
On-Site Incineration at the
Baird and McGuire Superfund Site
Holbrook, Massachusetts

**Incineration at the Baird and McGuire Superfund Site
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Site Name: Baird and McGuire Superfund Site	Contaminants: Dioxins, volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), pesticides, and heavy metals, including lead and arsenic	Period of Operation: March 1995 to March 1997
Location: Holbrook, Massachusetts	Technology: <ul style="list-style-type: none"> • Removal of moisture from soil using rotary dryer • Combustion of contaminants in dry soil using rotary kiln • System designed to treat 25 tons of contaminated soil per hour • Ash and flue gases discharged from kiln • Residuals generated from incinerator returned to excavated areas on site 	Cleanup Type: Remedial action
Site General Contractor: OHM Remediation Services Corporation 16406 U.S. Route 224 East Findlay, OH 45839 (419) 423-3526	Cleanup Authority: CERCLA <ul style="list-style-type: none"> • ROD signed in September 1986 (soil) • ROD signed in September 1989 (sediment) • U.S. Corps of Engineers Lead 	Point of Contact: Chet Janowski U.S. EPA Region 1 John F. Kennedy Building One Congress Street Boston, MA 02203
SIC Code: 2879 (Pesticides) 2841 (Soaps) 2842 (Floor Wax) 2869 (Solvents)	Type/Quantity of Media Treated: Soil (210,000 tons) and sediment (1,500 cubic yards)	
Waste Source: Land disposal of process wastes		
Purpose/Significance of Application: Treats wide range of contaminants in soil and sediment, including dioxin, VOCs, PAHs, and Pesticides	Regulatory Requirements/Cleanup Goals: Destruction and Removal Efficiency (DRE) of 99.99% for principal organic hazardous constituents (POHCs) as required by Resource Conservation and Recovery Act (RCRA) incinerator regulations in 40 CFR part 264, subpart O	
Results: Trial burn data indicate that all DRE emission standards were met		

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(Continued)

Description:

Between 1912 and 1983, the site was operated as a chemical mixing and batching company. During a remedial investigation at the site, dioxin concentrations in the soil were measured as high as 27.8 $\mu\text{g}/\text{kg}$. A Record of Decision (ROD) signed in 1986 specified on-site incineration as the selected remedy for the contaminated soils at the site. A second ROD signed in 1989 specified on-site incineration as the selected remedy for the contaminated sediments of the nearby Cochato River.

The incineration system included a rotary dryer for removal of moisture from the soil. The dried soil was fed to the rotary kiln where the contaminants in the soil were volatilized and destroyed. From March 1995 through March 1997, the incinerator processed approximately 210,000 tons of contaminated soil and 1,500 cubic yards of contaminated sediment. All of the residuals generated from the incineration and subsequent ancillary operations, including ash and wastewater treatment sludge, were landfilled on site. Treatment performance and emissions data collected during this application indicated that all required performance standards and emissions requirements were achieved.

The total cost for remediation using the incineration system was approximately \$133,000,000.

EXECUTIVE SUMMARY

This report presents cost and performance data for the application of on-site incineration of contaminated soil at the Baird and McGuire Superfund site (Baird and McGuire) in Holbrook, Massachusetts. A rotary kiln incinerator was operated from March 1995 through March 1997 as part of a remedial action. Contaminants of concern in the soil were dioxins, volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), pesticides, and heavy metals, including lead and arsenic.

The Baird and McGuire site was operated as a chemical mixing and batching company from 1912 to 1983. Some of the raw materials used on site were stored in a tank farm and piped to on-site laboratory and mixing buildings. Other raw materials were stored in drums. During the remedial investigation, dioxin concentrations in the soil were measured as high as 27.8 $\mu\text{g}/\text{kg}$.

A Record of Decision (ROD) signed in 1986 specified on-site incineration as the selected remedy for the contaminated soils at the site. A second ROD signed in 1989 specified on-site incineration as the selected remedy for the contaminated sediments of the nearby Cochato River. Both RODs set standards requiring a destruction and removal efficiency (DRE) of 99.9999% for principal organic hazardous constituents (POHCs).

The remediation activities performed at Baird and McGuire also included the construction and operation of a groundwater treatment system. Only issues relating to on-site incineration are discussed in this report.

All of the material that was incinerated was mechanically screened to remove debris before incineration. The incineration system included a rotary dryer for removal of moisture from the soil. The dried soil was fed to the rotary kiln where the contaminants in the soil were volatilized and destroyed. Off-gases from the rotary kiln were then routed to a secondary combustion chamber (SCC).

The exhaust gas from the rotary kiln was directed to an air pollution control system (APCS) consisting of a baghouse for particulate removal, a quench tower, a wet scrubber for fine particulate removal. Wastewater from the APCS was treated in an on-site wastewater treatment system.

All of the residuals generated from the incineration and subsequent ancillary operations, including ash and wastewater treatment sludge, were landfilled on site.

During two years of operation, the incinerator processed approximately 210,000 tons of contaminated soil, and 1,500 cubic yards of contaminated sediment. Treatment performance and emissions data collected during this application indicated that all performance standards and emissions requirements were achieved.

The total cost for remediation using the incineration system was approximately \$133,000,000.

SITE INFORMATION

Identifying Information

Baird and McGuire Superfund Site
Holbrook, Massachusetts

CERCLIS # MAD001041987

ROD Date: September 30, 1986 (soil)
September 14, 1989 (sediment)

Background

Historical Activity that Generated

Contamination at the Site: Mixing, packaging and distribution of pesticides, disinfectants, soaps, floor waxes and solvents

Corresponding SIC Codes: 2879 - Pesticides, 2841 - Soaps, 2842 - Floor Wax, and 2869 - Solvents

Waste Management Practice That Contributed

to Contamination: Land disposal of process wastes

Site History:

- The site operated from 1912 until its closure in 1983. During this period, activities at the site included mixing, packaging, storing and distribution of various products, including pesticides, disinfectants, soaps, floor waxes, and solvents.

Treatment Application

Type of action: Remedial (on-site rotary kiln incineration)

Period of operation: March 1995 - March 1997

Quantity of material treated: 210,000 tons of contaminated soil and 1,500 cubic yards of contaminated sediment.

- The Baird and McGuire site is located near the western bank of the Cochato River in northwest Holbrook, Norfolk County, Massachusetts. The site consists primarily of coniferous woodlands and wooded wetlands. Approximately two-thirds of the site is within the 100-year floodplain of the Cochato River.
- Contamination at the site has been attributed to the direct discharge of process wastes to soils, a nearby brook and wetlands, and a former gravel pit, all of which are within the current site borders.
- Soil and sediment at Baird and McGuire was contaminated with dioxin, VOCs, PAHs, other organic compounds, pesticides, and heavy metals such as lead and arsenic.
- A site inspection was conducted in January 1984 and a Remedial Investigation (RI) and a Feasibility Study (FS) were conducted in 1985 and 1986 respectively.

SITE INFORMATION (CONT.)

Background (Cont.)

- The highest concentrations of contaminants were under and around former process buildings. In this area, soil sampling and subsequent analysis did not show any discernable decrease in contamination with depth. Contamination was assumed to exist to bedrock at a depth of approximately 15 feet. [3]
- Elevated concentrations of contaminants were also found in the area used as an on-site disposal area for a removal action in 1983-1984. This area was fenced and capped after EPA removed approximately 1,000 cubic yards of contaminated soil. [3]
- Based on the results of an RI and FS, a ROD was signed on September 30, 1986 specifying excavation and on-site incineration of contaminated soils at the site. Another ROD was signed on September 14, 1989 specifying excavation and on-site incineration of contaminated sediment at the site.
- It was estimated that 191,000 cubic yards of soil would be excavated for incineration. This quantity included only the "Hot Areas" which were established such that the contaminant concentrations in the remaining soils would be one to two orders of magnitude less than those to be excavated. [1]
- Between 1995 and 1997, an on-site rotary kiln incinerator was employed to remediate the excavated soil and sediment.
- During two years of operation, the incinerator processed approximately 210,000 tons of contaminated soil and 1,500 cubic yards of contaminated sediment.

Regulatory Context:

- A ROD signed in September 1986 (soil) and a ROD signed in 1989 (sediment) specified on-site incineration as the selected remedy for both contaminated soil and contaminated sediment.
- Compliance standards for the incineration were set based on the Resource Conservation and Recovery Act (RCRA) regulations for incinerators in 40 CFR part 264 subpart O.
- Site activities were conducted under the authority of the Comprehensive Environmental Response Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and the National Contingency Plan (40 CFR part 300).

Remedy Selection: On-site incineration was selected as the remedy for contaminated soil and sediment at the Baird and McGuire Superfund site because it was a cost-effective alternative that was protective of human health and the environment. [1,2]

SITE INFORMATION (CONT.)

Timeline

Table 1. Timeline [1,2,10]

Date	Activity
1912-1983	Chemical mixing and batching occurs at Baird and McGuire site
May 1981	Site Investigation
March 1983	EPA-initiated immediate removal action. Removal of approximately 1,000 cubic yards of contaminated soil and construction of a clay cap
July 1985	Site sampling and analysis revealed the presence of dioxin.
May 1985 - August 1986	Remedial Investigation/Feasibility Study
September 1986 September 1989	Records of Decision signed
January 1995	Trial burn
March, 1995 - March 1997	Rotary kiln incinerator operational

Site Logistics/Contacts

Site Management: United States Army Corps of Engineers-lead

Oversight: United States Environmental Protection Agency

Remedial Project Manager:
Chet Janowski
U.S. EPA Region 1
John F. Kennedy Building
One Congress Street
Boston, MA 02203

Treatment System Vendor:
OHM Remediation Services Corporation
16406 U.S. Route 224 East
Findlay, OH 45839
(419) 423-3526

MATRIX DESCRIPTION

Matrix Identification

Type of Matrix Processed Through the Treatment System: Soil and sediment

MATRIX DESCRIPTION (CONT.)

Contaminant Characterization

Primary Contaminant Groups: Dioxin, VOCs PAHs, other organic compounds, pesticides, and heavy metals such as lead and arsenic.

- The contaminant of greatest concern was dioxin. The maximum concentration detected was 28.7 µg/kg in the soil beneath the process buildings. [3]

Matrix Characteristics

The matrix characteristics that most significantly affect cost or performance at this site and their measured values are presented in Table 2. The results of these measurements were obtained based on the analysis of contaminated soil incinerated during the trial burn.

Table 2. Matrix Characteristics of Soil [10]

Parameter	Value
Moisture Content	9%
Heat Content	430 BTU/lb
Ash Content	97%
Chloride Total	0.06 %
Total Chromatographical Organics (TCO)	5,600 mg/kg

TREATMENT SYSTEM DESCRIPTION

Primary Treatment Technology

Rotary Kiln Incinerator, including:

- Rotary dryer
- Rotary kiln incinerator
- Secondary combustion chamber

Supplemental Treatment Technology

Pre-treatment (soil): Screened and dried

Post-treatment (air): Air Pollution Control System, including:

- High temperature baghouse
- High energy wet scrubbing system
- Quench tower

Post-treatment (water): On-site wastewater treatment for treatment of wastewater from wet scrubbing and quenching.

MATRIX DESCRIPTION (CONT.)

System Description and Operation

- The excavated soil was mechanically screened to remove debris prior to incineration. The excavated sediment was placed into specially designed containers and trucked to the incinerator. Feed soils and sediments were dried in a rotary dryer before being processed in the incinerator.
- A flow diagram of the incinerator system is presented as Figure 1.
- The dried material was fed to the rotary kiln via a drag-chain conveyor. The organic contaminants were volatilized and partially destroyed in the kiln chamber.
- The kiln was manufactured by OHM Remediation Services Corporation and had a length of 40 feet and an inside diameter of 8 feet. The kiln was lined with high-density castable refractory brick and was designed such that the optimal throughput of contaminated soil was approximately 25 tons per hour.
- The kiln was rated at 32 million BTU/hr. The kiln drive system employed a 40 hp motor and rotated at a maximum rate of 120 revolutions per hour.
- Kiln ash was quenched in a water bath and discharged to a storage area. Settled solids were continually removed from the ash quench bath by a drag-chain conveyor.
- The exhaust gas from the rotary kiln was routed through the rotary dryer to provide heat for soil drying. After passing through the dryer, the exhaust gas entered the baghouse through an internal, 180-degree bend knockout chamber. The exhaust gas then passed through 456 bag modules.
- The baghouse was rated for a grain loading of treated exhaust gas less than or equal to 0.02 grains per dry standard cubic foot (dscf). The air to cloth ratio was 4.40 to 1. The design operating conditions for exhaust gas flow rate and exit temperature were 24,000 actual cubic feet per minute (acfm) and 350 °F.
- Dust removed by the baghouse was treated in an indirect-fired rotary chamber. Exhaust gas from this unit was fed back to the rotary dryer.
- Exhaust gas leaving the baghouse entered the downflow quench tower then passed through 3 levels of quench sprays. The gas was directed by a contactor tube to impact sump water at the base of the quench tower. [10]
- The gas then passed into a 23.5-foot-long mobile mounted, two-stage Hydro-Sonic Scrubber where chemical (caustic) and particulate scrubbing occurred. [10]
- Exhaust gas from the scrubber was routed to the SCC for further combustion of volatilized contaminants. The SCC operated at approximately 1,950°F. The exhaust gas residence time in the SCC was a minimum of 2 seconds.
- Combustion gas was drawn through the incinerator by an induced draft fan (resulting in a constant negative pressure throughout the system) and was exhausted through a 100-foot stack. Stack gas flow rate was 44,435 acfm and the stack exit temperature was approximately 175°F.
- All of the residuals generated from incineration and subsequent operations were returned to the excavated areas on site. This included the quenched ash from the rotary kiln, ash from the incineration of baghouse dust, and wastewater treatment sludge.

MATRIX DESCRIPTION (CONT.)

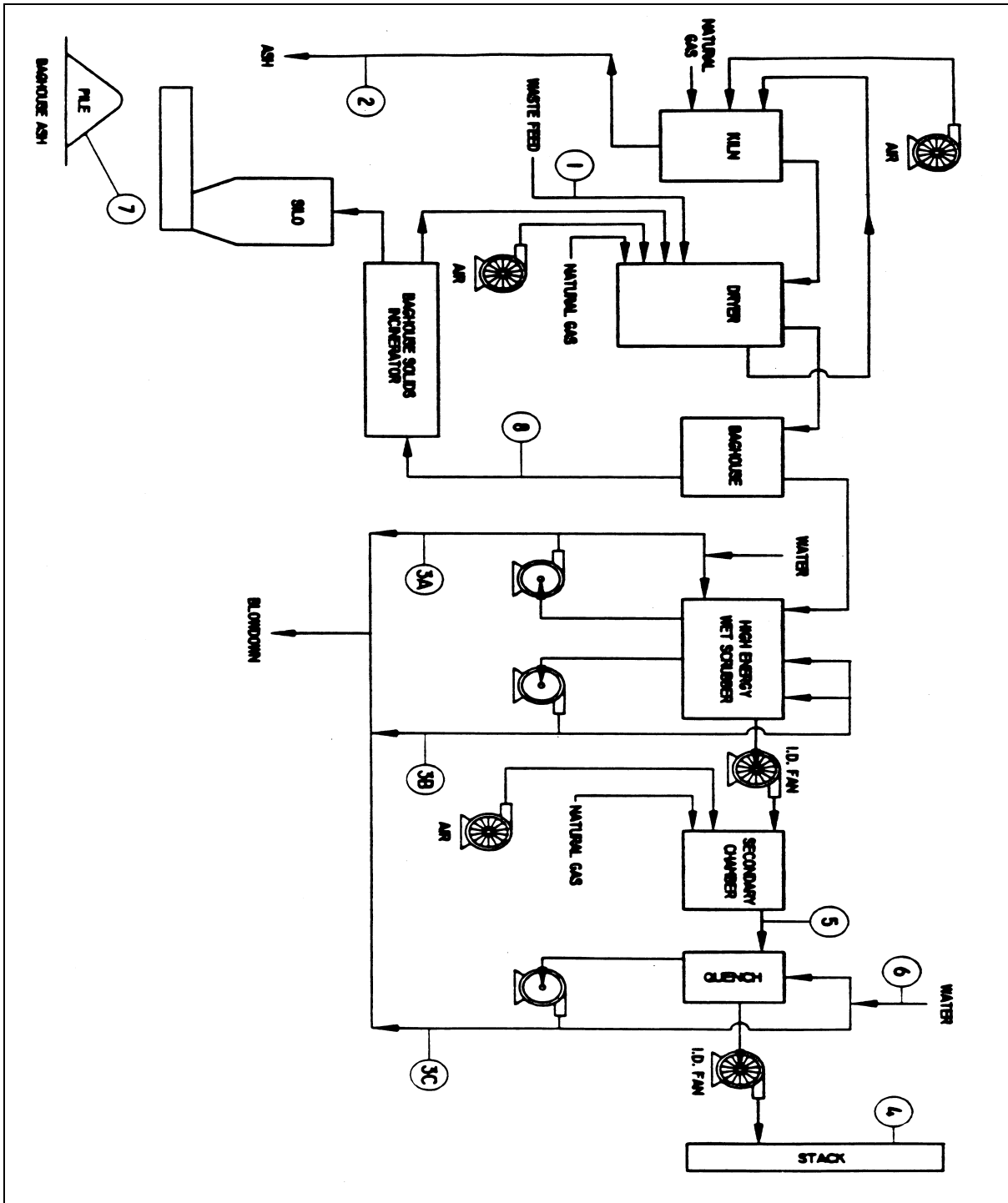


Figure 1. Incineration Flow Diagram, Baird & McGuire Superfund Site, Holbrook, Massachusetts

MATRIX DESCRIPTION (CONT.)

Table 3. Summary of Operating Parameters

Parameter	Value
Residence Time	Not Available
System Throughput	25 tph
Kiln Discharge Temperature	1,233°F

TREATMENT SYSTEM PERFORMANCE

Cleanup Goals/Standards

- The cleanup goals and standards were specified in the RODs. Compliance standards for the incineration were established based on the RCRA incinerator regulations in 40 CFR part 264 subpart O. [1,2]
- The RODs required a DRE of 99.9999% for principal organic hazardous constituents (POHCs).
- No quantitative soil cleanup standard was set. The limits of excavation were established such that contaminant concentrations in remaining soils were one to two orders of magnitude lower than the concentrations in the excavated soils. According to the findings of a risk assessment performed for the site, the remaining areas of contamination after excavation presented an excess lifetime cancer risk between 1×10^{-4} and 1×10^{-7} .
- Incineration performance requirements included:
 - 99% removal of HCl;
 - 99.99% DRE of all POHCs;
 - particulate emissions less than 180 mg/dscm (corrected)
 - 99.9999% DRE of dioxin surrogate [10]
- Site-specific criteria for arsenic and lead were developed by USACE based on the results of site-specific air modeling. The requirements specify a maximum stack emission rate for arsenic and lead of 0.00793 g/s and 0.00231 g/s, respectively. [10]

Treatment Performance and Compliance

- A trial burn was conducted from January 24, 1995 through January 26, 1995. The trial burn was conducted at conditions that would reflect worst-case destruction and removal of all constituents of concern. Naphthalene and monochlorobenzene were selected as the POHCs. 1,2,4,5-tetrachlorobenzene (TeCB) was selected as a surrogate for dioxin. Naphthalene and TeCB were spiked into the waste feed soil as solids and monochlorobenzene was spiked as a liquid. The spiking occurred as the waste feed entered the dryer. The data for the DREs is included in Table 4.
- The incinerator operated within the operating limits established during the trial burn, signifying that all cleanup requirements were met. The AWFCOs limits that were used during the operation of the incinerator are shown in Table 5. Information regarding the frequency of AWFCOs was not available. Trial burn operating parameters are shown in Table 6. (Information regarding actual values for operating parameters was not available.)
- The residual ash was tested for each of the POHCs. These data are presented in Table 7.

TREATMENT SYSTEM PERFORMANCE (CONT.)

Table 4. Average Destruction and Removal Efficiencies from Trial Burn [10]

Contaminant	Average Contaminant Feed Rate in Soil (lb/hr)	Average Contaminant Stack Gas Emission Rate (lb/hr)	DRE (%)
Naphthalene	205.21	1.0×10^{-5}	99.999951
Monochlorobenzene	16.3	3.4×10^{-5}	99.99979
1,2,4,5-Tetrachlorobenzene	203.7	1.8×10^{-5}	99.999991

Table 5. Automatic Waste Feed Cutoffs [10]

Parameter	Cutoff Limit
Maximum Average Feed Rate (one hour rolling average)	52,840 lbs/hr
Maximum Instantaneous Feed Rate (one minute average)	59,080 lbs/hr
Minimum Kiln Discharge Temperature	1170 °F
Minimum Kiln Exit Pressure	<-0.1 inch w.c.
Minimum SCC Gas Temperature	1880 °F
Draft Average SCC Exit Pressure	<-0.1 inch w.c.
Minimum Exhaust Gas Oxygen	>3%
Maximum Exhaust Gas Carbon Monoxide Concentration	199 ppm
Minimum Scrubber Nozzle No. 1 Recycle Flow Rate	40 gpm
Minimum Scrubber Nozzle No. 2 Recycle Flow Rate	32 gpm
Minimum Scrubber Pressure Drop	35 inch w.c.
Minimum Scrubber pH	6.0
Maximum Stack Gas Flow Rate	50,000 acfm

w.c. - Water column

Table 6. Operating Parameters [10]

Parameter	Trial Burn Value
Waste Feed Rate	5,194 lbs/hr
Kiln Discharge Temperature	1233 °F
Secondary Temperature	1951 °F
Secondary Oxygen	7.24 %
Kiln Draft	-1.42 inches w.c.
Baghouse Pressure Drop	3.71 inches w.c.
Scrubber Pressure Drop	46.8 inches w.c.
Scrubber pH	6.69

TREATMENT SYSTEM PERFORMANCE (CONT.)

Table 6. Operating Parameters [10]

Parameter	Trial Burn Value
Stack Temperature	174.8 °F
Stack Flow Rate	44435 acfm
Secondary Draft	-0.71 inches w.c.
Dryer Discharge Temperature	309.1 °F
Baghouse Quench	1514 gpm
Secondary Combustion Chamber Retention Time - calculated	2.51 seconds

w.c. - Water column

Table 7. Contaminant Concentration in Residual [10]

Spiked POHCs	Concentration in Ash (mg/kg)
Naphthalene	<0.316
Monochlorobenzene	<0.810
1,2,4,5-Tetrachlorobenzene	<0.422

Performance Data Quality

- According to the site personnel, the QA/QC program used throughout the remedial action met all EPA requirements. All monitoring and sampling analysis was performed using EPA-approved methods, and the vendor did not note any exceptions to the QA/QC protocols.

TREATMENT SYSTEM COST

Procurement Process

- USACE contracted with OHM Remediation Services to acquire and operate the incinerator at the site. OHM Remediation Services used several subcontractors to implement specific aspects of the operation. [10]

TREATMENT SYSTEM COST (CONT.)

Cost Data

- The estimated cost for operating the incinerator at the site was \$133,000,000 [11]. A total of 248,000 tons of soil and sediment were incinerated. This corresponds to a total unit cost for incineration of \$540 per ton. A detailed breakdown of these costs was not available.

OBSERVATIONS AND LESSONS LEARNED

Observations and Lessons Learned

- Under certain unusual weather conditions, the steam plume from the incinerator stack touched down on nearby residences. In response to the public concern that was generated, USACE added 50 feet to the height of the incinerator stack. According to EPA officials, there were no public health reasons for this action. [8]

REFERENCES

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10. Trial Burn Report for the Baird and McGuire Superfund Site, Holbrook, MA, March 10, 1995.
11. Engineering News-Record, McGraw-Hill Companies, July 14, 1997.