UNIT COST	COST $
331XX	18	06		Pads (Tumulus/Retrievable Storage/Other)		CY		
	18	07		Storage Bldgs/Protective Cvr Structures/Other Bldgs &		CY		
	18	08		Cribs		CY		
	18	09		Deep Well Injection		MGA		
	18	10		Incinerator		CY		
	18	15		Construction of Permanent Disposal Facility		EA		
	18	20		Container Handling		EA		
	18	21		Transportation to Storage/Disposal Facility	275,467	TON	14	3,762,000
	18	22		Disposal Fees and Taxes		TON		
	18	23		Mixed Waste Storage Fees and Taxes		TON		
	18	9x		Other (Use Numbers 90-99)				
	19			**DISPOSAL (COMMERCIAL)**				
	19	20		Container Handling		EA		
	19	21		Transportation to Storage/Disposal Facility	2,200	TON	275	604,000
	19	22		Disposal Fees and Taxes		TON		
	19	23		Mixed Waste Storage Fees and Taxes		TON		
	19	9x		Other (Use Numbers 90-99)				
	20			**SITE RESTORATION**				
	20	01		Earthwork	207,896	CY	14.99	3,117,000
	20	02		Permanent Markers		EA		
	20	03		Permanent Features	1	EA	245,000	245,000
	20	04		Revegetation and Planting	8	ACR	10,750	86,000
	20	05		Removal of Barriers		EA		
	20	9x		Other (Use Numbers 90-99)				
	21			**DEMOBILIZATION**				
	21	01		Removal of Temporary Facilities	1	EA	408,000	408,000
	21	02		Removal of Temporary Utilities	1	EA	99,000	99,000
	21	03		Final Decontamination	1	EA	812,000	812,000
	21	04		Demobilization of Construction Equipment and Facilities	1	EA	318,000	318,000
	21	05		Demobilization of Personnel		EA		
	21	06		Submittals		EA		
	21	07		Construction Plant Takedown		EA		
	21	9x		Other (Use Numbers 90-99)				
	9X			**OTHER (Use Numbers 90-99)**				
				TOTAL AMOUNT $				112,381,000

WBS Number				DESCRIPTION	QTY	UOM	UNIT COST	COST $
34XXX				**HTRW POST CONSTRUCTION AND FINANCIAL CLOSEOUT ACTIVITIES**				
341XX				**FISCAL/FINANCIAL CLOSE ACTIVITIES**				
342XX				**HTRW OPERATION AND MAINTENANCE (POST CONSTRUCTION)**				
	02			**MONITORING, SAMPLING, TESTING, AND**				
	02	01		Meteorological Monitoring		EA		
	02	02		Radiation Monitoring		EA		
	02	03		Air Monitoring and Sampling		EA		
	02	04		Monitoring Wells		EA		
	02	05		Sampling Surface Water/Groundwater/Liquid Waste		EA		
	02	06		Sampling Soil and Sediment		EA		
	02	07		Sampling Asbestos		EA		
	02	08		Sampling Radioactive Contaminated Media		EA		
	02	09		Laboratory Chemical Analysis		EA		
	02	10		Radioactive Waste Analysis		EA		
	02	11		Geotechnical Testing		EA		
	02	12		Geotechnical Instrumentation		EA		
	02	13		On-site Laboratory Facilities		EA		
	02	14		Off-site Laboratory Facilities		EA		
	02	9X		Other (Use Numbers 90-99)		EA		
	03			**SITEWORK**				
	03	04		Roads/Parking/Curbs/Walks		SY/YR		
	03	05		Fencing		LF/YR		
	03	06		Electrical Distribution		LF/YR		
	03	07		Telephone/Communication Distribution		LF/YR		
	03	08		Water/Sewer/Gas Distribution		LF/YR		
	03	09		Steam and Condensate Distribution		LF/YR		
	03	10		Fuel Line Distribution		LF/YR		
	03	11		Storm Drainage/Subdrainage		LF/YR		
	03	12		Permanent Cover Structure Over Contaminated Area		SF/YR		
	03	14		Fuel Storage Tanks (New)		EA/YR		
	03	9X		Other (Use Numbers 90-99)				
	05			**SURFACE WATER COLLECTION AND CONTROL**				
	05	01		Berms/Dikes		LF/YR		
	05	02		Floodwalls		SF/YR		
	05	03		Levees		LF/YR		
	05	04		Terraces and Benches		LF/YR		
	05	05		Channels/Waterways (Soil/Rock)		LF/YR		
	05	06		Chutes or Flumes		LF/YR		
	05	07		Sediment Barriers		LF/YR		

WBS Number				DESCRIPTION	QTY	UOM	UNIT COST	COST $
342XX	05	08		Storm Drainage		LF/YR		
	05	09		Lagoons/Basins/Tanks/Dikes/Pump System		ACR/YR		
	05	10		Pumping/Draining/Collection		MGA		
	05	11		Transport to Treatment Plant		MGA		
	05	13		Erosion Control		ACR/YR		
	05	9X		Other (Use Numbers 90-99)				
	06			**GROUNDWATER COLLECTION AND CONTROL**				
	06	01		Extraction and Injection Wells		EA/YR		
	06	02		Subsurface Drainage/Collection		LF/YR		
	06	03		Slurry Walls		SF/YR		
	06	04		Grout Curtain		SF/YR		
	06	05		Sheet Piling		SF/YR		
	06	06		Lagoons/Basins/Tanks/Dikes/Pump System		ACR/YR		
	06	07		Pumping/Collection		MGA		
	06	08		Transport to Treatment Plant		MGA		
	06	9x		Other (Use Numbers 90-99)				
	07			**AIR POLLUTION/GAS COLLECTION AND CONTROL**				
	07	01		Gas/Vapor Collection Trench System		LF/YR		
	07	02		Gas/Vapor Collection Well System		EA/YR		
	07	03		Gas/Vapor Collection at Lagoon Cover		SY/YR		
	07	04		Fugitive Dust/Vapor/Gas Emissions Control		ACR/YR		
	07	9x		Other (Use Numbers 90-99)				
	08			**SOLIDS COLLECTION AND CONTAINMENT**				
	08	01		Contaminated Soil Collection		CY		
	08	02		Waste Containment, Portable (Furnish/Fill)		CY		
	08	03		Transport to Treatment Plant		CY		
	08	04		Radioactive Specific Waste Containment (Furnish/Fill)		CY		
	08	05		Capping of Contaminated Area/Waste Pile (Soil/Asph		ACR/YR		
	08	06		Nuclear Waste Densification (Dynamic Compaction)		CY		
	08	9x		Other (Use Numbers 90-99)				
	09			**LIQUIDS/SEDIMENTS/SLUDGES COLLECTION AND CONTAINMENT**				
	09	01		Dredging/Excavating		CY		
	09	02		Industrial Vacuuming		CY		
	09	03		Waste Containment, Portable (Furnish/Fill)		MGA		
	09	04		Transport to Treatment Plant		MGA		
	09	05		Radioactive Specific Waste Containment (Furnish/Fill)		MGA		
	09	06		Pumping/Draining/Collection		MGA		
	09	07		Lagoons/Basins/Tanks/Dikes/Pump System		ACR/YR		

WBS Number				DESCRIPTION	QTY	UOM	UNIT COST	COST $
342XX	09	9x		Other (Use Numbers 90-99)				
	11			**BIOLOGICAL TREATMENT**				
	11	01		Activated Sludge (Seq Batch Reactors)		MGA		
	11	02		Rotating Biological Contactors		MGA		
	11	03		Land Treatment/Farming (Solid Phase Biodegradation)		CY		
	11	04		In-Situ Biodegradation/Bioreclamation		CY		
	11	05		Trickling Filters		MGA		
	11	06		Biological Lagoons		MGA		
	11	07		Composting (Soil Pile Bioremediation)		CY		
	11	08		Sludge Stabilization - Aerobic		CY		
	11	09		Sludge Stabilization - Anaerobic		CY		
	11	10		Genetically Engineered Organisms (White Rot Fungus)		CY		
	11	11		Slurry Biodegradation		CY		
	11	12		Bioventing		SF		
	11	13		Bioslurping		SF		
	11	14		Biopile (Heap Pile Remediation)		CY		
	11	50		Post Construction O&M of Permanent Plant Facility		EA/YR		
	11	9x		Other (Use Numbers 90-99)				
	12			**CHEMICAL TREATMENT**				
	12	01		Oxidation/Reduction (Catalytic)		MGA		
	12	02		Solvent Extraction		MGA		
	12	03		Chlorination		MGA		
	12	04		Ozonation		MGA		
	12	05		Ion Exchange		MGA		
	12	06		Neutralization		MGA		
	12	07		Chemical Hydrolysis		MGA		
	12	08		Ultraviolet Photolysis (UV Oxidation)		MGA		
	12	09		Dehalogenation (Catalytic Dechlorination)		CY		
	12	10		Alkali Metal Dechlorination		CY		
	12	11		Alkali Metal/Polyethylene Glycol (A/PEG)		CY		
	12	12		Base-Catalyzed Decomposition Process		CY		
	12	13		Electrolysis		MGA		
	12	14		Vapor Recovery/Reuse (Internal Combustion Engine)		CF		
	12	50		Post Construction O&M of Permanent Plant Facility		EA/YR		
	12	9x		Other (Use Numbers 90-99)				
	13			**PHYSICAL TREATMENT**				
	13	01		Filtration/Ultrafiltration		MGA		
	13	02		Sedimentation		MGA		
	13	03		Straining		MGA		
	13	04		Coagulation/Flocculation/Precipitation		MGA		

WBS Number				DESCRIPTION	QTY	UOM	UNIT COST	COST $
342XX	13	05		Equalization		MGA		
	13	06		Evaporation		MGA		
	13	07		Air Stripping		MGA		
	13	08		Steam Stripping		MGA		
	13	09		Soil Washing (Surfactant/Solvent)		CY		
	13	10		Soil Flushing (Surfactant/Solvent)		CY		
	13	11		Solids Dewatering		CY		
	13	12		Oil/Water Separation		MGA		
	13	13		Dissolved Air Floatation		MGA		
	13	14		Heavy Media Separation		CY		
	13	15		Distillation		MGA		
	13	16		Chelation		MGA		
	13	17		Solvent Extraction		MGA		
	13	18		Supercritical Extraction		MGA		
	13	19		Carbon Adsorption - Gases		CF		
	13	20		Carbon Adsorption - Liquids		MGA		
	13	21		Membrane Separation - Reverse Osmosis		MGA		
	13	22		Membrane Separation - Electrodialysis		MGA		
	13	23		Soil Vapor Extraction		CY		
	13	24		Shredding		CY		
	13	25		Aeration		CY		
	13	26		Advanced Electrical Reactor		CY		
	13	27		Low Level Waste (LLW) Compaction		CY		
	13	28		Agglomeration		CY		
	13	29		In-Situ Steam Extraction		MGA		
	13	30		Filter Presses		MGA		
	13	31		Lignin Adsorption/Sorptive Clays		CY		
	13	32		Air Sparging		MGA		
	13	50		Post Construction O&M of Permanent Plant Facility		EA/YR		
	13	9x		Other (Use Numbers 90-99)				
	14			**THERMAL TREATMENT**				
	14	01		Incineration		CY		
	14	02		Low Temperature Thermal Desorption		CY		
	14	03		Supercritical Water Oxidation		MGA		
	14	04		Molten Salt Destruction		CY		
	14	05		Radio Frequency Heating		CY		
	14	06		Solar Detoxification		CY		
	14	07		High Temperature Thermal Desorption		CY		
	14	50		Post Construction O&M of Permanent Plant Facility		EA/YR		
	14	9x		Other (Use Numbers 90-99)				
	15			**STABILIZATION/FIXATION/ENCAPSULATION**				
	15	01		Molten Glass		CY		

WBS Number				DESCRIPTION	QTY	UOM	UNIT COST	COST $
342XX	15	02		In-Situ Vitrification		CY		
	15	03		In-Situ Pozzolan Process (Lime/Portland Cement)		CY		
	15	04		Pozzolan Process (Lime/Portland Cement)		CY		
	15	05		Asphalt-Based Encapsulation		CY		
	15	06		Radioactive Waste Solidification (Grouting/Other)		CY		
	15	07		Sludge Stabilization (Aggregate/Rock/Slag)		CY		
	15	50		Post Construction O&M of Permanent Plant Facility		EA/YR		
	15	9x		Other (Use Numbers 90-99)				
	18			**DISPOSAL (OTHER THAN COMMERCIAL)**				
	18	01		Landfill/Burial Ground/Trench/Pits		CY		
	18	02		Above-Ground Vault		CY		
	18	03		Underground Vault		CY		
	18	04		Underground Mine/Shaft		CY		
	18	05		Tanks		MGA		
	18	06		Pads (Tumulus/Retrievable Storage/Other)		CY		
	18	07		Storage Bldgs/Protective Cvr Structures/Other Bldgs &		CY		
	18	08		Cribs		CY		
	18	09		Deep Well Injection		MGA		
	18	10		Incinerator		CY		
	18	15		Post Construction O&M of Permanent Disposal Fac		EA/YR		
	18	20		Container Handling		EA		
	18	21		Transportation to Storage/Disposal Facility		TON		
	18	22		Disposal Fees & Taxes		TON		
	18	23		Mixed Waste Storage Fees & Taxes		TON		
	18	9x		Other (Use Numbers 90-99)				
	9X			**OTHER (Use Numbers 90-99)**				
				TOTAL AMOUNT $				0