ENVIROCON

# CLOSEOUT REPORT

## Former Hazardous Waste Management Facility
## Soil Remediation
## Brookhaven National Laboratory
## Upton, New York

**Prepared for:**
**Brookhaven Science Associates, LLC**
**Building No. 460**
**Upton, NY 11973**
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# EXECUTIVE SUMMARY

The *Record of Decision – Operable Unit I and Radiologically Contaminated Soils (Including Areas of Concern 6, 8, 10, 16, 17, and 1*8) (OU I ROD*),* dated August 1999, was developed by Brookhaven National Laboratory (BNL) for the U.S. Department of Energy (DOE). Specifically, the OU I ROD addressed contamination found at OU I and Areas of Concern (AOC)s 6, 8, 10, 16, 17 and 18. All the identified areas contained radiologically contaminated soils resultant from past waste handling operations, spills, or inadvertent use of contaminated soils for landscaping. The soils at the former Hazardous Waste Management Facility (HWMF) (AOC 1) had become contaminated with radionuclides as a result of leaks from past waste handling operations.

Soil cleanup objectives were established for this site and outlined in the OU I ROD. The soil cleanup objectives for radiological contamination were based on a dose, from remaining concentrations of all radionuclides present, of 15 millirem per year (mrem/year) above background considering 50 years of institutional control for industrial land use, per U.S. DOE Residual Radioactive Material Guideline Computer Code (RESRAD). The cleanup objective also was based on a 15 millirem per year dose to a future resident after 100 years of institutional control.

Remedial Action construction activities commenced in September 2004 and were completed during August 2005. The following summarizes the as-left conditions at the former HWMF and how they satisfy the requirements of the OU I ROD:

- The average Cs-137 and Sr-90 concentrations following remediation are 7.63 pCi/g and 1.51 pCi/g, respectively. The 95% upper confidence level (UCL) concentrations for Cs-137 and Sr-90 are 16.6 pCi/g and 5.3 pCi/g respectively.
- The dose to an industrial worker after 50 years of institutional controls is 1.8 mrem/yr and 4.0 mrem/yr using the average and 95% UCL concentrations, respectively. These annual dose projections are well below the 15 millirem per year cleanup goal in the OU I ROD.
- The dose to an industrial worker with no time for radioactive decay (i.e. present day) using the average and 95% UCL concentrations is 5.4 mrem/yr and 11.8 mrem/yr respectively. The dose to a resident after 50 years of institutional controls using average and UCL values are 6.1 mrem/yr and 14.5 mrem/yr. These additional dose projections indicate that the OU I ROD requirements are satisfied by a wide margin.

The former HWMF, AOC 1 meets all the completion requirements as specified in OSWER Directive 9320.2-09-A-P, *Closeout Procedures for National Priorities List Sites*. The affected areas were remediated in accordance with the decommissioning criteria of 10 CFR Part 834, Radiation Protection for the public and environment.

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# ACRONYM LIST

| | |
|---|---|
| ALARA | As Low As Reasonably Achievable |
| AOC | Area of Concern |
| AOI | Area of Interest |
| BNL | Brookhaven National Laboratory |
| CPM | Counts Per Minute |
| CERCLA | Comprehensive Environmental Response, Compensation & Liability Act |
| CY | Cubic Yards |
| DAC-Hr | Derived Air Concentration-Hour |
| DCGL | Derived Concentration Guideline Level |
| $DCGL_w$ | Project Specific Derived Concentration Guideline Level |
| $DCGL_{EMC}$ | Elevated Measurement Comparison Derived Concentration Guideline Level |
| DOE | Department Of Energy |
| DQO | Data Quality Objective |
| EMC | Elevated Measurement Comparison |
| EPA | United States Environmental Protection Agency |
| GPS | Global Positioning System |
| HWMF | Hazardous Waste Management Facility |
| HASP | Health and Safety Plan |
| IAG | Interagency Agreement |
| IH | Industrial Hygiene |
| ISOCS | In Situ Object Counting System |
| IVS | Independent Verification Survey |
| LBGR | Lower Bound of the Gray Region |
| MARSSIM | Muli-Agency Radiological Survey and Site Investigation Manuel |
| MVA | Mercury Vapor Analyzer |
| NaI | Sodium Iodide |
| NYSDEC | New York State Department of Conservation |
| ORISE | Oak Ridge Institute for Science and Education |
| USC | United States Code |
| OU | Operable Unit |
| QA/QC | Quality Assurance/Quality Control |
| RCRA | Resource Conservation and Recovery Act |
| RCT | Radiological Controls Technician |
| RDIP | Remedial Design Implementation Plan |
| RESRAD | Residual Radioactive Materials Guidelines |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| SI | Supplemental Investigation |
| STL | Severn Trent Laboratories |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TLD | Thermoluminscent Dosimeter |
| WAC | Waste Acceptance Criteria |
| WCS | Waste Confirmation Sample |

# 1.0 INTRODUCTION

## *1.1 Purpose*

The purpose of this of this closeout report is to document the following at the former HWMF, BNL in accordance with *Closeout Procedures at National Priority List Sites, OSWER Directive 9320.2-09A-P* (EPA, June 2001):

- The excavation of contaminated soil above site cleanup goals;
- The removal of contaminated subsurface structures;
- The results of the final status survey and sampling, including Oak Ridge Institute for Science and Education (ORISE) independent verification survey and sampling results;
- The post closure dose assessment in accordance with the RESRAD;
- The characterization and disposal of soil and debris at Envirocare of Utah (Envirocare); and
- Site restoration.

BNL contracted Envirocon, Inc. to conduct the remaining remedial activities at the former HWMF, designated as AOC 1 within OU I, in accordance with the OU I ROD and the *Remedial Action Work Plan, Operable Unit I, Area of Concern 1, Former Hazardous Waste Management Facility* (BNL, March 2003). The scope of the remedial work was outlined in detail in the *Remedial Design Implementation Plan, Operable Unit I, Area of Concern 1, Former Hazardous Waste Management Facility Remedial Action Work Plan* (BNL, March 2004) and is identified throughout this document as the Former HWMF Soils Removal Project.

Previously completed work is listed in Section 2.0. The scope of work for the Former HWMF Soils Removal Project included the following:

- Remove radiologically and chemically contaminated soils above prescribed cleanup goals;
- Remove sub-surface storage structures;
- Package on-site, transport, and dispose of radiologically and chemically contaminated soils and debris off-site at a permitted facility;
- Collect and analyze endpoint samples to ensure cleanup goals have been achieved;
- Perform Final Status Surveys;
- Perform site restoration per the BNL project specification documents; and
- Prepare a dose assessment and a closeout report.

## 1.2 Site History and Regulatory Framework

BNL site is located in Suffolk County, New York, and is comprised of approximately 5,320 acres. Approximately 900 acres are developed. The U.S. Army occupied the BNL site, formerly Camp Upton, during World Wars I and II. Between the wars, the Civilian Conservation Corps operated the site. It was transferred to the Atomic Energy Commission in 1947, to the Energy Research and Development Administration in 1975, and to the U.S. DOE in 1977. A map illustrating the location of the BNL site is presented as Figure 1-1.


**Figure 1-1. Brookhaven National Laboratory location.**

In 1980, the BNL site was placed on New York State's Department of Environmental Conservation (NYSDEC) list of Inactive Hazardous Waste Sites. On December 21, 1989, the BNL site was included on the EPA's National Priorities List because of soil and groundwater contamination that resulted from BNL's past operations. Subsequently, the EPA, NYSDEC, and DOE entered into a Federal Facilities Agreement (herein referred to as the Interagency Agreement; [IAG]) that became effective in May 1992 (Administrative Docket Number: II-CERCLA-FFA-00201) to coordinate the cleanup.

The IAG identified AOCs that were grouped into OUs to be evaluated for response actions. The IAG requires a remedial investigation/feasibility study (RI/FS) for OU I, pursuant to 42 United States Code (USC) 9601 et. seq., to meet Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requirements. An RI was performed at BNL by CDM in 1996 and IT in 1999. An FS was prepared by CDM in 1999. These studies are discussed further in Section 1.4.

BNL's *Site Baseline Report* (SAIC, 1992) grouped the identified AOCs into seven OUs; several were subsequently combined. This closeout report documents completion of the remedial action for AOC 1 (former HWMF) within OU I.

The former HWMF was used from the 1940s to 1997 as the central receiving facility for processing, limited treatment (neutralization), and storage of radioactive waste, hazardous waste, and mixed waste generated at BNL. The former HWMF operated as a Resource Conservation and Recovery Act (RCRA) permitted facility from 1992 until it underwent RCRA closure in 1998. As a result of several spills of hazardous and radioactive materials during operations at the former HWMF, the soils became contaminated with levels of cesium-137 (Cs-137), radium-226 (Ra-226), strontium-90 (Sr-90), mercury, and lead above cleanup goals established in the OU I ROD.

## 1.3 Operable Unit I Background

As part of remedial efforts at BNL, 30 AOCs were identified and grouped into seven OUs. The seven OUs were subsequently reduced to six OUs as a result of combining OU II and OU VII into OU II/VII. A map illustrating the BNL site and the OUs is presented as Figure 1-2.

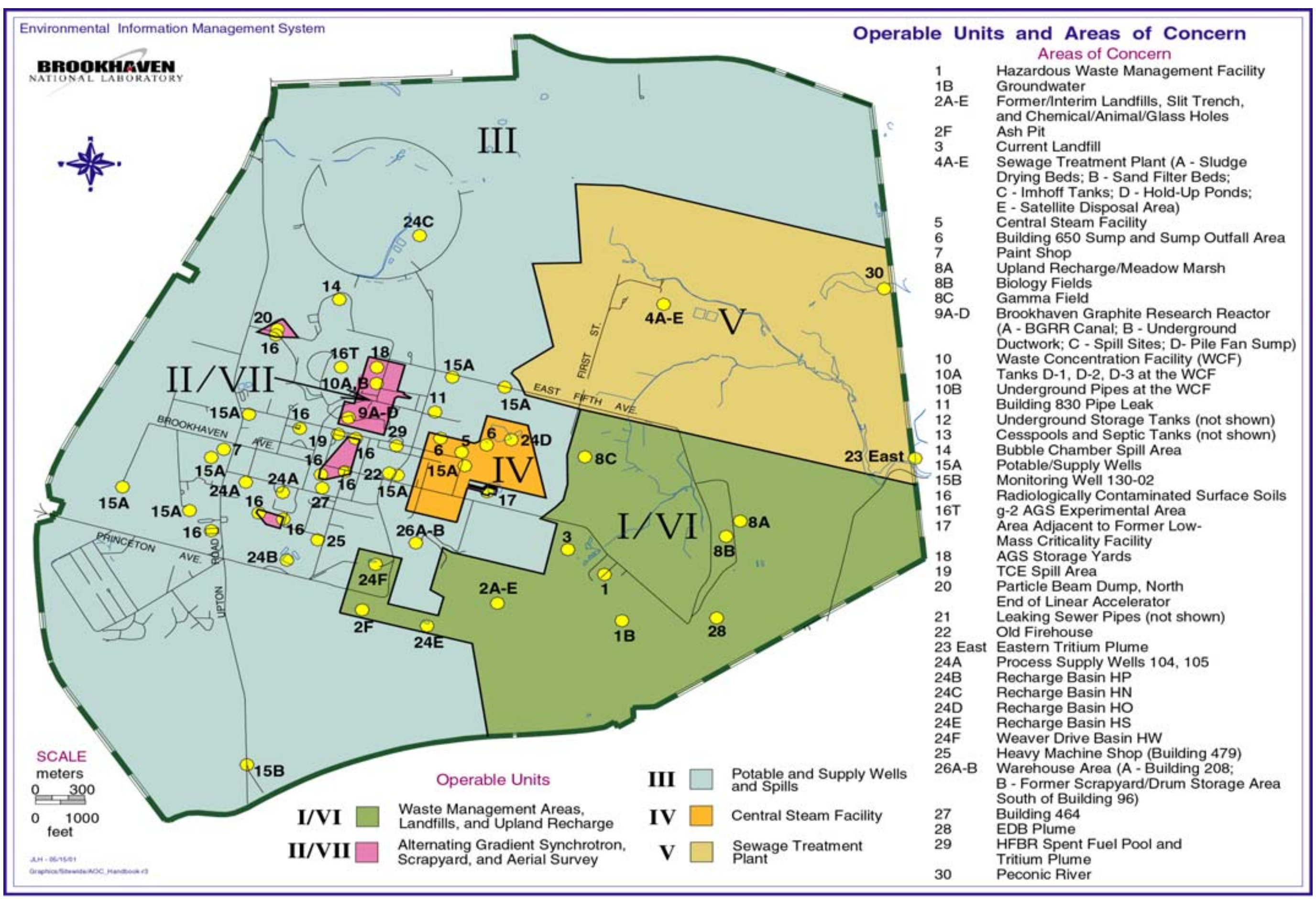


**Figure 1-2. BNL's Operable Units.**

The OU I ROD addressed AOCs grouped under OU I, including radiologically contaminated soils from AOCs 6, 8, 10, 16, 17, and 18. OU I sites include the former HWMF (AOC 1), Ash Pit (AOC 2F), Wooded Wetland (AOC 3), Upland Recharge/Meadow Marsh (AOC 8), and Recharge Basins HS and HW (AOC 24E and 24F). Radiologically contaminated soil was the principal threat addressed in the OU I ROD. The majority of the radiologically contaminated soil containing the highest contaminant levels was located at the former HWMF.

### 1.3.1 Former HWMF - AOC I

The former HWMF is located in the southeastern portion of the BNL site (Figure 1-3). It comprises about 12 acres (Figure 1-4). There were various buildings and former operational areas within the former HWMF. Approximately three acres were paved or contained buildings, and the remaining nine acres are open space or wooded.

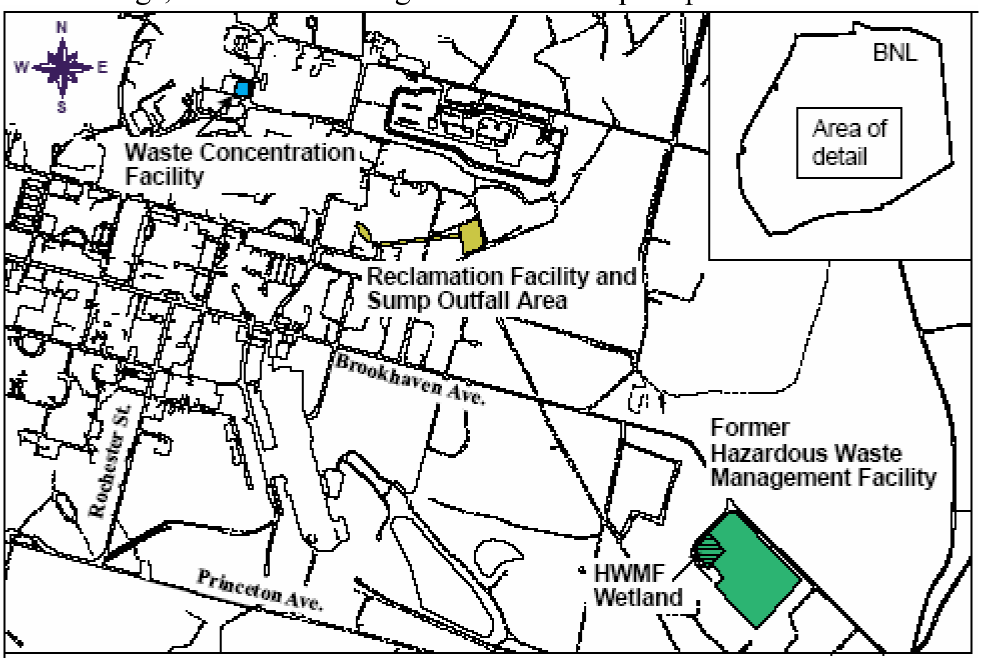


**Figure 1-3. Former HWMF location.**

In the northwestern portion of the former HWMF is a shallow wetland that seasonally ponds. It encompasses an area of approximately two acres, half of which lies inside the boundary of the former HWMF fence line. The wetland is shown on the National Wetland Inventory Mapping and was delineated as a federal wetland under Section 404 of the Clean Water Act. The NYSDEC regulates the wetland as a breeding ground for the Tiger Salamander, a New York State endangered species. The wetland received surface runoff from the former HWMF area, and as a result, the wetland sediment was contaminated with concentrations of Cs-137 above the cleanup goals established in the OU I ROD.

There were eight buildings and structures located at the former HWMF that were used for various chemical and/or radioactive operations and storage:

- 444 Building – Old Chemical Building (including the incinerator)
- 445 Building – Former HWMF Office Building/High Bay Shop
- 446 Building – Radioactive-waste Sorting Barn
- 447 Building – Rigging Shed/Equipment Storage Building
- 448 Building – Chemical Receipt Back Barn (Radioactive/Mixed waste storage)
- 483 Building – Chemical Storage Building
- 625 Structure – Detonation Area Viewing Bunker
- Sprung / Tent Structure

Above grade structures and buildings at the former HWMF were removed during the summer of 2003. Only the building slabs remain. This work is documented in the *Former Hazardous waste Management Facility Decontamination and Decommissioning Closeout Report* (BNL, November 2003). The building slabs are further discussed in Sections 3.4 and 3.5.

## 1.4 Remedial Investigation/Feasibility Study

An RI was conducted at BNL by CDM in 1996 and IT in 1999. An FS was prepared by CDM in 1999. The former HWMF (AOC 1) was included in the OU I RI. The RI was performed to evaluate the nature and extent of contamination, as well as the potential risks associated with the areas of concern. Several investigative approaches were utilized including radiological surveys, soil/sediment sampling, surface water sampling, and test pits.

Baseline chemical and radiological risk assessments were performed as part of the RI Report. A preliminary screening of ecological risks and a focused ecological risk assessment (including an addendum to the focused ecological risks assessment) were also completed. To further delineate soil, sediment, and asphalt contamination addressed in the RI, BNL also conducted a Supplemental Investigation (SI) at the former HWMF in 2003.

### 1.4.1 Supplemental Investigation Findings

Soil, sediment, and asphalt samples were collected based on data gaps and the radiological walkover survey results. Samples were analyzed for gamma emitting isotopes and Sr-90 using an on-site In Situ Object Counting System (ISOCS) and Beta Scintillation, respectively. In addition to ISOCS and Beta Scintillation analyses, samples were collected and analyzed for Toxicity Characteristic Leaching Procedure (TCLP), alpha isotopes, Total Lead, and polychlorinated biphenyls (PCBs).

As part of the SI, a radiological survey was performed using a Ludlum 2221 detector w/44-10 sodium Iodide probe attached to the Trimble Pro XR Global Positioning System (GPS). The results of this survey and additional pre-excavation walkover surveys are further discussed in Section 3.1.

Based on the RI and SI, Cs-137 and Sr-90 were detected in the former HWMF asphalt and soil above the cleanup goals of 67 pCi/g and 15 pCi/g, respectively. Maximum detected concentrations for Cs-137 and Sr-90 were 810,000 pCi/g and 1,300 pCi/g, respectively. Mercury was also detected above the cleanup goal of 1.84 mg/kg in soils in the vicinity of an UST and its associated piping, with a maximum concentration of 184 mg/kg. Detected radionuclides and chemical contaminants are listed in Table 1-1.

**TABLE 1-1**
**Radionuclides Detected in AOC 1 Former HWMF (Including the Wetland)**

| Radionuclide | Maximum Concentration (pCi/g) | Representative Site Value[1] (pCi/g) | Cleanup Goal[2] (pCi/g) |
|---|---|---|---|
| Am-241 | 11 | 4.6 | 160 |
| Cs-137 | 810,000 | 3,958 | 67 |
| Co-60 | 6.5 | 0.4 | 3,356 |
| Pu-238 | 0.18 | 0.06 | 274 |
| Pu-239/240 | 19 | 3.4 | 170 |
| K-40 | 20 | 7.0 | NA[3] |
| Sr-90 | 1,300 | 29 | 15 |
| H-3 | 54 | 0.2 | $9.6x10^{15}$ |
| U-235 | 21 | 7.4 | 29 |
| U-238 | 2.8 | 0.73 | 11 |

[1] Representative site values were determined as follows: 25% percentile of the difference between the maximum and minimum value chosen to represent the site value given that the data is log normally distributed.
[2] Remediation goals were developed from RESRAD analyses reported in the OU I FS Report, March 1999. Cs-137 and Sr-90 are the only isotopes specified in the ROD.
[3]Not applicable – no remediation goal established for K40.

**TABLE 1-1 Cont.**
**Chemical Contaminants of Concern in Sediment/Surface Soils for AOC 1 Former HWMF (Including the Wetland)**

| Chemical | Maximum Concentration (mg/kg) | Cleanup Goal (mg/kg) |
|---|---|---|
| Lead | 4010 | 400 |
| Mercury | 184 | 1.84 |

# 2.0 SITE BACKGROUND

The following is a chronology of the main remedial events and the associated plans for AOC 1, the former HWMF:

- August 1999 - *OU I Record of Decision*
- October 2000 - *Remedial Design and General and Supplemental Specifications for Remedial Action, Operable Unit I Contaminated Soil and Debris*
- 2000-2002 - Aboveground waste in storage removed
- December 2001 - *Decommissioning Plan for the Former Hazardous Waste Management Facility Buildings and Structures*
- July 2002 - *Characterization and Waste Management Plan for the Former Hazardous Waste Management Facility Buildings and Structures*
- 2002 - Characterization field work for the decommissioning of the former HWMF buildings and structures
- March 2003 - *Remedial Action Work Plan, Operable Unit I, Area of Concern 1, Former Hazardous Waste Management Facility*
- April 2003 - *Supplemental Investigation Plan, Former Hazardous Waste Management Facility, Soil, Asphalt, and Debris*
- May 2003 - *Former Hazardous Waste Management Facility Decontamination and Decommissioning Characterization Report*
- June-July 2003 - SI field work
- July-September 2003 - Building decommissioning and decontamination field work, including removal of contaminated asphalt and underground storage tanks (UST)
- September 2003 - *Supplemental Investigation Report, Former Hazardous Waste Management Facility, Soil, Asphalt, and Debris*
- November 2003 - *Former Hazardous Waste Management Facility Decontamination and Decommissioning Closeout Report*
- March 2004 - *Remedial Design Implementation Plan, Operable Unit 1, Area of Concern 1, Former Hazardous Waste Management Facility*
- September 2004–August 2005 - Excavated contaminated soil above cleanup goals and removed contaminated subsurface structures
- March-August 2005 - Performed final status survey

## *2.1 OU I ROD Findings*

The OU I ROD addresses contamination at AOCs 6, 8, 10, 16, 17, and 18. These areas contained radiologically contaminated soils resultant from past waste handling operations, spills, or inadvertent use of contaminated soils for landscaping. Soils at the former HWMF (AOC 1) became contaminated as the result of waste handling operations and spills. Contamination was present in the form of Cs-137, Sr-90, Ra-226, lead, and mercury.

As a result of the OU I ROD findings, the DOE determined that remedial actions were required for several AOCs. The remedial actions for the former HWMF (AOC 1) included the excavation and disposal of radiological, mercury, and lead contaminated soil and wetlands sediment/surface soil to meet prescribed cleanup goals, as well as the removal and disposal of out-of-service facilities, tanks, piping, and equipment.

The OU I ROD established the following remedial objectives:

- Minimize threats to human health and the environment from site contaminants;
- Prevent or minimize the leaching of contaminants from the soils into the underlying aquifer as a result of the infiltration of precipitation;
- Prevent or minimize the migration of contaminants present in surface soils via surface runoff and windblown dusts;
- Prevent or minimize human exposure including direct external exposure, ingestion, inhalation, and dermal contact (for future residents, trespassers, site workers, and construction workers) and environmental exposure to contaminants in the surface and subsurface soils; and
- Prevent or minimize the uptake of contaminants present in the soils by ecological receptors.

The OU I ROD presented six alternatives for the remediation of contaminated soils and provided a comparative analysis of each alternative. The selected remedy was the excavation and off-site disposal of radiologically contaminated soils above cleanup goals, as well as the implementation of institutional controls. In addition, some associated structures would be removed as part of remedial efforts.

## *2.2 Site Cleanup Criteria*

The radiological contaminants of concern at the former HWMF were CS-137, Ra-226, and Sr-90. The cleanup goals for specific radionuclides at the former HWMF were calculated using RESRAD, 15 millirem per year (mrem/yr) above background (*OSWER Directive 9200.4-1., EPA, 1997*), industrial land use with 50 years of institutional control, and residential land use with 100 years of institutional control by the DOE. The EPA's acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$ was also set as a cleanup criterion for the former HWMF remedial action. In addition, the NYSDEC cleanup guideline of 10 mrem/yr, from Technical Administrative Guidance Memorandum (TAGM) 4003, was considered. The primary radiological isotope present at the site was Cs-137; its cleanup goal established in the OU I ROD is 67 picocuries per gram (pCi/g).

The potential for radiologically contaminated soil to impact groundwater also was considered. A soil cleanup goal for Sr-90 was calculated as 15 pCi/g, based on its potential to impact the groundwater. The goal also protects both residential and industrial uses. A 5-pCi/g-cleanup goal was selected for Ra-226 based on DOE Order 5400.5, *Radiation Protection of the Environment and the Public*.

The chemical contaminants of concern at the former HWMF were mercury and lead. The cleanup goal established for mercury is 1.84 milligrams/kilograms (mg/kg), based on the EPA's soil screening level guidance (*OSWER Directive 9355.4-23*) for protecting groundwater and residential use. A cleanup goal of 400 mg/kg for lead was also chosen based on the EPA's soil screening level guidance; this level is protective of residential use.

## 2.3 Design Criteria

Technical specifications and design criteria for the Former HWMF Soils Removal Project were developed in response to the evaluation of remedial actions described in the OU I ROD. The remedial approach and associated reference documents for the former HWMF were presented to Envirocon as part of BNL's contract document package.

The remedial design, presented in the *Remedial Design and General and Supplemental Specifications for Remedial Action Operable Unit I Contaminated Soil and Debris* (URS, October 2000), the *Remedial Action Work Plan, Operable Unit I, Area of Concern 1, Former Hazardous Waste Management Facility* (BNL, March 2003), and the *Remedial Design Implementation Plan, Operable Unit 1, Area of Concern 1, Former Hazardous Waste Management Facility* (BNL, March 2004) was developed by BNL to satisfy the requirements specified in the OU I ROD. The remedial design was developed in compliance with federal, state, and local regulatory requirements.

The remedial design included:

- A plan and process for ensuring the total exposure from all radioisotopes does not exceed 15 mrem/yr above background following the 50-year period for institutional control for the site;
- A method for instituting an ALARA analysis to identify cost effective measures for reducing exposure to residual contamination below cleanup goals;
- Methods to reduce waste volumes that require offsite disposal;
- An evaluation of waste acceptance criteria for offsite disposal to determine whether further stabilization of mixed wastes is required;
- An approach for post-remediation sampling to confirm that cleanup goals have been achieved; and
- An evaluation of transport and shipping regulations.

### 2.4 Community Relation Activities

A Community Relations Plan was completed for BNL in September 1991. In accordance with this plan and CERCLA sections 113 (k)(2)(B)(I-v) and 117, the community relations program focused on distribution of public information and community involvement. Community relations activities include a stakeholders' mailing list, community meetings, availability sessions, site tours, and workshops. An Administrative Record was established to document the basis for selecting the remedial actions at BNL. This record, as well as current site reports, press releases, and fact sheets are maintained at the BNL Research Library, Building 477A, Upton, N.Y., 11973.

The Administrative Record is also kept at the EPA's Region II Administrative Records Room, 290 Broadway, New York, N.Y., 10007-1866.

In accordance with CERCLA guidance and state requirements the project work plan, quality assurance plan, engineering evaluation/cost analysis, risk assessment, remedial investigation, and feasibility study were made available for public review. A full discussion of BNL's community involvement programs is presented in the OU I ROD.

## 3.0 CONSTRUCTION ACTIVITIES

All pre-construction tasks were completed prior to excavating, including equipment mobilization, radiological walkover surveys, site inspections, excavation area mark-outs, silt fence installation, and securing the general work area.

As noted in Section 1.3.1, above grade structures and buildings at the former HWMF were removed during the summer of 2003 leaving only the building slabs. The objective of the Former HWMF Soils Removal Project was to safely characterize, remediate, and dispose of radiologically and chemically contaminated soil, sediment, and debris in accordance with the OU I ROD, as well as the project specific plans. During the course of conducting walkover surveys at the site, it was noted that several of the building slabs that remained from the previous building removal project exhibited elevated gamma count rates. Subsequently, BNL conducted additional remediation of the building slabs. Following the additional remediation activities on building slabs, a final status survey and dose assessment was performed by Envirocon. The final status survey was independently verified by ORISE. This work is further discussed in sections 3.4 and 3.5. Final status surveys were completed using the *Multi-Agency Radiological Survey and Site Investigation Manual* (*MARSSIM*) guidelines.

Soils and subsurface structures at the former HWMF were divided into 11 areas designated A-K. These areas were further divided into survey units in accordance with the *MARSSIM* guidelines for survey unit classification and size. A survey unit is a physical area of structure or land area of specified size and shape for which a separate decision will be made on whether or not cleanup goals are met. Soils contaminated above cleanup goals and sub-surface structures were designated as Class 1 survey units. The maximum suggested area for Class 1 soil area survey units is 2,000 square meters ($m^2$). Areas A and C-K were divided into nine (9) Class 1 survey units as shown on Figure 3-1. A site map showing the planned Class 1 and 2 survey units is presented as Figure 3-2. The *MARSSIM* classifications are discussed in further detail in Section 3.5.3.

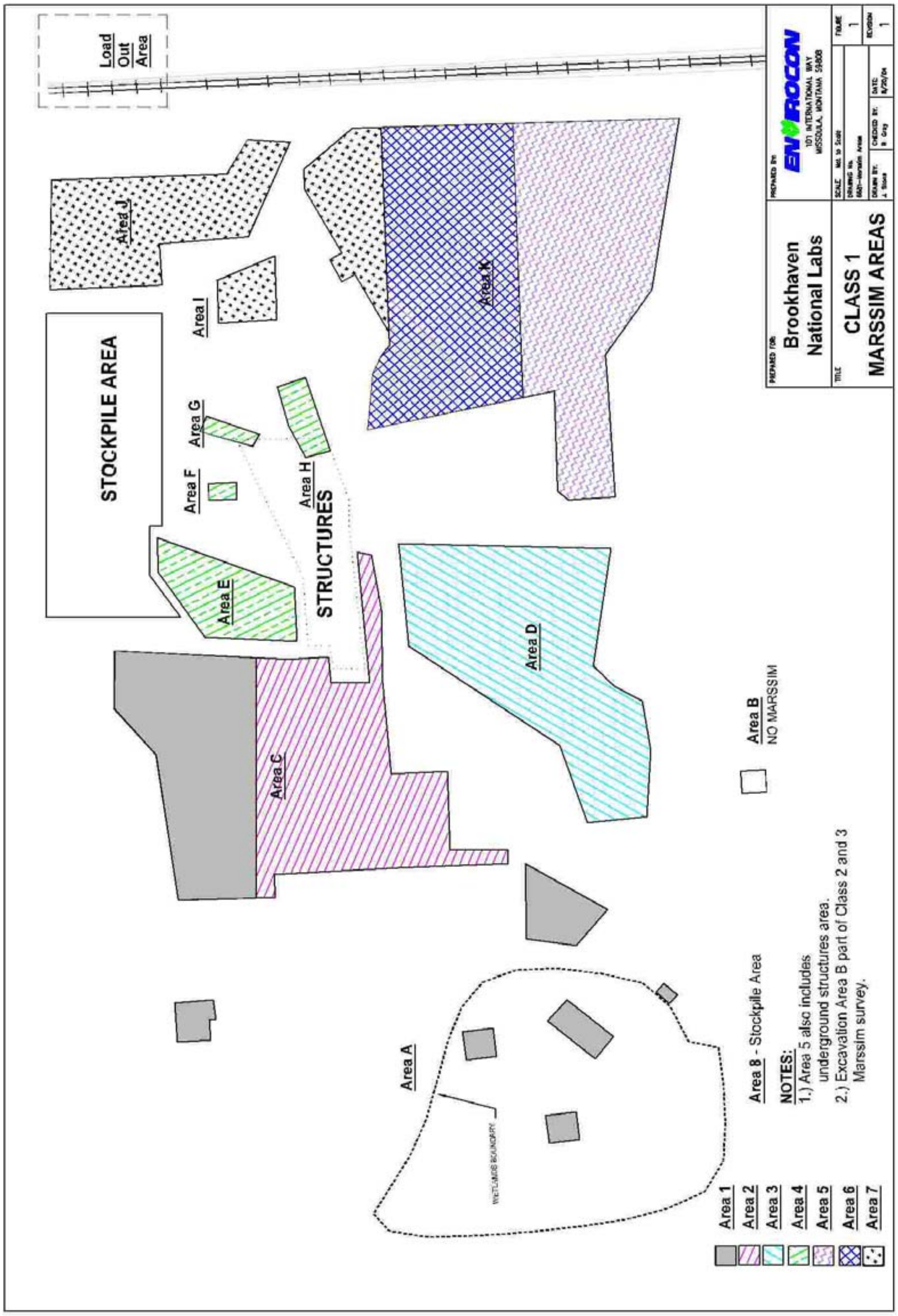


**Figure 3-1. Nine (9) Planned MARSSIM Class 1 excavation areas**.

## 3.1 Field Screening Prior To Excavation

During the SI work, seasonal standing water and extensive vegetation prohibited the completion of a radiological walkover survey in the wetlands area. A radiological walkover survey was performed in this area prior to the start of excavation activities. The survey was performed using Ludlum Model 2221 scaler/ratemeters used in conjunction with collimated two-inch-by-two-inch Sodium Iodide (NaI) detectors. Results from this radiological walkover survey and the SI walkover survey are presented as Figure 3-3.

## 3.2 Soil Excavation

Prior to the start of remedial activities, survey units were surveyed and marked out by Municipal Land Survey in accordance with the *Remedial Design Implementation Plan, Operable Unit I, Area of Concern 1, Former Hazardous Waste Management Facility* (BNL, March 2004) and the *Remedial Action Field Sampling Plan, Area of Concern 1, Former Hazardous Waste Management Facility* (Envirocon, October 2004). Soil and sediment were removed with an excavator and placed into a front-end loader bucket. Excavated materials were then either staged in an onsite soil stockpile, or direct loaded into railcars for shipment and final disposal at Envirocare of Utah (Envirocare).

According to the OU I ROD, the planned excavation volume for the Former HWMF Soils Removal Project was 35,000 CY. In process site characterization performed under the SI while the revision 6 baseline was being prepared resulted in an excavation volume estimate of 15,649 CY. An approximate total (pending Area K topographic surveys) of 13,500 cubic yards (CY) of soil and debris were shipped for disposal. Radiological surveys and onsite ISOCS analyses performed during remedial activities dictated the decreased excavation volume. In addition, an estimated 900 CY of contaminated soil was not excavated due to the planned future activities discussed below.

An area located in the northeast portion of the former HWMF was initially slated for remediation under the Former HWMF Soils Removal Project; however, a decision was subsequently made by BNL to de-scope that area, as it would be used for staging materials from other from remedial actions at BNL prior to being loaded into railcars for shipment and disposal. The estimated 900 CY of contaminated soil, designated as the Waste Loading Area on Figure 3-7-1, was not excavated as a result of this change in scope. The Waste Loading Area will be remediated in accordance with the cleanup goals specified in the OU I ROD upon the completion of waste loading activities associated with the demolition and decontamination work at BNL's reactors.


**Photograph 1 – Soil removal at the former HWMF.**

Soils contaminated above cleanup goals for Cs-137 and Sr-90 were excavated in one-foot lifts unless prescribed excavation depths were one foot or less. In these cases initial excavation lifts were slightly less than one foot. After each lift, excavations were surveyed with a collimated NaI gamma scintillation detector. Further excavations were guided by the radiological survey results.

Except in several isolated areas where Sr-90 concentrations exceeded those of Cs-137 (Refer to Section 3.5.3 for the discussion on those areas), Cs-137 was the primary radiological contaminant that drove the remediation of the site. As a result, gamma count rates using field instruments (NaI gamma scintillation detectors) were used to identify areas requiring excavation to meet the site cleanup goals. An excavation action level of approximately 20,000 counts per minutes (cpm), uncorrected for background gamma count rates, was established as the criterion for determining when excavations were complete. This criterion was determined using a correlation between data from field radiological surveys, onsite ISOCS analyses, and offsite gamma spectroscopy analyses at Severn Trent Laboratories (STL). Correlation curves for instrument response and measured soil activity are presented as Figures 3-4 and 3-5.


**Photograph 2 – Excavating and surveying at the former HWMF.**

Survey units with levels of lead and mercury above cleanup goals were excavated to prescribed depths. In areas where chemical and radiological contamination were commingled, radiological surveys determined the final excavation depth and endpoint samples were collected to ensure cleanup goals were met for chemical contaminants. If endpoint sample results were above the project cleanup goals for lead and mercury, additional excavating was performed until endpoint concentrations were below those goals. Areas where soil was contaminated with lead and mercury concentrations above cleanup goals are shown on Figure 3-6. A map showing the final dimensions of the Class 1 and Class 2 survey units is presented as Figure 3-7-1.

## 3.3 Sub-surface Storage Structure Removals

In addition to excavating soils, several sub-surface storage structures were removed at the former HWMF. These structures included concrete and steel waste trenches, as well as corrugated, concrete, and clay pipes used for waste storage referred to as vertical holes and slant holes. Three additional structures were discovered and removed during remedial activities, referred to as discovered underground structures. Approximately 490 CY of waste debris from the removal of sub-surface storage structures was size reduced and loaded into rail cars for disposal at Envirocare. Waste debris was size reduced to meet the Envirocare Waste Acceptance Criteria (WAC). The locations of sub-surface structures are shown on the former HWMF site plan (Figure 1-4).

### 3.3.1 Trenches

Nine trenches were removed during remedial activities at the former HWMF, designated as C1 through C9. The soil adjacent to each trench was excavated until the structure was fully exposed. Excavated soils were surveyed in accordance with project soil screening procedures. Approximately 570 CY of soil were shipped for disposal.

A concrete crusher was used to remove and dismantle each trench. In addition to concrete, several of the trenches were lined with a steel jacket. Trench debris, including steel and concrete, was segregated, surveyed, and size reduced with a shear prior to being loaded into railcars for shipment and final disposal at Envirocare. Approximately 200 CY of trench debris were shipped for disposal.


**Photograph 3 – Uncovering trench at the former HWMF.**

### 3.3.2 Slant Holes and Vertical Holes

Eight slant holes (A-1 through A-8) and sixteen vertical holes (B-1 through B-16) were removed during remedial activities at the former HWMF. The slant holes consisted of either corrugated or steel pipe. The vertical holes consisted of either vitrified clay or concrete pipe. Prior to removal, a fixative spray was applied to the walls and bottoms of each structure, followed by an injection of a sand and cement grout to prevent the spreading of loose contamination. Overburden soils were excavated, surveyed, and segregated in accordance with project soil screening procedures. Soils contaminated above cleanup goals were either stockpiled or direct loaded in rail cars for disposal. Soils below cleanup goals were set aside and later used as backfill. Approximately 140 CY of soil were used as backfill and approximately 970 CY of soil were shipped for disposal.


**Photograph 4 – Applying fixative to slant-holes at the former HWMF.**

After each structure was exposed, it was removed with an excavator and size reduced. The waste debris, including corrugated pipe, concrete, steel, and vitrified clay was surveyed and segregated prior to being loaded into railcars for shipment and final disposal. Slant holes debris was placed in supersacks for contamination control purposes due to the presence of removable alpha activity (discussed below) prior to loading the material into railcars. Approximately 20 CY of slant holes debris and 20 CY of vertical holes debris were shipped for disposal.

Due to the presence of dispersible alpha contamination on piping associated with slant holes A-1 and A-2, additional controls were implemented during sizing and packaging operations. These controls included establishing a designated sizing area where the ground was covered with geotextile and plastic as well as managing the dispersible alpha contamination with water during sizing and packaging activities. In addition, representative samples were collected from these pipes to ensure compliance with the Envirocare WAC. These sample results are summarized in Section 3.6.1.

Elevated gamma dose rates of 1000 mrem/hr at contact were observed at the bottom of vertical hole B-4. The source was later determined to be two small Sr-90 needles. Upon the establishment of the proper radiological controls, the two Sr-90 needles were removed from the excavation area. As a result of BNL's activity estimate for Sr-90 of 180 micro curies, it was determined the objects did not meet Envirocare's WAC. The Sr-90 needles were transferred to the BNL Waste Management Division for disposition, and later transported to Los Alamos National Laboratory for final disposal.


**Photograph 5 – Removal of vertical hole at the former HWMF.**

### 3.3.3 Discovered Sub-surface Structures

Three additional sub-surface structures were encountered during remedial activities in Excavation Areas C and D, as shown on Figure 1-4. Each structure consisted of a steel trench approximately 22 feet (ft) long, 2 ft wide and 3 ft deep. The tops of the structures were at or just below grade. A four-course concrete block wall surrounded the sub-surface portions of the structures. The structures were filled to grade with soil.

**Photograph 6 – Discovered sub-surface structure as the former HWMF.**

The soils inside and adjacent to each structure were excavated until the four walls were fully exposed. Excavated soils were surveyed and in accordance with project soil screening procedures. Approximately 160 CY of soil adjacent to the structures were shipped for disposal.

The structures were removed and dismantled with a concrete crusher. Structure debris, including steel and concrete, was size reduced with a shearer and segregated prior to being loaded into railcars for shipment and final disposal. Approximately 50 CY of debris were shipped for disposal from the discovered sub-surface structures.

### 3.3.4 Building 444 Drywell and Building 445 Septic Tank/Leach Field

The Building 444 drywell and Building 445 septic tank were previously removed during the building decommissioning and decontamination field work. This work is documented in the *Former Hazardous Waste Management Facility Decontamination and Decommissioning Closeout Report* (BNL, November 2003). The Building 444 drywell was included in the final status survey as part of Excavation Area A, and included in the ORISE independent verification survey. The final status survey is discussed further in Section 3.5.

The Building 445 leach field, located southwest of Building 445 (see Figure 3-6), was excavated as part of the Former HWMF Soils Removal Project. The clean soil above the percolation pipes was excavated and stockpiled to the south of the leach field. Approximately one foot of contaminated soil was excavated from the leach field and stockpiled inside the former HWMF for disposal with other waste soil from the site. Post-excavation samples were collected and analyzed for total mercury. Hot spots that were above the project cleanup goal for mercury were re-excavated and re-sampled until the results were below the project cleanup goal. The associated endpoint sample results are presented in Table 3-8.

## 3.4 Concrete Slab Remedial Actions

Radiological surveys of the five building slabs (444, 445, 446, 448, and 447) and the concrete slab between excavation areas C and E (C/E Concrete Slab) were performed with a Ludlum Model 2221 scaler/ratemeter with a collimated two-inch-by-two-inch NaI detector in accordance with the project surveying procedures. Initial survey results indicated elevated gamma count rates that are summarized below in Table 3-1. Locations of the building slabs are illustrated on Figure 1-4.

**Table 3-1**
**Initial Concrete Slab Radiological Survey Results**

| Building Slab No. or Description | Approx. Surface Area ($ft^2$) | Approximate Range of Gamma Count Rate (NaI 2x2) |
|---|---|---|
| 444 | 1628 | 10,000 to 200,000 cpm |
| 445 | 3774 | 5,000 to 30,000 cpm |
| 446 | 1650 | 35,000 to 70,000 cpm |
| 447 | 576 | 2,000 to 6,000 cpm |
| 448 | 1575 | 30,000 to 300,000 cpm |
| C/E Concrete Slab | 192 | 7,000 to 46,000 cpm |

Portions of buildings slabs 444, 445, 446, 448 were determined to require further remedial action. The initial remedial action consisted of scabbling the surface (approx. one-quarter to three-quarter inch) of the concrete slabs. Isolated residual contamination was evident on a portion of the Building 448 slab after scabbling. This area of concrete was removed with a jackhammer. In addition, a small section of the northwest corner of the Building 445 slab was removed with the use of a backhoe. Approximately 10 CY of concrete slab debris was removed, loaded into railcars, and shipped to Envirocare for final disposal.

## 3.5 Final Status Surveys and Sampling

This section describes the methodology used for evaluating the concentrations of radiological and chemical contaminants of concern after completion of remediation activities. In addition, results of radiological surveys and analytical results for radionuclides and chemical contaminants are provided from soil sampling activities conducted during the course of the remediation of the site.

The primary scope of the project was remediation of contaminated soils, asphalt road areas, and removal of subsurface structures that were radiologically impacted from previous operations at the former HWMF.

As indicated in Section 3.2, excavation of radiologically contaminated soils was controlled by conducting excavation surveys with collimated gamma scintillation detectors. Gamma count rates were used to determine when the excavations were complete in each area. During excavation activities walkover surveys were performed and samples were collected and analyzed for Cs-137 using the onsite ISOCS unit. In addition, areas known to contain elevated Sr-90 concentrations were sampled and analyzed by beta scintillation or gas flow proportional counting methods to confirm that cleanup goals were met prior to initiating the final status survey. Following completion of the excavation surveys, a complete (100% coverage) GPS-based walkover survey was conducted using the collimated NaI scintillation detectors to document that radiological status of the survey unit.

Following completion of the walkover survey in each area, soil sampling was conducted to determine the post-remediation concentrations for the radionuclides of concern and to verify that the dose-based criteria established for the site had been met. For areas where chemical contaminants, i.e., mercury and lead, were present (based on SI data), soil sampling was also conducted to verify that cleanup goals for these contaminants were met. All soil samples were collected at depth of 0 to 6 inches from the bottom of the excavation in accordance with BNL EM-SOP-601, *Collection of Soil Samples, Rev. 1* (BNL, March 2003).

The residual radiological contamination that was present on concrete building foundations and structures within the fenced portion of the former HWMF was also evaluated. Final status surveys and dose assessments conducted for the building slabs are described in this section, as well as Section 3.7. The Waste Loading Area described in Section 3.2 was not included in the final status survey design; however the site conditions in this area were documented upon completion of the Former HWMF Soils Removal Project.

### 3.5.1 Acceptance Criteria

This section provides the radionuclide-specific acceptance criteria for the land areas at the former HWMF. The following references were used to develop the FSSP, acceptance criteria and ALARA analysis:

- MARSSIM, NUREG-1575, Rev.1, August 2000.
- NUREG-1549, July 1998, Decision Methods for Dose Assessment to Comply With Radiological Criteria for License Termination, NRC.

- NUREG/CR-5512, October 1999, Vol. 3, Residual Radioactive Contamination From Decommissioning. Parameter Analysis. Draft Report for Comment, NRC.

- RG DG-4006, August 31, 1999, Demonstrating Compliance with the Radiological Criteria for License Termination.

- NUREG-1727, September 15, 2000, NMSS Decommissioning Standard Review Plan.

- NUREG-1757, September 2002, Consolidated NMSS Decommissioning Guidance. Decommissioning Process for Materials Licensees.

- Argonne National Laboratory (ANL), July 2001, User's Manual For RESRAD Version 6, ANL/EAD-4, Argonne, IL.

- ANL, 1993, Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil, ANL/EAIS-8, Argonne, IL.


**Radionuclides of Concern**

A review of the *Remedial Action Field Sampling Plan, Area of Concern 1, Former Hazardous Waste Management Facility* (Envirocon, October 2004), RESRAD models previously performed for the site, former HWMF operational monitoring, and other historical documents and procedures was performed to identify all of the radionuclides potentially used at the site. The primary radionuclides of concern, based on exposure potential, were Sr-90, Cs-137 and Ra-226. Other radionuclides of concern that were monitored a include Am-241, Pu-238, Pu-239/240, U-234, U-235, U-238 and tritium.

**Derived Concentration Guideline Level (DCGL) for Soil**

The cleanup goal for radionuclides in soil was based on a total effective dose equivalent limit of 15 millirem per year above background as suggested in *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination* (OSWER Directive 9200.14-18) (EPA, August 1997). Cleanup levels were calculated using the RESRAD computer code, 15 millirem per year, the assumed future land use, and 50 to 100 years of continued DOE control.

The results of the radiological soil analyses for each survey unit were subjected to a hierarchy of analyses and statistical testing to determine whether the survey unit met the cleanup goals established for the site. First, survey units were identified that had 100% of the individual sample results below the $DCGL_W$. Second, the average value for each of the primary radionuclides was determined and compared to the $DCGL_W$. Third, a determination of whether Ra-226 was present in concentrations above normal background levels was performed. Fourth, the analytical data for each survey unit was evaluated to determine if the sum of the fractions was below 1.

For survey units with one or more individual sample results above the $DCGL_w$, additional statistical evaluations were used to determine whether the survey units met the specified cleanup goals. The Elevated Measurements Comparison (EMC) test was applied first. If the data set did not pass the EMC test, the Sign test was then used to determine whether the survey unit met the cleanup goals.

*MARSSIM* provides release criteria adjustments for elevated localized total contamination based on dose modeling of smaller areas. Such adjustments are made by applying "area factors" in an EMC test. This has also been referred to as "Hot Spot Criteria". Table 3-2 presents area factors (based upon *MARSSIM* guidance) to be used for elevated measurement comparisons and to determine sampling requirements in situations where the scan instrument's minimum detectable concentration is greater than the appropriate $DCGL_W$. The appropriate $DCLG_{EMC}$ values are calculated by multiplying the appropriate $DCGL_W$ and the area factors presented in Table 3-2.

$$DCGL_{EMC} = \text{Area Factor} * DCGL_W$$

The elevated measurement criterion is only applicable to Class 1 areas since elevated activity exceeding the $DCGL_W$ is not expected in Class 2 areas. For Class 1 soil survey units, individual activity measurements above the $DCGL_w$ may be allowed, providing the appropriate statistical evaluations are successfully completed.

One of these statistical tests to be performed for survey units with individual measurements above the $DCGL_w$ is the EMC or "sigma" test. The survey unit is considered to meet the EMC test if the formula meets the criterion specified in the following formula:

$$\frac{\delta}{DCGL} + \frac{(\text{average concentration in elevated area} - \delta)}{(\text{area factor for elevated area})(\text{DCGL})} < 1$$

The value of $\delta$ is the average of the measurements outside of any elevated areas. A separate term is included for each elevated reading exceeding the $DCGL_W$.

Based on the development of hot spot criteria for the site, small areas of elevated radioactivity (above the $DCGL_w$) were allowed to remain, provided the levels of contamination and the size of the areas of elevated radioactivity fell within the hot spot criteria. Table 3-2 lists the hot spot criteria for Cs-137. Table 3-3 lists the hot spot criteria for Sr-90.

**TABLE 3-2**
**MARSSIM Hot Spot Criteria for Cs-137**

| Max. Area (m²)[1] | Area Factor[2] | Allowable Hot Spot Soil Conc. (pCi/g Cs-137) |
|---|---|---|
| 1000 m2 | 1.1 | 74 pCi/g |
| 300 m2 | 1.3 | 87 pCi/g |
| 100 m2 | 1.4 | 94 pCi/g |
| 30 m2 | 1.7 | 114 pCi/g |
| 10 m2 | 2.4 | 161 pCi/g |
| 1 m2 | 3.0 | 200 pCi/g |

[1] Assumes a total survey unit area of 10,000 $m^2$
[2]From *MARSSIM* Table 5.6

**TABLE 3-3**
**MARSSIM Hot Spot Criteria for Sr-90**

| Max. Area (m²)[1] | Area Factor[2] | Allowable Hot Spot Soil Conc. (pCi/g Sr-90) |
|---|---|---|
| 1000 m2 | 1.23 | 18.5 pCi/g |
| 300 m2 | 4.07 | 61.1 pCi/g |
| 100 m2 | 11.9 | 179 pCi/g |
| 30 m2 | 38.2 | 573 pCi/g |

[1]Assumes a total survey unit area of 10,000 $m^2$
[2]For Sr-90, area factors were not available in the *MARSSIM*; therefore area factors were calculated using the same methodology as described therein for the other nuclides.

The release criteria for land areas are the average activity concentrations in soil (pCi/g) that correspond to the dose-based radiological criteria of 10 CFR, part 834. The limits are radionuclide specific and the sum of fractions (unity rule) must be applied to show compliance with the acceptance criteria. Tables 3-2 and 3-3 present the area factors (based on *MARSSIM* guidance) to be used for EMC for Cs-137 and Sr-90, respectively. The appropriate $DCGL_{EMC}$ values are calculated by multiplying the appropriate $DCGL_w$ by the appropriate area factors provided in these tables.

### 3.5.2 Survey Objective

The final status survey of each Class 1 and Class 2 survey units were designed in accordance with Chapter 5 of the *MARSSIM* and employed a triangular grid system. In the discussion that follows, the number of soil samples in a given survey unit is n.

The mean survey unit Cs-137, Ra-226 and Sr-90 concentrations were determined for each survey unit by calculating the weighted average of the n samples from that unit. If xi ±

σi is the Cs-137 concentration and its uncertainty for the ith sample in a survey unit, then the mean $\overline{x}$ and its uncertainty $\overline{\sigma x}$ for that survey unit are:

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} xi \text{ and } \overline{\sigma x} = \frac{1}{n}\sqrt{\sum_{i=1}^{n} \sigma i2}$$

All uncertainties are determined at the 95 percent confidence level (two standard deviations).

The mean survey unit Sr-90 concentration average $\overline{y}$ and its uncertainty $\overline{\sigma y}$ and the mean survey unit Ra-226 concentration average $\overline{z}$ and its uncertainty $\overline{\sigma z}$ were determined similarly.

The value D for use in applying the unity rule and its uncertainty σD are:

$$D = \frac{\overline{x}}{67\,pCi/g-1} + \frac{\overline{y}}{15\,pCi/g-1}\text{; and}$$

$$\sigma D = \sqrt{\left(\frac{\sigma x}{67\,pCi/g-1}\right)^2 + \left(\frac{\sigma y}{15\,pCi/g-1}\right)^2}$$

**Error! Reference source not found.**3-8 (from *MARSSIM* Figure D.3) illustrates the decision rule, except that the value 1 substitutes for the DCGL in the figure. The measurement distribution of D, f(δ), is centered at D, the true value of the application of the unity rule. This distribution is shown in the lower graph of Figure 3-8.

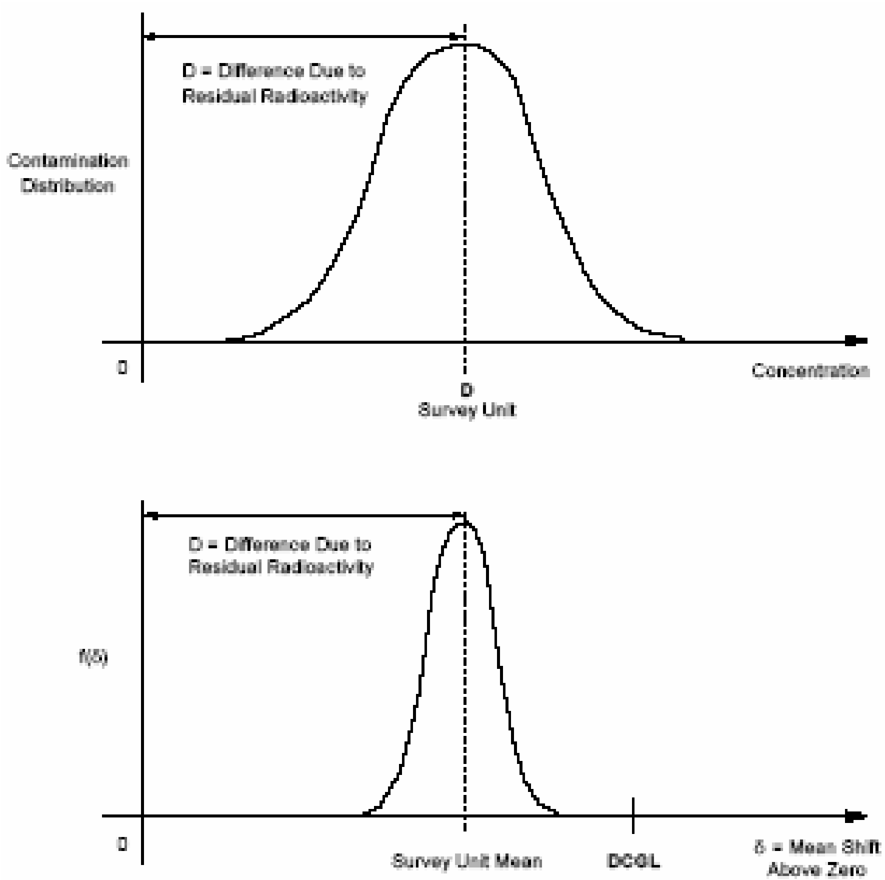


**Figure 3-8. Decision Rule Graph.**

As stated in *MARSSIM* Appendix D, "If f(δ) lies far to the left (or to the right) of [D = 1] [see *MARSSIM* Figure 5-1], a decision of whether or not the survey unit demonstrates compliance can be easily made. However, if f(δ) overlaps [D = 1], statistical decision rules are used to assist the decision maker."

Therefore, application of the results of the above calculations and the alternative actions leads to the following decision rules:

- If $\sigma D \leq 1 - D$ for a survey unit, then that survey unit meets the unity rule criterion at the 95 percent confidence level. No further action is required.

- If $-\sigma D \leq 1 - D \leq +\sigma D$ for a survey unit, then the survey of that survey unit is inconclusive at the 95 percent confidence level. An additional statistical test (the Sign test) is then used, as described in the *MARSSIM*. If the Sign test is also inconclusive, BNL personnel, in coordination with stakeholders and regulatory authorities, will decide the next course of action. Suggested further actions include spot remediation with or without periodic monitoring, or periodic monitoring until contamination has decayed and met the unity rule criterion.

- If $1 - D \leq -\sigma D$ for a survey unit, then that survey unit does not meet the unity rule criterion at the 95 percent confidence level. BNL personnel, in coordination with stakeholders and regulatory authorities, will decide the next course of action. Either land use restrictions with periodic monitoring until contamination has decayed and met the unity rule criterion or additional remediation followed by a another final status survey may be required.

The measured gamma count rates, exposure rates, and BetaScintTM results were compiled and analyzed similarly to provide additional information for the decision-making process. However, soil sample analytical results provided the primary data for decision-making.

Final status surveys were performed to demonstrate that average residual radioactivity levels within each survey unit meet the applicable acceptance criteria. The principal features of the final status survey land area protocol applied at the area are discussed in this report and include:

- Hypothesis Testing;
- Acceptable Decision Error Rates;
- Sign test;
- Establishing Radiological Background;
- Locating Discrete Soil Samples; and
- Scanning.

**Hypothesis Testing**

To provide statistically robust decisions regarding survey unit acceptability with respect to achieving the unrestricted use acceptance criteria approved for the survey area, the paired hypothesis testing approach was used. The paired hypotheses are the null, $H_O$, and alternative, $H_A$ statements. The null hypothesis $H_O$ poses that the measured average residual contamination in a survey unit *exceeds* the remedial objective (i.e., the $DCGL_W$ activity concentration). The complementary alternative hypothesis $H_A$ presumes that the measured average residual contamination in a survey unit is *at or below* the remedial objective. The outcome of hypothesis testing was used to ascribe a statistically based level of confidence or probability to the decision made regarding the "true" as-left condition of a survey unit.

A Type I decision error occurs when the null hypothesis is rejected when it is true and is sometimes referred to as a false positive error. The probability of making a Type I decision error, or the level of significance, is denoted by alpha ($\alpha$). Alpha reflects the amount of evidence the decision maker would like to see before abandoning the null hypothesis and is also referred to as the size of the test.

A Type II decision error occurs when the null hypothesis is accepted when it is false. This is sometimes referred to as a false negative error. The probability of making a Type

II decision error is denoted by beta ($\beta$). The term $(1 - \beta)$ is the probability of rejecting the null hypothesis when it is false and is also referred to as the power of the test.

Decisions made from the results of the final status survey were based primarily on radioanalysis of soil samples for Cs-137, Ra-226 and Sr-90 concentrations. Experience indicates that uncertainties in the analytical data are significantly less than the $DCGL_w$s. This means that application of the decision rules with uncertainties at the 95 percent confidence level provides a 5 percent probability for both alpha and beta, neglecting the uncertainty in the $DCGL_w$s.

**Decision Error Rates**

Survey unit radiological measurement data were used to objectively determine the success or failure of the remediation work, i.e., whether the "true" as-left radiological condition is at or below ("success"), or above ("failure"), the applicable remedial objective. This final status survey determination framework for the cleanup area are depicted in the matrix below.

Hypothesis Testing Matrix for Survey Unit Final Status Survey Measurement Decisions

| | | Survey Unit Decision | |
|---|---|---|---|
| | Hypothesis | *"Success"* (Reject $H_O$) | *"Failure"* (Accept $H_O$) |
| "True" Condition of the Survey Unit | **$H_A$** Meets remedial objective (e.g., at or below $DCGL_W$ value) | No decision error (probability = $1 - \alpha$) | Incorrectly fail to release survey unit (Type II error with probability = $\beta$) |
| | **$H_O$** Exceeds remedial objective (e.g., exceeds $DCGL_W$ value) | Incorrectly release survey unit (Type I error with probability = $\alpha$) | No decision error (probability = $1 - \beta$) |

"*Success*" means that the null hypothesis $H_O$ can be rejected and, therefore, the alternative hypothesis $H_A$ is to be accepted at a decision error confidence interval of $(1 - \alpha)$. The rejection of $H_O$ also means that there is a very small likelihood (equal to the interval $\alpha$) that the "success" decision is incorrect. Similarly, "*failure*" means that $H_O$ is accepted (and $H_A$ rejected) at a decision error confidence interval of $(1- \beta)$, with again a small likelihood (equal to $\beta$) that the failure decision is incorrect.

The error control Data Quality Objective (DQO) confidence intervals selected for the remediation area are $\alpha = 0.05$ for Type I errors and $\beta = 0.05$ for Type II errors. The Type

I error control DQO was selected because decisions regarding the success of remediation efforts directly affect the sustained protection of human health and environmental resources. The same DQO is used to cap conservative Type II decision errors because it is also important to limit unwarranted remediation.

The results of the statistical analysis are presented in Section 3.5.4.

### 3.5.3 Final Status Survey Design

Based on the size of the former HWMF and the duration of radiological operations that were conducted there, the entire portion of the site was considered as radiologically impacted. Those areas known or subsequently found to contain contamination levels above the cleanup goals (described below) were designated as Class 1 survey units in accordance with the *MARSSIM* guidelines. Remaining areas within the fenced portion of the site were designated as Class 2 survey units. This determination is supported by previous site characterization data and the presence of isolated hot spots in various areas throughout the site.

A two-step approach to cleanup confirmation for radiological soil contamination was followed using the *MARSSIM* approach at the former HWMF. The first step consisted of a GPS-based gamma scintillation walkover survey of remediated areas. Gamma walkover surveys were conducted using collimated two-inch-by-two-inch NaI detectors in conjunction with a Ludlum Model 2221 scaler/ratemeters, in accordance with the project soil screening procedures. The second step involved the collection of soil samples for on-site and offsite analysis to verify that residual radiological contamination levels were sufficiently low to meet the cleanup goals established for the site.

Class 1 survey units were established for soil remediation areas that contained radiological contamination above the cleanup goals prior to remedial activities. These were comprised of areas where soils and sub-surface structures were removed. The suggested maximum size area for a Class 1 survey unit is 2000 $m^2$ for soil areas. A total of 15 Class 1 survey units were established for the final status survey of soil excavation areas.

Class 2 survey units included areas that had the potential to become contaminated, but were not expected to exceed cleanup goals. A conservative survey approach was taken by classifying all areas inside of the fenced in former HWMF as Class 1 or Class 2 survey units even though not all of these areas were considered potentially contaminated. The suggested maximum size area for a Class 2 soil survey unit is 10,000 $m^2$. A total of 3 Class 2 survey units were established for the final status survey.

A random-start triangular grid patter for establishing the sample locations was set up in each survey unit. The spacing and number of sample locations in each survey unit was established using *MARSSIM* guidelines and Visual Sampling Plan (VSP) software.

Based on a series of ISOCS measurements of soil samples collected at the former HWMF during the early part of the project, the sample variability sigma ($\sigma$) was expected to be

18 pCi/g for Cs-137 soil contamination measurements in the Class 1 survey units. The Cs-137 $DCGL_w$ is 67 pCi/g and the Lower Bound of the Gray Region (LBGR) is 6.7pCi/g (Scan MDC value). The delta (Δ) is therefore 60.3. This corresponds to a relative shift (Δ/σ) of 3.35 and sample size of 14 using *MARSSIM* Table 5.5, using an error rate of 0.05 for both α and β. In accordance with the *MARSSIM* guidelines, an additional 20% was added to this value, which results in a sample density of approximately 17 samples per survey unit. Based on the size and configuration of the individual survey unit, slight adjustments in sample size were made for selected Class 1 survey units. Using the identical methodology as used for the Class 1 survey units, a sample size of 14 samples was calculated for Class 2 survey units.

Initial (starting point) sample locations for each survey unit were identified in the field with the aid of site landmarks. Subsequent sample locations were determined by taking field measurements with a tape measure or rope that had been cut to length to identify the proper spacing. The boundaries of the Class 1 and Class 2 survey units, as well as the associated sample locations are presented as Figure 3-7-1.

Surface soil samples were collected from the land surface to 6 inches (15 centimeters) below the surface in accordance with BNL EM-SOP-600, *Collection of Soil Samples, Rev. 1* (BNL, March 2003). The minimum volume per sample was one liter. Samples were thoroughly mixed and manually compacted as they were containerized into Marinelli beakers. Vegetation, animal matter, and rocks were excluded from the samples as much as reasonably possible.

Samples were immediately identified and labeled. The attached label included the sample ID number and date.

The sample identification code was SS05YYZZ, where "SS" denoted "surface soil sample," "05" refers to the year 2005, "YY" is the designator for the survey unit or reference area sampled, and "ZZ" is the sequential number to designate the samples. The location where each sample was collected was immediately cross-referenced with its sample identification code in project onsite records to assure proper correlation between analytical results and locations when the project report is prepared.

Sample results were averaged over a survey unit, samples were relatively large, disposable sample equipment was used, and any contribution of cross-contamination to uncertainties were negligible in comparison with statistical uncertainties in analysis results. Therefore, extensive cleaning of sampling equipment was not required. However, care was taken to prevent the transfer of sample material between samples from the same survey unit. No sample preparation steps were performed during the collection of the surface soil samples other than removal of non-soil material (grass, sticks, rocks, etc.).

Each sample collected to represent the final status of each survey unit was analyzed for Cs-137, Sr-90, and Ra-226. In addition, a single composite sample (composed of equal-sized aliquots from each of the discrete grab sample locations for each survey unit) was also prepared and analyzed for Am-241, Pu-238, Pu-239/240, U-234, U-235, U-238 and tritium.

In addition, there were several smaller areas within the former HWMF where characterization data indicated that Sr-90 was present in soil at higher concentrations than Cs-137. Additional Sr-90 sampling was performed in these areas to verify that additional excavation for Sr-90 was not required. These sample locations are illustrated on Figure 3-9.

Samples collected during the SI indicated that concentrations of Sr-90 could be found below the design excavation depth in the SB-37, SB-38, and SB-40 areas presented on Figure 3-9. Samples were collected in these areas with the use of a hand auger at the excavation depth indicated in the *Remedial Design Implementation Plan, Operable Unit 1, Area of Concern 1, Former Hazardous Waste Management Facility* (BNL, March 2004). Sr-90 results for these samples were 0.01 pCi/g, 0.12 pCi/g, and 0.07 pCi/g respectively.

The survey plan for concrete building slabs included fixed-point gamma count rate measurements at a distance of 1 meter above the surface of the slabs to approximate the whole body dose. The number and spacing of measurement locations was determined in accordance with *MARSSIM* guidelines. A total of 13 Class 1 survey units were established for the final status survey of the concrete slabs. The dimensions of the concrete slabs and the associated radiological survey points are presented as Figures 3-10-1 through 3-10-6. A summary of the radiological survey results is included as Appendix D.

A Class 1 survey was also performed on a soil pile containing material that was segregated during excavation activities to be later used as backfill for site restoration. In accordance with *MARSSIM* guidelines, the pile (65'x 30') was considered a single Class 1 survey unit. The sampling locations and dimensions for the clean soil pile are presented as Figure 3-11-1. The walkover survey results are presented as Figure 3-11-2.

Endpoint sample locations for Mercury and Lead were chosen in accordance with the *Remedial Design Implementation Plan, Operable Unit I, Area of Concern 1, Former Hazardous Waste Management Facility* (BNL, March 2004) and the *Remedial Action Field Sampling Plan, Area of Concern 1, Former Hazardous Waste Management Facility* (Envirocon, October 2004). These samples were shipped to STL for offsite analyses. Mercury and Lead sample locations are presented as Figure 3-6.

### 3.5.4 Final Status Survey and Sampling Results

The results of the final status radiological walkover survey exhibit count rates below 20,000 cpm for nearly all areas within the former HWMF and are less than 15,000 cpm for approximately 95% of the area. The 20,000 cpm count rate was determined to approximate the cleanup goal for Cs-137 in soil (67 pCi/g). Areas remaining that exceed 20,000 cpm, which were all less than 1 $m^2$ in size, are well within the hot spot criteria described above. The results from the final status radiological walkover survey are presented as Figure 3-7-2.

The results of soil sample results for each Class 1 and Class 2 survey unit are summarized in Table 3-4. According to the final status survey sample results, average concentrations for Cs-137 and Sr-90 are well below the cleanup goals of 67 pCi/g and 15 pCi/g, respectively. In addition, no sample results exceeded the cleanup goal of 5 pCi/g for Ra-226. Further, the results of the Ra-226 analyses indicate concentrations are at background levels. The site background level was previously determined to be 0.56 pCi/g (CDM, 1996). The average concentration measured at the former HWMF (based on 333 measurements) was 0.49 pCi/g.

All of the survey units also met the unity rule, i.e., the average Cs-137 concentration divided by its cleanup goal, plus the average concentration of Sr-90 divided by its cleanup goal was less than unity.

Of the fifteen Class 1 survey units, nine survey units had 100% of the individual sample results fall below the cleanup criteria for the three primary radionuclides of concern. Of the three Class 2 survey units, two survey units had 100% of the individual sample results fall below the cleanup criteria for the three primary radionuclides of concern.

There were seven survey units that had one or more individual sample locations that exceeded the cleanup goals for Cs-137 or Sr-90. The EMC test was run for survey units A, C3, D3, D4, K3, K4 and Z3. The size of the elevated measurement concentration area was determined by the ratio of the number of the total sample measurements that exceeded the $DCGL_w$ divided by the total number of sample locations times the area of the survey unit. This value was divided by the area factor in Table 3-2 (for Cs-137) or Table 3-3 (for Sr-90) to determine Sigma. The results of the EMC test are shown in the Table 3-5 below. As indicated in the table, some of the survey units failed this test. Consequently, they were subjected to the Sign test in order to determine whether these survey units met the applicable cleanup goals.

**Table 3-5**
**Summary of EMC Test Results**

| Survey Unit | Radionuclide | Size of EMC Area ($m^2$) | Size of Survey Unit ($m^2$) | Area Factor | Sigma[1] |
|---|---|---|---|---|---|
| A | Sr-90 | 63 | 2000 | 3.9 | .48 |
| C3 | Cs-137 | 45 | 675 | 1.2 | .95 |
| D3 | Cs-137 | 80 | 1436 | 1.2 | .90 |
| D3 | Sr-90 | 80 | 1436 | 2.2 | 1.01 |
| D4 | Sr-90 | 224 | 2014 | 1.2 | 1.87 |
| K3 | Cs-137 | 78 | 1405 | 1.2 | .91 |
| K4 | Cs-137 | 44 | 741 | 1.2 | 1.23 |
| Z3 | Cs-137 | 416 | 5829 | 1.2 | 1.22 |

[1]Pass criteria is any value less than or equal to one.

Survey unit C3, D3, K3, K4 and Z3 each had a single Cs-137 result that was above 67 pCi/g. The Cs-137 concentrations above the cleanup goal were 74 pCi/g, 71 pCi/g, 72 pCi/g, 96 pCi/g and 95 pCi/g, respectively. The average Cs-137 concentration for each of these survey units was well below the Cs-137 cleanup goal. Although these results are well within the Cs-137 hot spot criteria specified in Section 3.5.1, further statistical analysis of the data was performed.

In accordance with the *MARSSIM* guidelines, the Sign test was used to determine whether the survey units met the cleanup goal as a whole. Each of the five survey units had a critical value that was greater than the critical value specified in Table I.3 of *MARSSIM* for $\alpha = 0.05$. Since the critical values exceed the specified critical value for the sample size used, the null hypothesis (that the survey unit does not meet the cleanup goal) is rejected. Therefore further remediation of these survey units was not warranted.

There were three survey units that had one or more sample results that were greater than the cleanup goal of 15 pCi/g for Sr-90. Concentrations detected above the remediation goal were as follows. Survey unit A had a single sample result of 20.1 pCi/g. Survey unit D3 had a single sample result of 32.1 pCi/g. Survey unit D4 had two Sr-90 sample results above the cleanup goal. One sample result was 43.5 pCi/g and the second was 81.1 pCi/g. The average Sr-90 concentration for each of these survey units was well below the Sr-90 cleanup goal; however, further statistical analysis of the data was performed.

For survey units A, D3 and D4, a Sign test was performed in accordance with the *MARSSIM* guidelines. Survey unit A had a sample size of N=32. The critical value for this sample size at an Alpha value of 0.05 (95 percent confidence interval), is 21, per *MARSSIM* Table I.3. Both survey units D3 and D4 had a sample size of N=18. The critical value for this sample size is 12. The critical value for survey unit A was 31. Critical values for survey units D3 and D4 were 17 and 16, respectively. Since the critical values exceed the specified critical value for the sample size used, the null hypothesis (that the survey unit does not meet the cleanup goal) is rejected. Therefore further remediation of these survey units was not warranted. The Sign test results are summarized in Table 3-6 below.

**Table 3-6**
**Summary of Sign Test Results for Survey Units with Individual Sample Results Above the $DCGL_w$.**

| Survey Unit | Sample Size (N) | Radionuclide | Critical Value | MARSSIM Table I.3 Criterion |
|---|---|---|---|---|
| A | 32 | Sr-90 | 31 | 21 |
| C3 | 15 | Cs-137 | 14 | 11 |
| D3 | 18 | Cs-137, Sr-90 | 17 | 12 |
| D4 | 18 | Sr-90 | 16 | 12 |
| K3 | 18 | Cs-137 | 17 | 12 |
| K4 | 17 | Cs-137 | 16 | 12 |
| Z3 | 14 | Cs-137 | 13 | 10 |

A summary of the statistical tests for each survey unit is presented as Table 3-7.

In addition, composite sample results for alpha-emitting isotopes Am-241, Pu-238, Pu-239/240, U-238, U-235 and U-234, and tritium are were present below detection limits or at very low concentrations, i.e., less than 1 pCi/g. The composite samples were created by taking an equal size aliquot from each soil sample within the survey unit. Each composite sample was homogenized prior to analysis. While specific cleanup goals were not established for these isotopes, the resultant concentrations for all radionuclides for which sampling was conducted (excluding Ra-226 and other uranium series radionuclides, which are at background concentrations) were included as input to the RESRAD computer code used to conduct the radiological dose assessment for the project. This dose assessment is further discussed in Section 3.7.

Radioanalytical results for each sample collected are provided in Appendix A.

Chemical results for soil samples analyzed for mercury and lead also indicated that residual soil concentrations for these contaminants are within the respective cleanup goals for these contaminants, i.e., 400 mg/kg for lead and 1.84 mg/kg for mercury. The results of the chemical soil sampling are provided in Table 3-8.

### 3.5.5 Final Status Survey Conclusions

As indicated above, results of the final status survey and sampling following the completion of the remediation of the site demonstrate conformance to the site cleanup goals established in the OU I ROD and the former HWMF project plans. For each of the eighteen survey units, the average concentrations were within the specified $DCGL_w$ values for Cs-137, Sr-90 and Ra-226. Each survey unit also met the sum of the fractions criteria established as specified in The RI/FS and OU I ROD documents. Finally, the concentrations of isolated sample results that exceeded the $DCGL_w$ were shown to meet the $DCGL_{EMC}$ criteria and/or they passed the Sign test. Based on these results, each survey unit is determined to meet the cleanup goals established for the site.

Conformance with the radiological dose objective of 15 mrem/yr and the NYSDEC TAGM cleanup guideline of 10 mrem/yr is discussed in Section 3.7.

### 3.5.6 Final Status Survey Independent Verification

Independent Verification Surveys (IVSs) were conducted by an ORISE survey team. The ORISE survey team conducted surveying and sampling during three separate trips that were designed to support BNL by performing in process surveys of the completed survey units.

The first site visit occurred on April 17, 2005. During this visit, samples were collected from Survey Unit A. Seven samples were collected of the sediment from the bottom of the wetlands area.

A second ORISE site visit occurred from June 13-17, 2005. During this site visit, a complete walkover survey was conducted of Class 1 Survey Units A, C-1, C-2, C-3, D-1, D-2, D-3, D-4, D-5, D-6, and L and Class 2 survey units Z-1 and Z-2. In addition a total of 65 samples were collected.

A final ORISE site visit occurred from August 9-11, 2005. During this site visit, a complete radiological walkover survey was conducted of Class 1 Survey Units K1 through K4, Class 2 Survey Unit Z-3, and remediated hot spot locations within Class 1 Survey Unit C-1.

Results from these sampling events are presented in a separate ORISE Report included as Appendix E.

## ~~3.5~~3.6 Waste Management

### ~~3.5.1~~3.6.1 Waste Characterization and Handling

The waste management strategy, waste characterization, packaging, handling, and storage were performed in accordance with the *EM Waste Management Plan* (BNL, January 2002), the *Remedial Design Implementation Plan* (PWGC, March 2004), the *Waste Management Plan for the Former Hazardous Waste Management Facility Soil Remediation* (Envirocon, August 2004), and the *BNL Standard Based Management System*. Excavated soil and debris contaminated above cleanup goals were either stockpiled or direct loaded into railcars for shipment to Envirocare for final disposal. Small quantities of contaminated water were solidified with Waste Lock 770 or Zap Zorb and mixed with waste soils to be loaded and shipped for final disposal at Envirocare. Lime was temporarily used as a drying/solidifying agent for moist waste soils, however this practice was discontinued due to the resulting increase in soil pH levels. This issue is further discussed in Section 9.0.

**Photograph 7 – Stockpiled waste soils at the former HWMF.**

**Photograph 8 – Loading railcars with waste soil at the former HWMF.**

Waste verification sampling for soil and debris disposal was performed, in accordance with the *EM Waste Management Plan* (BNL, January 2002), at a frequency of 1 sample per five railcars (approximately 1 sample per 340 CY of soil). Samples were analyzed for the Envirocare suite of parameters, which includes complete TCLP, gamma spectroscopy, Strontium-90 analysis, alpha spectroscopy, gross beta, PCBs/Pesticides, and physical parameters (pH, Reactivity, flashpoint). Since 339 railcars were shipped from the former HWMF, a total of 62 waste verification samples were collected and analyzed by STL. According to these sample results, the soil and debris shipped met Envirocare's WAC. Waste verification sample results are provided in Tables 3-9 through 3-12.

Due to the presences of dispersible alpha contamination in Slant Holes A-1 and A-2 (discussed in Section 3.3.2), representative waste confirmation samples were collected from soil and debris contained within the pipes to ensure compliance with Envirocare's WAC. These samples were shipped to STL and analyzed by alpha spectroscopy. Maximum concentrations reported by STL were as follows: 1,950 pCi/g Cs-137; 10,800 pCi/g Sr-90; 9,200 pCi/g Pu-239/240; and 2,110 pCi/g Am-241. According to these results, debris from Slant Hoes A-1 and A-2 meet Envirocare's WAC.

The Former HWMF Soils Removal Project also received, loaded, and shipped approximately 3,900 CY of waste soil and debris from the Waste Concentration Facility – 811 Underground Tank Removal and Soil Remediation Project (811 Project). Waste confirmation sample data was received from the 811 Project prior to the shipment of this soil and debris. Waste confirmation data from the 811 Project is presented in *Closeout Report, Brookhaven National Laboratory, Operable Unit 1 Area of Concern (AOC) 10, Waste Concentration Facility, Volumes 1 & 2* (Weston Solutions, June 2005).

### ~~3.5.2~~3.6.2 Waste Shipment and Disposal

MHF, Incorporated; ECDC Logistics, LLC; and Cavanagh Services Group, LLC provided railcars for transportation of the waste soil and debris to Envirocare. After the railcars arrived on site, they were inspected and released for loading. The bottom of the inside of each railcar was covered with a geotextile liner and a Black Stallion® railcar liner was placed within each railcar prior to loading. Approximately 95-100 tons of waste was placed into each rail car. The weights of the soil and debris were determined utilizing a bucket scale on the front-end loader. After the waste was loaded into the railcar, the liner was closed/secured using tie wraps and bungee hooks for transport and secured into position. In addition, either a hard or soft tarp cover was secured over each railcar for shipment.

**Photograph 9 – Sealed Black Stallion® liner in railcar at the former HWMF.**

A total of 339 railcars were loaded and transported to Envirocare for final disposal, which equates to approximately 32,200 tons of material (including material from the 811 Project). Waste loading and shipping was initiated on October 20, 2004 and was completed on September 8, 2005. Waste soil and debris shipments tables are included in Appendix B.

### ~~3.5.3~~3.6.3 Pollution Prevention and Waste Minimization Opportunities

Waste minimization and pollution prevention methods employed during remedial activities at the former HWMF include:

- Operating equipment outside of the controlled areas as much as possible to minimize contact with contaminated areas;
- Lining loader buckets with spill sheets to reduce the spread of contamination;
- Constructing roads of reusable material for equipment traffic and minimizing the use of blue stone;
- Constructing run-on berms around excavations;
- Constructing a berm and raised fence at the north side of the railcar loading area to contain storm water inside the work site;

- Surveying and segregating clean and contaminated soils during sub-surface structure removals;
- Performing a Class 1 *MARSSIM* survey of a stockpile to ensure that it could be used as backfill;
- Size reducing waste to meet Envirocare's WAC; and
- Judicious use of consumables.

## ~~3.6~~3.7 Post Remediation Dose Assessment

A dose assessment was conducted to evaluate radiological dose impacts from residual radioactive materials remaining following the completion of the Former HWMF Soils Removal Project. The dose assessment for the soil excavation areas was conducted using the RESRAD computer code, version 6.3. The average site concentration for each radionuclide was used as input to the model (see Table 3-4). In addition, the code was run at the 95% upper confidence level (mean plus two standard deviations) as an additional measure of conservatism. In accordance with the RI/FS and OU I ROD, two potential radiological dose scenarios were evaluated following remediation. The first assessment considered the radiation dose to a hypothetical industrial worker after 50 years of institutional control. The second assessment considered the radiation dose to a future resident, assuming 100 years of institutional control.

Based on the results of the RESRAD model runs for the soil areas, the most significant contribution (>99 percent) of the projected radiation dose to the industrial worker was external gamma radiation from residual Cs-137. Therefore, in lieu of using RESRAD to evaluate project radiation doses to a hypothetical industrial worker, actual gamma dose rate measurements were used to develop the projected radiation dose from the building slabs. Gamma dose rates were measured with a gamma scintillation detector at a distance of one meter above the building slab surfaces. Survey units were established and measurements were taken using *MARSSIM* guidelines as discussed in Section 3.5. The results were then averaged to determine the average radiation dose for each building slab under current conditions. The results of the radiation survey measurements for the building slabs are provided in Figures 3-10-1 through 3-10-6. Radiation doses were then adjusted based on the 30.0 year half-life of Cs-137 to evaluate the future dose rates at 50 and 100 years post remediation.

Input parameters were identical to those used in the risk assessments performed as part of the RI/FS process.

For the industrial exposure scenario, a combined indoor/outdoor scenario was also evaluated, assuming 17% of the time outdoors and 6% of the time indoors. In addition, it was assumed that 50% of water consumption was from a groundwater well located at the remediated site.

Occupancy factors for the residential scenarios assumed 50% occupancy indoors and 25% occupancy outdoors.

Finally, an additional dose assessment was performed, which evaluated dose contributions from residual radioactive material in soils and the average dose from the building slabs. For this evaluation, the calculated dose was the average of the industrial worker dose (assuming average site soil concentrations) and the dose from working on the building slabs.

The results of the dose assessment indicate that the maximum projected dose to an industrial worker at Year 50 and the maximum projected dose to a resident at Year 100 at the former HWMF would be well below the dose objective of 15 mrem/yr established for the Former HWMF Soils Removal Project. The results also indicate that the NYSDEC TAGM guideline of 10 mrem/yr would also be met under each of the two scenarios described above. The results of the RESRAD computer modeling for each scenario are summarized in Table 3-17 below. Summary reports from the individual RESRAD code runs are provided in Appendix C.

**Table 3-17**
**RESRAD Computer Modeling Results Summary**

| Exposure Scenario | Soil Concentration Data | Occupancy Factors[1] | Former HWMF Location | Projected Dose at Year 0 (mrem/yr TEDE) | Projected Dose at Year 50 (mrem/yr TEDE) | Projected Dose at Year 100 (mrem/yr TEDE) |
|---|---|---|---|---|---|---|
| Industrial | Average | 17% Indoor<br>6% Outdoor | Soils | 5.4 | 1.8 | 0.6 |
| Industrial | 95% UCL | 17% Indoor<br>6% Outdoor | Soils | 11.8 | 4.0 | 1.4 |
| Residential | Average | 50% Indoor<br>25% Outdoor | Soils | 19.1 | 6.1 | 2.0 |
| Residential | 95% UCL | 50% Indoor<br>25% Outdoor | Soils | 44.9 | 14.5 | 4.7 |
| Industrial | Average | 23% Indoor | Building Slab 444 | 17.0 | 5.4 | 1.7 |
| Industrial | Average | 23% Indoor | Building Slab 445 | 9.0 | 2.8 | 0.9 |
| Industrial | Average | 23% Indoor | Building Slab 446 | 14.8 | 4.7 | 1.5 |
| Industrial | Average | 23% Indoor | Building Slab 447 | 2.6 | 0.8 | 0.3 |
| Industrial | Average | 23% Indoor | Building Slab 448 | 13.6 | 4.3 | 1.4 |
| Industrial | Average | 23% Indoor | C/E Slab | 18.6 | 5.9 | 1.8 |
| Industrial | Average | 23% Indoor | Building Slabs (Avg.) | 12.6 | 4.0 | 1.3 |
| Industrial | Average | 11% on Building Slabs<br>6% in Non-contaminated Buildings<br>6% Outdoors | Soils and Building Slab Surfaces | 9.0 | 2.9 | 1.0 |

[1]Based on 8760 hours per year.

### 3.8 Site Restoration

The excavation areas were backfilled with material from off-site sources as well as the on-site BNL Research Support Building Construction Project. All fill material was analyzed to ensure it complied with the NYSDEC TAGM 4046 guidelines. These results are summarized in Tables 3-13 through 3-16.

Backfill material was placed and compacted in 12-inch lifts to at least 90 percent of the maximum density as determined by ASTM D698. The material was placed in sufficient quantities to ensure drainage would not significantly accumulate in any area and potentially create a wetland. Topsoil was placed following the placement of backfill material. The topsoil was tested to ensure it complied with the NYSDEC TAGM 4046 guidelines. These results are summarized in Table 3-13 through 3-16.

Site restoration was completed in accordance with the *Remedial Design Implementation Plan* (PWGC, March 2004) with two exceptions:

- The site was seeded with native grass seed (at a rate of 2 pounds of seed per 1,000 $ft^2$ of disturbed soil area) instead of winter rye seed; and
- Three (3) inches of topsoil cover was placed instead of six (6) inches.

Wetland restoration was completed in accordance with the NYSDEC Wetlands Permit to support a habitat for the Tiger Salamander. Restoration consisted of backfilling the excavated portion of the wetland with nutrient-rich soil in areas where standing water was less than eight (8) inches in depth and replanting it with vegetation common to the area, including Sedges and Tussock Sedge. The seed mixture spread in the wetlands area included Little Bluestem, Switch Grass, Tioga Deer Tongue, Red Top, and Barnyard Grass. In areas where the standing water level was lower than what was projected, sedges were not planted and the seed mixture was supplemented with winter rye seed at a rate of 2 pounds of seed per 1,000 $ft^2$ of area. The backfill soil characteristics were chosen to ensure that the wetland could retain water and supply necessary nutrients to support the existing ecological habitat.

## 4.0 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

As discussed in Section 3.0, the average concentrations for Cs-137, Sr-90, and Ra-226 were well below the cleanup goals. The calculated radiological doses from all radioisotopes were also well below the levels stipulated in the OU I ROD. The isolated areas with mercury and lead contamination were excavated until the concentrations in those areas were below the cleanup goals of 1.84 mg/kg and 400 mg/kg respectively.

Physical and radiological inspections were conducted on both incoming and outgoing railcars. Inspections were also conducted on stormwater control measures as well as excavation operations. Excavation monitoring and field sampling procedures were also reviewed periodically.

Quality control/quality assurance (QA/QC) samples were collected in accordance with the Remedial Action Field Sampling Plan, Area of Concern 1, Former Hazardous Waste Management Facility (Envirocon, October 2004) and Collection and Frequency of Field Quality Control Samples, EM-SOP-200 (BNL, March 2003). A total of 19 field duplicates were collected. QA/QC results are summarized on Table 4-1.

# ~~6.0~~5.0 FINAL INSPECTION AND CERTIFICATIONS

As described in Section 3.5.4, IVSs were performed by ORISE upon the completion of final status surveys performed by Envirocon. These IVSs confirmed that the cleanup criteria were met for the Former HWMF Soils Removal Project.

A health and safety plan (HASP), the *Former Hazardous Waste Management Facility Soil Remediation Health and Safety Plan* (Envirocon, October 2004), was developed to address hazards associated with the Former HWMF Soils Removal Project. The information presented in the HASP was reviewed by the site employees prior to initiating the project work activities. A copy of the HASP was available onsite at all times for site employees to thoroughly review.

In addition to the HASP, Activity Hazard Analyses (AHAs) were written to highlight controls for specific tasks. The AHAs served as the primary procedure tool for ongoing hazard assessment and adjusting controls based upon employee suggestions, inspection findings, lessons learned, modification to work plans and procedures, and newly identified hazards. Site employees were expected to be familiar with and comply with all aspects of the AHAs.

Industrial hygiene (IH) and radiological monitoring were conducted in accordance with the *Community Air Monitoring Plan for the Former Hazardous Waste Management Facility Soil Remediation* (PWGC, January 2004), the *Former Hazardous Waste Management Facility Soil Remediation Health and Safety Plan* (Envirocon, October 2004), and the BNL Radiological Work Permit (RWP ERD04-06).

## *5.1 Industrial Hygiene Monitoring*

IH monitoring was conducted by Envirocon personnel. A designated Site Health and Safety Officer was onsite during remedial activities. IH monitoring included real-time particulate air monitoring with MIE, Inc. DataRAMs (DataRAM), since contaminant-laden dust was seen to offer the greatest exposure potential to the chemical contaminants of concern. Personal DataRAMs were deployed whenever the planned remedial activities were perceived to have the potential to produce dust (excavating, size reducing, loading). DataRAMs were also placed at the north, south, east, and west perimeters of the former

HWMF (work zone), as well as immediately downwind of remedial activities. The action level of 0.150mg/m$^3$, established in the *Community Air Monitoring Plan for the Former Hazardous Waste Management Facility Soil Remediation* (PWGC, January 2004), was not exceeded during the remedial activities.

Additional real-time IH monitoring instruments that were maintained onsite during remedial activities included a MuliRAE monitor with sensors for volatile organics, oxygen level, combustible gases, carbon monoxide, and nitrogen dioxide, as well as a Jerome Mercury Vapor Analyzer (MVA). The MultiRAE was maintained onsite to be deployed in the event of a site discovery that had the potential to produce volatiles. The MultiRAE was not utilized during this project. The MVA was used when remedial activities were carried out in areas of known mercury contamination, however there were no mercury vapor detections.

In addition to real-time air monitoring, air samples were also collected for metals and silica (as quartz). There were no metal detections and silica sample results were below the applicable permissible exposure limit. IH analytical data, real-time monitoring data sheets, and equipment analytical logs are available from Envirocon upon request.

### ~~6.~~25.2 Radiological Monitoring

Radiological monitoring was conducted by BNL Radiological Control Technicians (RCT)s. Continuous RCT coverage was provided during remedial activities. Radiological monitoring included both general area and personal lapel air sample collection. General area air samples were collected with SAIC low volume air samplers positioned downwind of remedial activities and at the soil and debris dumping/railcar loading area. Each individual entering the work zone, or one individual in each work group (individuals working together on a similar task), wore an AIRCHEK personal lapel air sampler. General area and personal lapel air sample results were used to track derived air concentration-hour (DAC-Hr) exposures. A hold point for DAC-Hr exposures was determined by calculating 20 percent of the DAC-Hr hold point for Americium-241. All general area and personal lapel air sample results were below this hold point (4 E-13 micro Ci/cubic centimeter).

Thermoluminescent dosimeters (TLD) were worn by each individual entering the work zone. Alarming dosimeters were worn in instances when workers had the potential to be exposed to high radiation. The ALARA goal for individual dose for the Former HWMF Soils Removal was 250 mrem. No worker received a dose exceeding 12 percent (30 mrem) of this goal over the duration of the project.

Workers entering the work zone were also required to have a whole body count prior to starting work on the project and at the end of the project, or on an annual basis. In addition workers were required to complete a whole body monitoring using a PCM-1B or equivalent hand held instrument each time they exited the site, in accordance with FS-SOP-4027, *Entry/Egress Requirements For Areas Controlled For Radiological Purposes* (BNL, January 2003).

In addition to personal and general area monitoring, equipment used during remedial activities was monitored for radiological contamination. All equipment that was released from the work zone was surveyed in accordance with FS-SOP-1005, *Radiological Surveys Required For Release Of Materials From Areas Controlled For Radiological Purposes* (BNL, October 2004).

# ~~7.0~~6.0 OPERATION AND MAINTENANCE ACTIVITES

Post remediation operation and maintenance activities at the former HWMF will be performed in accordance with the *Operable Unit 1 Soils and Operable Unit V Long-Term Monitoring and Maintenance Plan* (BNL, 2005) to ensure that land uses remain protective of public health and the environment. These activities will include inspections of site fencing, Tiger Salamander habitat monitoring and surveys, and institutional controls (warning notices, entry and access restrictions, land-use and real property controls, notifications and restrictions, digging permits, and government ownership). The clean fill and topsoil cover, placed during site restoration, will also be inspected for signs of erosion.

BNL's Long-Term Response Action Group (LTRA) will perform operation and maintenance activities. The LTRA Group Manager will ensure that the controls listed above are in place and routine monitoring is performed.

# ~~8.0~~7.0 PROTECTIVENESS

The removal of contaminated soils and associated structures at the former HWMF, as well as the implementation of monitoring and institutional controls will protect human health and the environment. The removal of these wastes has minimized both the risk of exposure to on-site workers and the risks associated with future-use scenarios by decreasing radiation dose levels at the site. These remedial actions have also minimized the potential for the migration of contaminants into the underlying groundwater. In addition, removal of contaminated soils in the wetlands area reduced the risk of exposure to the Tiger Salamander.

# ~~9.0~~8.0 FIVE YEAR REVIEW

Five-year reviews will be conducted to determine whether the remedy implemented continues to be protective of human health and the environment. These reviews will be performed in accordance with the *Comprehensive Five-Year Review Guidance, OSWER No. 9355.7-03B-P* (EPA, June 2001). The former HWMF will be included in the second sitewide Five-Year Review in 2010.

# ~~10.~~09.0 LESSONS LEARNED

The following is a summary of the lessons learned from this project and the corrective actions for future projects:

- The excavation process was most efficient when excavation proceeded in one area until the cleanup goal was reached rather than moving the excavation to another area to allow a walkover survey map to be generated between each excavation lift.

- The moisture content of soils, including frozen soils, to be loaded should be closely monitored to prevent liquids from leaking from railcars during transit. Lime should not be used as a solidifying/drying agent because it may increase the soil pH to levels that are unacceptable for the disposal facility. These lessons learned were shared throughout the DOE as part of the Transportation Improvement Review on Rail Shipments held on May 18-19, 2005 in Oak Ridge, Tennessee.

- Soft covers for railcars, if properly installed, can be used instead of hard covers. They are as effective in protecting the load from wind and precipitation during transit.

- A geophysical survey with ground penetrating radar should be considered during the investigation phase for sites of this size with several buildings that had been in use for decades. The results of this survey could be used to help identify borehole locations.

- The railcar loading process was modified to require covering the loaded cars the day they were loaded if inclement weather was forecasted. The National Weather Services web site, www.nws.noaa.gov, was an extremely effective tool for forecasting weather conditions. This procedural change minimized precipitation falling into loaded, but uncovered railcars.

- The railcar liners were upgraded from a system with ropes, to secure the liner between each of the nylon cable ties, to the Black Stallion® railcar liner with ratchet type nylon straps. The nylon straps proved to be superior to the rope in both the efficiency and quality of installation

- For railcars loaded with substantial amounts of debris, a non-woven geotextile was placed under the liner and above the Black Stallion® railcar liner. In addition, a second liner, fabricated of non-woven geotextile, was placed inside the liner package. Prior to loading the car with debris, a soil layer was placed in the railcar. The debris was topped off with another soil layer. These measures were effective in preventing damage to the liner package from the debris.

# 10.0 SUMMARY OF PROJECT COSTS

The remediation of soils and underground structures at the former HWMF cost approximately $9,700,000 to complete. This was just one part of the total cost of $27,860,000 estimated in the OU I ROD for radiologically contaminated soils. The cost summary presented in the OU I ROD included the remediation of the Building 811 UST's and soils, the Building 650 sump and outfall, chemical holes, landscape soils, and the building demolition at the former HWMF. The actual cost to complete these projects was approximately $31,000,000.

ENVIROCON

# ~~11.0~~11.0 REFERENCES


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TABLE 3-4
Former Hazardous Waste Management Facility
Final Status Survey Data Summary

| Survey Unit | MARSSIM Class | Cs-137 (pCi/g) Min | Cs-137 Max | Cs-137 Diff | Cs-137 Avg | Cs-137 Std Dev | Cs-137 No. samples below DCGL | Cs-137 Avg below DCGL | Sr-90 (pCi/g) Min | Sr-90 Max | Sr-90 Diff | Sr-90 Avg | Sr-90 Std Dev | Sr-90 No. samples below DCGL | Sr-90 Avg below DCGL | Ra-226 (pCi/g) Min | Ra-226 Max | Ra-226 Diff | Ra-226 Avg | Ra-226 Std Dev | Ra-226 No. samples below DCGL | Ra-226 Avg below DCGL | Composite Sample Results (pCi/g) Pu 238 | Pu 239/240 | U-234 | U-235 | U-238 | Am-241 | H3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 1 | 0.06 | 23.10 | 23.04 | 6.05 | 5.12 | 32 | 6.05 | 0.09 | 20.10 | 20.01 | 2.22 | 4.05 | 31 | 1.64 | 0.08 | 1.27 | 1.19 | 0.40 | 0.21 | 32 | 0.40 | 0.03 | 0.11 | 0.60 | 0.02 | 0.49 | 0.04 | 0.00 |
| C-1 | 1 | 0.19 | 41.80 | 41.61 | 5.37 | 8.69 | 25 | 5.37 | 0.10 | 6.95 | 6.85 | 1.01 | 1.47 | 25 | 1.01 | 0.26 | 1.08 | 0.82 | 0.52 | 0.17 | 25 | 0.52 | 0.00 | 0.02 | 0.65 | 0.04 | 0.54 | 0.04 | 0.69 |
| C-2 | 1 | 0.00 | 59.60 | 59.60 | 4.04 | 12.01 | 24 | 4.04 | 0.00 | 5.12 | 5.12 | 1.10 | 1.48 | 24 | 1.10 | 0.24 | 0.99 | 0.75 | 0.63 | 0.20 | 24 | 0.63 | 0.00 | 0.05 | 0.87 | 0.01 | 0.63 | 0.04 | 0.39 |
| C-3 | 1 | 1.78 | 74.00 | 72.22 | 15.62 | 18.77 | 14 | 11.45 | 0.15 | 3.79 | 3.64 | 1.06 | 0.96 | 15 | 1.06 | 0.13 | 0.54 | 0.41 | 0.40 | 0.10 | 15 | 0.40 | 0.00 | 0.10 | 0.36 | 0.01 | 0.43 | 0.02 | 0.52 |
| D-1 | 1 | 0.32 | 42.60 | 42.28 | 8.48 | 11.13 | 18 | 8.48 | 0.17 | 1.74 | 1.57 | 0.70 | 0.49 | 18 | 0.70 | 0.15 | 0.58 | 0.43 | 0.39 | 0.14 | 18 | 0.39 | 0.00 | 0.06 | 0.44 | 0.09 | 0.28 | 0.03 | 0.09 |
| D-2 | 1 | 0.03 | 16.50 | 16.47 | 2.49 | 3.99 | 18 | 2.49 | 0.00 | 12.60 | 12.60 | 1.49 | 2.96 | 18 | 1.49 | 0.21 | 1.28 | 1.07 | 0.50 | 0.25 | 18 | 0.50 | 0.00 | 0.00 | 0.55 | 0.02 | 0.57 | 0.09 | 0.00 |
| D-3 | 1 | 0.02 | 71.00 | 70.98 | 10.03 | 21.16 | 17 | 6.44 | 0.11 | 32.10 | 31.99 | 2.65 | 7.38 | 17 | 0.92 | 0.40 | 1.22 | 0.82 | 0.65 | 0.24 | 18 | 0.65 | 0.05 | 0.12 | 0.69 | 0.02 | 0.66 | 0.04 | 0.00 |
| D-4 | 1 | 0.02 | 12.90 | 12.88 | 2.82 | 3.78 | 18 | 2.82 | 0.16 | 81.10 | 80.94 | 8.60 | 20.85 | 16 | 1.89 | 0.20 | 0.87 | 0.67 | 0.52 | 0.21 | 18 | 0.52 | 0.04 | 0.01 | 0.47 | 0.00 | 0.43 | 0.00 | 0.16 |
| D-5 | 1 | 0.32 | 43.60 | 43.28 | 8.01 | 11.16 | 18 | 8.01 | 0.02 | 8.70 | 8.68 | 1.98 | 2.32 | 18 | 1.98 | 0.12 | 0.57 | 0.45 | 0.42 | 0.13 | 18 | 0.42 | 0.00 | 0.10 | 0.47 | 0.07 | 0.68 | 0.02 | 0.12 |
| D-6 | 1 | 0.03 | 11.20 | 11.17 | 2.96 | 3.30 | 18 | 2.96 | 0.01 | 4.43 | 4.42 | 1.16 | 1.10 | 18 | 1.16 | 0.23 | 0.86 | 0.63 | 0.58 | 0.19 | 18 | 0.58 | 0.03 | 0.08 | 0.76 | 0.02 | 0.60 | 0.00 | 0.07 |
| L | 1 | 1.10 | 44.60 | 43.50 | 11.60 | 11.01 | 17 | 11.60 | 0.00 | 0.66 | 0.66 | 0.25 | 0.20 | 17 | 0.25 | 0.33 | 0.69 | 0.36 | 0.52 | 0.11 | 17 | 0.52 | 0.00 | 0.31 | 0.55 | 0.02 | 0.48 | 0.11 | 0.00 |
| Z-1 | 2 | 0.54 | 29.70 | 29.16 | 5.19 | 7.55 | 14 | 5.19 | 0.03 | 0.84 | 0.81 | 0.43 | 0.29 | 14 | 0.43 | 0.32 | 0.53 | 0.21 | 0.41 | 0.06 | 14 | 0.41 | 0.01 | 0.18 | 0.60 | 0.07 | 0.53 | 0.02 | 0.00 |
| Z-2 | 2 | 0.02 | 10.10 | 10.08 | 2.47 | 3.00 | 14 | 2.47 | 0.00 | 2.49 | 2.49 | 0.51 | 0.57 | 14 | 0.51 | 0.21 | 0.61 | 0.40 | 0.36 | 0.11 | 14 | 0.36 | 0.01 | 0.20 | 0.27 | 0.01 | 0.41 | 0.01 | 0.02 |
| K-1 | 1 | 0.06 | 50.40 | 50.34 | 8.74 | 14.60 | 18 | 8.74 | 0.00 | 12.90 | 12.90 | 1.48 | 3.02 | 18 | 1.48 | 0.30 | 0.97 | 0.67 | 0.60 | 0.20 | 18 | 0.60 | 0.03 | 0.04 | 0.91 | 0.01 | 0.38 | 0.07 | 0.00 |
| K-2 | 1 | 0.02 | 23.20 | 23.18 | 4.03 | 6.17 | 18 | 4.03 | 0.00 | 0.93 | 0.93 | 0.28 | 0.26 | 18 | 0.28 | 0.16 | 1.13 | 0.97 | 0.42 | 0.24 | 18 | 0.42 | 0.03 | 0.01 | 0.31 | 0.03 | 0.27 | 0.04 | 0.00 |
| K-3 | 1 | 0.03 | 72.00 | 71.97 | 9.37 | 19.84 | 17 | 5.13 | 0.00 | 0.96 | 0.96 | 0.33 | 0.27 | 17 | 0.33 | 0.16 | 0.50 | 0.34 | 0.37 | 0.09 | 17 | 0.37 | 0.02 | 0.05 | 0.32 | 0.00 | 0.40 | 0.02 | 0.13 |
| K-4 | 1 | 0.02 | 96.00 | 95.98 | 16.90 | 25.63 | 16 | 11.96 | 0.13 | 8.20 | 8.07 | 1.27 | 1.91 | 17 | 1.27 | 0.18 | 0.86 | 0.68 | 0.49 | 0.20 | 17 | 0.49 | 0.06 | 0.10 | 0.74 | 0.05 | 0.57 | 0.00 | 0.01 |
| Z-3 | 2 | 0.98 | 95.00 | 94.02 | 13.13 | 25.81 | 13 | 6.83 | 0.10 | 1.64 | 1.54 | 0.67 | 0.43 | 14 | 0.67 | 0.38 | 0.85 | 0.47 | 0.63 | 0.14 | 14 | 0.63 | 0.00 | 0.00 | 0.61 | 0.03 | 0.76 | 0.12 | 0.03 |
| Avg. Site Conc. | | | | | 7.63 | | | | | | | 1.51 | | | | | | | 0.49 | | | | 0.02 | 0.08 | 0.57 | 0.03 | 0.51 | 0.04 | 0.12 |
| ROD Cleanup Goal | | | | | 67.00 | | | | | | | 15.00 | | | | | | | 5.00 | | | | | | | | | | |

(See Note Below)

Assumes a background concentration of 0.56 pCi/g Ra-226
Data is uncensored, i.e., actual concentrations are presented as reported from the lab, even if below the reported MDA.
Negative results are reported as 0.00.
Average concentration is an arithmetic mean of all sample results in each survey unit

**TABLE 3-7**

Former Hazardous Waste Management Facility
Screen Test and Statistical Test Report

| Survey Unit | MARSSIM Class | Cs-137 | | | | Sr-90 | | | | Ra-226 | | | | Sum of Fractions | Cleanup Goals Met |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $DCGL_W$ | $DCGL_{avg}$ | EMC | Sign Test | $DCGL_W$ | $DCGL_{avg}$ | EMC | Sign Test | $DCGL_W$ | $DCGL_{avg}$ | EMC | Sign Test | | |
| A | 1 | Pass | Pass | Pass | Pass | Failed | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| C-1 | 1 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| C-2 | 1 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| C-3 | 1 | Failed | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| D-1 | 1 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| D-2 | 1 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| D-3 | 1 | Failed | Pass | Pass | Pass | Failed | Pass | Fail | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| D-4 | 1 | Pass | Pass | Pass | Pass | Failed | Pass | Fail | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| D-5 | 1 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| D-6 | 1 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| L | 1 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| Z-1 | 2 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| Z-2 | 2 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| K-1 | 1 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| K-2 | 1 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| K-3 | 1 | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| K-4 | 1 | Pass | Pass | Fail | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |
| Z-3 | 2 | Pass | Pass | Fail | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Yes |

established as specified in The RI/FS and ROD documents. Finally, the concentrations of isolated sample results that exceeded the DCGLw were shown to meet the $DCGL_{EMC}$ criteria and/or they passed the Sign test. Based on these results, each survey unit is determined the meet the cleanup goals established for the site.

**TABLE 3-8**

Former Hazardous Waste Management Facility
Mercury and Lead Sample Results

| Sample ID | Date | Mercury results (mg/kg)[1] | Lead results (mg/kg)[2] | Chain of Custody |
|---|---|---|---|---|
| A-17 | 6/6/2005 | 0.054 | N/A | 21202 |
| A-18 | 6/6/2005 | 1.1 | N/A | 21202 |
| A-27 | 6/6/2005 | 0.056 | N/A | 21202 |
| A-28 | 6/6/2005 | 0.45 | N/A | 21202 |
| A-29 | 6/6/2005 | 0.095 | N/A | 21202 |
| C2-04 | 3/14/2005 | 0.03 | N/A | 20299 |
| C2-12 | 3/14/2005 | ND | N/A | 20299 |
| 445-02 | 1/14/2005 | 0.33 | N/A | 19820 |
| 445-04 | 1/14/2005 | 0.55 | N/A | 19820 |
| 445-07 | 1/14/2005 | ND | N/A | 19820 |
| 445-08 | 1/14/2005 | 0.025 | N/A | 19820 |
| 445-09 | 1/14/2005 | 0.06 | N/A | 19820 |
| 445-10 | 1/14/2005 | 0.026 | N/A | 19820 |
| 445-01A | 7/6/2005 | 0.061 | N/A | 20748 |
| 445-03A | 7/6/2005 | 0.18 | N/A | 20748 |
| 445-05D | 9/7/2005 | 0.14 | N/A | 21370 |
| H6-100A | 7/21/2005 | 1.3 | N/A | 20751 |
| 445-06B | 7/22/2005 | 0.012 | N/A | 20751 |
| K4-04 | 7/29/2005 | 0.025 | N/A | 20920 |
| K4-03 | 7/29/2005 | 0.12 | N/A | 20920 |
| K4-02 | 7/29/2005 | 0.15 | N/A | 20920 |
| K4-01 | 7/29/2005 | 0.0075 | N/A | 20920 |
| K4-05 | 7/29/2005 | 0.04 | N/A | 20920 |
| B-04-SW | 8/9/2005 | 0.47 | N/A | 20922 |
| B-05-SE | 8/9/2005 | 0.78 | N/A | 20922 |
| B-06-NW-B2 | 8/18/2005 | 0.85 | N/A | 20923 |
| B-06-NW-A4 | 8/20/2005 | 0.23 | N/A | 20924 |
| B-07-NE | 8/9/2005 | 0.17 | N/A | 20922 |
| A-17 | 6/6/2005 | N/A | 7.8 | 21202 |
| A-18 | 6/6/2005 | N/A | 11.9 | 21202 |
| A-27 | 6/6/2005 | N/A | 169 | 21202 |
| A-28 | 6/6/2005 | N/A | 68.1 | 21202 |
| A-29 | 6/6/2005 | N/A | 12.3 | 21202 |
| D-23 | 7/11/2005 | N/A | 6.6 | 20749 |

[1]Mercury analyzed per EPA SW-846 Method 7471A

[2]Lead analyzed per EPA SW-846 Method 3050B

**TABLE 3-9**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
TCLP Volatiles

| Parameter | Allowable Conc. | WCS01 | WCS02 | WCS03 | WCS04 | WCS05 | WCS06 | WCS07 | WCS08 | WCS09 | WCS10 | WCS11 | WCS12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Butanone | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Carbon Tetrachloride | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Chlorobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Chloroform | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,2-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,1-Dichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Tetrachloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Trichloroethene | ND | ND | ND | .015 J | ND | .015 J | .001 J | ND | ND | ND | ND | ND | ND |
| Vinyl chloride | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

| Parameter | Allowable Conc. | WCS13 | WCS14 | WCS15 | WCS16 | WCS17 | WCS18 | WCS19 | WCS20 | WCS21 | WCS22 | WCS23 | WCS24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Butanone | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Carbon Tetrachloride | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Chlorobenzene | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Chloroform | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,2-Dichloroethane | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,1-Dichloroethene | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Tetrachloroethene | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | 0.009 | ND | ND |
| Trichloroethene | ND | ND | ND | ND | NA | ND | ND | 0.009 | 0.009 | ND | ND | ND | ND |
| Vinyl chloride | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |

Concentrations in ppm

**TABLE 3-9**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
TCLP Volatiles

| Parameter | Allowable Conc. | WCS25 | WCS26 | WCS27 | WCS28 | WCS29 | WCS30 | WCS31 | WCS32 | WCS33 | WCS34 | WCS35 | WCS36 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Butanone | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Carbon Tetrachloride | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Chlorobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Chloroform | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,2-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,1-Dichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Tetrachloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Trichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Vinyl chloride | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

| Parameter | Allowable Conc. | WCS37 | WCS38 | WCS39 | WCS40 | WCS41 | WCS42 | WCS43 | WCS44 | WCS45 | WCS46 | WCS47 | WCS48 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Butanone | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Carbon Tetrachloride | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Chlorobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Chloroform | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,2-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,1-Dichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Tetrachloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Trichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Vinyl chloride | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

Concentrations in ppm

**TABLE 3-9**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
TCLP Volatiles

| Parameter | Allowable Conc | WCS49 | WCS50 | WCS51 | WCS52 | WCS53 | WCS54 | WCS55 | WCS56 | WCS57 | WCS58 | WCS59 | WCS60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Butanone | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Carbon Tetrachloride | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Chlorobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Chloroform | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,2-Dichloroethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,1-Dichloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Tetrachloroethene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Trichloroethene | ND | ND | ND | 0.011 J | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Vinyl chloride | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

**Concentrations in ppm**

| Parameter | Allowable Conc | WCS61 | WCS62 |
|---|---|---|---|
| Benzene | ND | ND | ND |
| 2-Butanone | NA | ND | ND |
| Carbon Tetrachloride | ND | ND | ND |
| Chlorobenzene | ND | ND | ND |
| Chloroform | ND | ND | ND |
| 1,2-Dichloroethane | ND | ND | ND |
| 1,1-Dichloroethene | ND | ND | ND |
| Tetrachloroethene | ND | ND | ND |
| Trichloroethene | ND | 0.016 J | ND |
| Vinyl chloride | NA | ND | ND |

**Concentrations in ppm**

TABLE 3-10

Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
TCLP Semi-volatiles, PCBs, Herbicides/Pesticides

| Parameter | Allowable Conc. | WCS01 | WCS02 | WCS03 | WCS04 | WCS05 | WCS06 | WCS07 | WCS08 | WCS09 | WCS10 | WCS11 | WCS12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pyridine | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,4-Dichlorobenzene | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Methylphenol | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 3-Methylphenol & 4-Methylphenol | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Nitrobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorobutadiene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,6-Trichlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,5-Trichlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4-Dinitrotoluene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Pentachlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| Aroclor 1016 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1221 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1232 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1242 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1248 | NA | ND | ND | ND | ND | ND | ND | ND | ND | 0.16 | ND | ND | ND |
| Aroclor 1254* | 0.928 | ND | ND | ND | 0.069 | ND | 0.054 | 0.26 | ND | 0.22 | ND | ND | ND |
| Aroclor 1260* | 4.10 E | 0.0001 | 0.0001 | ND | ND | ND | 0.084 | 0.2 | 0.048 | 0.33 | ND | ND | ND |
| | | | | | | | | | | | | | |
| Chlordane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Endrin | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| gamma-BHC (Lindane) | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Heptachlor | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Heptachlor epoxide | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Methoxychlor | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Toxaphene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| 2,4-D | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,5-TP (Silvex) | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

Concentrations in ppm

*PCB values referenced in Waste Management Plan

**TABLE 3-10**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
TCLP Semi-volatiles, PCBs, Herbicides/Pesticides

| Parameter | Allowable Conc. | WCS13 | WCS14 | WCS15 | WCS16 | WCS17 | WCS18 | WCS19 | WCS20 | WCS21 | WCS22 | WCS23 | WCS24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pyridine | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,4-Dichlorobenzene | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Methylphenol | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| 3-Methylphenol & 4-Methylphenol | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorethane | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Nitrobenzene | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorobutadiene | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,6-Trichlorophenol | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,5-Trichlorophenol | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4-Dinitrotoluene | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorobenzene | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Pentachlorophenol | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| Aroclor 1016 | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1221 | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1232 | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1242 | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1248 | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1254 | 0.928 | ND | ND | 0.26 | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1260 | 4.10 E | ND | ND | 0.22 | NA | 0.044 | ND | 0.057 | 0.051 | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| Chlordane | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Endrin | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| gamma-BHC (Lindane) | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Heptachlor | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Heptachlor epoxide | NA | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Methoxychlor | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Toxaphene | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| 2,4-D | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,5-TP (Silvex) | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |

Concentrations in ppm

*PCB values referenced in Waste Management Plan

**TABLE 3-10**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
TCLP Semi-volatiles, PCBs, Herbicides/Pesticides

| Parameter | Allowable Conc. | WCS25 | WCS26 | WCS27 | WCS28 | WCS29 | WCS30 | WCS31 | WCS32 | WCS33 | WCS34 | WCS35 | WCS36 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pyridine | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,4-Dichlorobenzene | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Methylphenol | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 3-Methylphenol & 4-Methylphenol | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Nitrobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorobutadiene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,6-Trichlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,5-Trichlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4-Dinitrotoluene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Pentachlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| Aroclor 1016 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1221 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1232 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1242 | NA | ND | ND | ND | 0.18 | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1248 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1254 | 0.928 | ND | ND | 0.46 | ND | ND | ND | ND | ND | ND | 0.09 | ND | 0.21 |
| Aroclor 1260 | 4.10 E | ND | 0.88 | 1.00 | 0.96 | 0.47 | 0.31 | 0.13 | 0.36 | ND | 0.12 | 0.065 | 0.41 |
| | | | | | | | | | | | | | |
| Chlordane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Endrin | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| gamma-BHC (Lindane) | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Heptachlor | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Heptachlor epoxide | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Methoxychlor | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Toxaphene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| 2,4-D | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,5-TP (Silvex) | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

Concentrations in ppm

*PCB values referenced in Waste Management Plan

**TABLE 3-10**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
TCLP Semi-volatiles, PCBs, Herbicides/Pesticides

| Parameter | Allowable Conc. | WCS37 | WCS38 | WCS39 | WCS40 | WCS41 | WCS42 | WCS43 | WCS44 | WCS45 | WCS46 | WCS47 | WCS48 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pyridine | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,4-Dichlorobenzene | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Methylphenol | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 3-Methylphenol & 4-Methylphenol | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Nitrobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorobutadiene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,6-Trichlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,5-Trichlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4-Dinitrotoluene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Pentachlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| Aroclor 1016 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1221 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1232 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1242 | NA | ND | ND | ND | 0.180 | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1248 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1254 | 0.928 | 0.11 | 0.240 | 0.065 | 0.450 | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1260 | 4.10 E | 0.098 | 0.130 | 0.150 | 0.500 | ND | 1.6 E | 2.6 D | 1.30 | 0.72 | 0.31 | 0.32 | 0.39 |
| | | | | | | | | | | | | | |
| Chlordane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Endrin | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| gamma-BHC (Lindane) | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Heptachlor | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Heptachlor epoxide | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Methoxychlor | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Toxaphene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| 2,4-D | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,5-TP (Silvex) | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

Concentrations in ppm

*PCB values referenced in Waste Management Plan

**TABLE 3-10**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
TCLP Semi-volatiles, PCBs, Herbicides/Pesticides

| Parameter | Allowable Conc | WCS49 | WCS50 | WCS51 | WCS52 | WCS53 | WCS54 | WCS55 | WCS56 | WCS57 | WCS58 | WCS59 | WCS60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pyridine | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,4-Dichlorobenzene | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Methylphenol | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 3-Methylphenol & 4-Methylphenol | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorethane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Nitrobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorobutadiene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,6-Trichlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,5-Trichlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4-Dinitrotoluene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorobenzene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Pentachlorophenol | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| Aroclor 1016 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1221 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1232 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1242 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1248 | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Aroclor 1254 | 0.928 | ND | 0.076 | ND | ND | ND | ND | ND | ND | 0.044 | 0.88 | 0.34 | ND |
| Aroclor 1260 | 4.10 E | 0.22 | 0.16 | 30 D | 0.59 | 0.052 | 0.109 | ND | 0.067 | 0.070 | 0.73 | 0.45 | 2 D |
| | | | | | | | | | | | | | |
| Chlordane | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Endrin | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| gamma-BHC (Lindane) | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Heptachlor | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Heptachlor epoxide | NA | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Methoxychlor | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Toxaphene | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| 2,4-D | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,5-TP (Silvex) | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

Concentrations in ppm

*PCB values referenced in Waste Management Plan

**TABLE 3-10**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
TCLP Semi-volatiles, PCBs, Herbicides/Pesticides

| Parameter | Allowable Conc. | WCS61 | WCS62 |
|---|---|---|---|
| Pyridine | ND | ND | ND |
| 1,4-Dichlorobenzene | NA | ND | ND |
| 2-Methylphenol | NA | ND | ND |
| 3-Methylphenol & 4-Methylphenol | NA | ND | ND |
| Hexachlorethane | ND | ND | ND |
| Nitrobenzene | ND | ND | ND |
| Hexachlorobutadiene | ND | ND | ND |
| 2,4,6-Trichlorophenol | ND | ND | ND |
| 2,4,5-Trichlorophenol | ND | ND | ND |
| 2,4-Dinitrotoluene | ND | ND | ND |
| Hexachlorobenzene | ND | ND | ND |
| Pentachlorophenol | ND | ND | ND |
| | | | |
| Aroclor 1016 | NA | ND | ND |
| Aroclor 1221 | NA | ND | ND |
| Aroclor 1232 | NA | ND | ND |
| Aroclor 1242 | NA | ND | ND |
| Aroclor 1248 | NA | ND | ND |
| Aroclor 1254 | 0.928 | ND | ND |
| Aroclor 1260 | 4.10 E | 0.38 | 0.69 |
| | | | |
| Chlordane | ND | ND | ND |
| Endrin | ND | ND | ND |
| gamma-BHC (Lindane) | NA | ND | ND |
| Heptachlor | ND | ND | ND |
| Heptachlor epoxide | NA | ND | ND |
| Methoxychlor | ND | ND | ND |
| Toxaphene | ND | ND | ND |
| | | | |
| 2,4-D | ND | ND | ND |
| 2,4,5-TP (Silvex) | ND | ND | ND |

Concentrations in ppm

*PCB values referenced in Waste Management Plan

**TABLE 3-11**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
Metals General Chemistry

| Parameter | Allowable Conc. | WCS01 | WCS02 | WCS03 | WCS04 | WCS05 | WCS06 | WCS07 | WCS08 | WCS09 | WCS10 | WCS11 | WCS12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 0.027 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Barium | 0.76 | .089 B | .118 B | .136 B | .310 B | .079 B | .142 B | .183 B | .206 B | .139 B | .125 B | .115 B | .102 B |
| Cadmium | 0.49 | ND | ND | ND | .009 B | ND | ND | .010 B | .004 B | ND | ND | ND | ND |
| Chromium | 0.206 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Lead | 0.56 | ND | ND | ND | ND | ND | ND | ND | .018 B | 0.183 | ND | ND | ND |
| Silver | 0.011 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Selenium | 0.029 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Copper | NA | .017 B | .012 B | ND | ND | ND | ND | .036 B | ND | ND | ND | ND | ND |
| Zinc | 1840 | .085 B | .031 B | .023 B | 0.598 | .018 B | 0.044 | 0.273 | .124 N | .096 BN | 0.044B | .180 B | .011 B |
| Mercury | 0.0645 | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.00028B | ND | ND |
| | | | | | | | | | | | | | |
| pH | 5-12 | 6.2 | 8.1 | 7.8 | 7.5 | 8.0 | 7.0 | 6.5 | 7.7 | 6.9 | 7.8 | 7.1 | 7.4 |
| Flashpoint | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F |
| Percent Moisture | 8-14.6% | 18.3 | 9.2 | 8.6 | 9.6 | 6.6 | 9.3 | 13.6 | 9.2 | 13.5 | 15.0 | 12.3 | 7.7 |
| Reactive Cyanide | ND | ND | ND | ND | ND | ND | 0.26B | ND | ND | ND | ND | ND | ND |
| Reactive Sulfide | 0.1 | ND | ND | ND | ND | ND | 36.8 | ND | ND | ND | ND | ND | ND |

| Parameter | Allowable Conc. | WCS13 | WCS14 | WCS15 | WCS16 | WCS17 | WCS18 | WCS19 | WCS20 | WCS21 | WCS22 | WCS23 | WCS24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 0.027 | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Barium | 0.76 | .097 B | .133 B | .222 B | NA | .169 B | .137 B | .067 B | .105 B | 0.044 B | 0.042 B | ND | .119 B |
| Cadmium | 0.49 | ND | .014 B | 0.026 | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Chromium | 0.206 | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Lead | 0.56 | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Silver | 0.011 | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Selenium | 0.029 | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Copper | | ND | ND | .011 B | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Zinc | 1840 | .013 B | .116 B | .190 B | NA | .053 B | .048 B | 0.019 | .046 B | 0.0246 B | 0.0227 B | .011 B | .014 B |
| Mercury | 0.0645 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| pH | 5-12 | 7.5 | 7.5 | 7.6 | NA | 7.6 | 7.4 | 7.8 | 7.4 | 6.6 | 7.7 | 7.7 | 7.8 |
| Flashpoint | >140° F | >140° F | >140° F | >140° F | NA | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F |
| Percent Moisture | 8-14.6% | 10.5 | 8.5 | 13.0 | NA | 14.2 | 16.9 | 9.3 | 12.3 | 9.4 | 7.1 | 9.0 | 14.0 |
| Reactive Cyanide | ND | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |
| Reactive Sulfide | 0.1 | ND | ND | ND | NA | ND | ND | ND | ND | ND | ND | ND | ND |

Concentrations in ppm

N- Spiked analyte recovery is outside stated control limits.

B- Estimated Result. Result is lower than reporting limit.

**TABLE 3-11**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
Metals General Chemistry

| Parameter | Allowable Conc. | WCS25 | WCS26 | WCS27 | WCS28 | WCS29 | WCS30 | WCS31 | WCS32 | WCS33 | WCS34 | WCS35 | WCS36 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 0.027 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Barium | 0.76 | .122 B | .364 B | .286 B | .240 B | 0.522 B | 0.725 B | 0.568 B | 0.612 B | 0.607 B | .194 B | .243 B | .220 B |
| Cadmium | 0.49 | ND | ND | .007 B | .010 B | ND | ND | ND | ND | 0.082 | .015 B | ND | .007 B |
| Chromium | 0.206 | ND | ND | ND | ND | ND | ND | ND | ND | 0.039 | ND | ND | ND |
| Lead | 0.56 | ND | 0.001 | ND | ND | ND | 0.724 | ND | ND | ND | ND | ND | ND |
| Silver | 0.011 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Selenium | 0.029 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Copper | | ND | 0.00 | .020 B | .019 B | .051 B | 0.302 | ND | .146 B | ND | 0.067 B | ND | ND |
| Zinc | 1840 | .020 B | 0.001 | 0.209 | 0.153 | 0.159 | 0.544 | 83.9 B | 0.155 | 0.628 | 0.117 | 0.119 | 0.124 |
| Mercury | 0.0645 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.00 B | ND |
| | | | | | | | | | | | | | |
| pH | 5-12 | 7.8 | 7.9 | 7.8 | 7.8 | 7.8 | 7.4 | 6.6 | 7.7 | 5.7 | 7.2 | 6.7 | 7.2 |
| Flashpoint | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F |
| Percent Moisture | 8-14.6% | 13.9 | 18.9 | 21.9 | 20.7 | 9.3 | 12.3 | 9.4 | 7.1 | 23.1 | 14.8 | 14.1 | 11.9 |
| Reactive Cyanide | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Reactive Sufide | 0.1 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

| Parameter | Allowable Conc. | WCS37 | WCS38 | WCS39 | WCS40 | WCS41 | WCS42 | WCS43 | WCS44 | WCS45 | WCS46 | WCS47 | WCS48 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 0.027 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Barium | 0.76 | .075 B | .087 B | ND | .176 B | .120 B | .147 B | .226 B,J | .333 B,J | 0.158 B | .188 B | .167 B | .161 B |
| Cadmium | 0.49 | ND | ND | ND | .006 B | ND | ND | ND | ND | ND | ND | ND | ND |
| Chromium | 0.206 | ND | ND | ND | ND | ND | ND | ND | .0151 B | ND | ND | ND | ND |
| Lead | 0.56 | ND | ND | ND | ND | ND | ND | ND | .168 B | ND | ND | ND | .205 B |
| Silver | 0.011 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Selenium | 0.029 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Copper | | ND | ND | ND | ND | ND | ND | .110 B | .0498 B | ND | .0384 B | ND | .0656 B |
| Zinc | 1840 | 0.109 | 0.092 B | .056 B | 2.25 | .987 B | .0485 B | .231 J | .169 J | .0702 B | .0513 B | .0553 B | 0.34 |
| Mercury | 0.0645 | 0.000 B | ND | ND | ND | ND | ND | .0081 B,J | .0084 B,J | .00029 B | ND | ND | ND |
| | | | | | | | | | | | | | |
| pH | 5-12 | 5.8 | 5.8 | 7.9 | 7.8 | 5.3 | 8.1 | 7.4 | 6.6 | 7.3 | 7.5 | 7.6 | 7.4 |
| Flashpoint | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F |
| Percent Moisture | 8-14.6% | 15.2 | 14.7 | 6.7 | 10.8 | 9.1 | 7.8 | 8.5 | 9.3 | 11.7 | 10.7 | 9.6 | 13.1 |
| Reactive Cyanide | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| *Reactive Sufide* | 0.1 | ND | ND | ND | ND | 13.2 B | ND | ND | ND | ND | 33.6 | ND | ND |

Concentrations in ppm

N- Spiked analyte recovery is outside stated control limits.

B- Estimated Result. Result is lower than reporting limit.

**TABLE 3-11**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
Metals General Chemistry

| Parameter | Allowable Conc. | WCS49 | WCS50 | WCS51 | WCS52 | WCS53 | WCS54 | WCS55 | WCS56 | WCS57 | WCS58 | WCS59 | WCS60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 0.027 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Barium | 0.76 | 0.149 B | 0.119 B | .165 B | .126 B | .121 B | .0848 B | .245 B | .161 B | .171 B | .220 B | .226 B | .262 B |
| Cadmium | 0.49 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | .0082 B |
| Chromium | 0.206 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Lead | 0.56 | 0.118 B | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Silver | 0.011 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Selenium | 0.029 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Copper | | ND | .0276 B | .0316 B | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Zinc | 1840 | 0.0722 B | .0561 B | 0.126 | 0.089 | .0807 B | .0763 B | .0646 B | .0456 B | .0751 B | 0.180 | 0.228 | 0.106 |
| Mercury | 0.0645 | ND | ND | .0025 B | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | | | | | | | | | | | | | |
| pH | 5-12 | 8 | 7 | 7 | 6.9 | 6.8 | 5.7 | 6.4 | 6.6 | 5.8 | 7.9 | 7.5 | 7.2 |
| Flashpoint | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F | >140° F |
| Percent Moisture | 8-14.6% | 4.8 | 6.4 | 13.2 | 9 | 6.4 | 7.1 | 7.2 | 6.2 | 6.5 | 6.5 | 5.9 | 6.8 |
| Reactive Cyanide | ND | ND | ND | ND | ND | ND | 0.075 B | ND | ND | ND | 0.032 B | ND | 0.032 B |
| Reactive Sufide | 0.1 | ND | ND | ND | 24.4 | ND | ND | ND | ND | ND | ND | ND | 29.8 |

| Parameter | Allowable Conc. | WCS61 | WCS50 |
|---|---|---|---|
| Arsenic | 0.027 | ND | ND |
| Barium | 0.76 | 0.216 B, J | 0.233 B, J |
| Cadmium | 0.49 | ND | ND |
| Chromium | 0.206 | ND | ND |
| Lead | 0.56 | 0.118 B | ND |
| Silver | 0.011 | ND | ND |
| Selenium | 0.029 | ND | ND |
| Copper | | ND | .0276 B |
| Zinc | 1840 | 0.0625 B, J | 0.0522 B, J |
| Mercury | 0.0645 | ND | ND |
| | | | |
| pH | 5-12 | 8.7 | 8.9 |
| Flashpoint | >140° F | >140° F | >140° F |
| Percent Moisture | 8-14.6% | 7.4 | 4.6 |
| Reactive Cyanide | ND | ND | ND |
| Reactive Sufide | 0.1 | ND | ND |

Concentrations in ppm

N- Spiked analyte recovery is outside stated control limits.

B- Estimated Result. Result is lower than reporting limit.

**TABLE 3-12**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
Radiological Analyses

| Parameter | Maximum Allowable Conc. | WCS01 | Uncertainty (+/-) | WCS02 | Uncertainty (+/-) | WCS03 | Uncertainty (+/-) | WCS04 | Uncertainty (+/-) | WCS05 | Uncertainty (+/-) | WCS06 | Uncertainty (+/-) | WCS07 | Uncertainty (+/-) | WCS08 | Uncertainty (+/-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Americium 241 | 8200 | ND | 0.26 | ND | 0.34 | ND | 0.91 | ND | 0.61 | 5.7 | 4.5 | ND | 0.93 | ND | 0.63 | ND | 0.29 |
| Beryllium 7 | 5000 | ND | 2.1 | ND | 3.0 | ND | 19 | ND | 7 | ND | 17 | ND | 8.3 | ND | 3.3 | ND | 1.7 |
| Cesium 134 | 15,000 | ND | 0.14 | ND | 0.17 | ND | 0.8 | ND | 0.39 | ND | 0.91 | ND | 0.49 | ND | 0.32 | ND | 0.22 |
| Cesium 137 | 2.00E+06 | 133 | 21 | 325 | 53 | 12,000 | 1800 | 1890 | 260 | 6380 | 940 | 1710 | 270 | 720 | 120 | 411 | 63 |
| Cobalt 57 | 10,000 | ND | 0.091 | ND | 0.13 | ND | 0.45 | ND | 0.28 | ND | 0.68 | ND | 0.33 | ND | 0.22 | ND | 0.13 |
| Cobalt 60 | 1000 | ND | 0.055 | ND | 0.042 | ND | 0.085 | .29 J | 0.1 | 0.41 | 0.18 | ND | 0.057 | 0.32 | 0.12 | 10.8 | 1.5 |
| Europium 152 | 4.00E+05 | ND | 0.34 | ND | 0.37 | ND | 2.5 | ND | 0.61 | ND | 2.4 | ND | 0.93 | ND | 0.46 | ND | 1.1 |
| Europium 154 | 5,000 | ND | 0.32 | ND | 0.32 | ND | 3.5 | ND | 0.8 | ND | 3.6 | ND | 1.4 | ND | 0.59 | ND | 1.1 |
| Europium 155 | 5,000 | ND | 0.33 | ND | 0.47 | ND | 1.7 | ND | 1 | ND | 2.5 | ND | 1.2 | ND | 0.83 | ND | 0.49 |
| Manganese 54 | 10,000 | ND | 0.038 | ND | 0.05 | ND | 0.42 | ND | 0.098 | ND | 0.43 | ND | 0.17 | ND | 0.067 | ND | 0.12 |
| Sodium 22 | 10,000 | ND | 0.050 | ND | 0.041 | ND | 0.260 | ND | 0.065 | ND | 0.230 | ND | 0.110 | ND | 0.051 | ND | 0.071 |
| Zinc 65 | 5000 | ND | 0.12 | ND | 0.095 | ND | 0.65 | ND | 0.19 | ND | 0.64 | ND | 0.25 | ND | 0.16 | ND | 0.29 |
| Potassium 40 | 5000 | 5.0 | 1.5 | 5.6 | 1.3 | ND[1] | 2.3 | 6.1 | 1.5 | ND | 1.3 | 4.5 | 1.7 | 7.3 | 1.8 | 5.6 | 1.6 |
| Plutonium 238 | 500 | ND | 0.0 | ND | 0.0 | ND | 0.0 | ND | 0.1 | ND | 0.3 | ND | 0.0 | ND | 0.1 | ND | 0.11 |
| Plutonium 239/240 | 1000 | 0.54 J | 0.16 | 0.059 J | 0.054 | .108 J | 0.082 | 0.31 J | 0.16 | .63 J | 4.4 | .28 J | 0.19 | 1.08 | 0.26 | .36 J | 0.14 |
| Strontium 90 | 25,000 | 4.26 | 0.92 | 1.02 J | 0.53 | 3.89 | 0.73 | 8.0 | 1.1 | 272 | 28 | 4.24 | 0.73 | 9.8 | 1.2 | 3.07 | 0.66 |

| Parameter | Maximum Allowable Conc. | WCS09 | Uncertainty (+/-) | WCS10 | Uncertainty (+/-) | WCS11 | Uncertainty (+/-) | WCS12 | Uncertainty (+/-) | WCS13 | Uncertainty (+/-) | WCS14 | Uncertainty (+/-) | WCS15 | Uncertainty (+/-) | WCS16 | Uncertainty (+/-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Americium 241 | 5000 | ND | 0.44 | ND | 0.29 | ND | 0.29 | ND | 0.91 | ND | 0.24 | 3.10 J | 0.92 | ND | 0.39 | NA | NA |
| Beryllium 7 | 5000 | ND | 5.8 | ND | 2.4 | ND | 2.5 | ND | 7.3 | ND | 3.1 | ND | 5.9 | ND | 4.6 | NA | NA |
| Cesium 134 | 15,000 | ND | 0.3 | ND | 0.17 | ND | 0.16 | ND | 0.40 | ND | 0.18 | ND | 0.33 | ND | 0.25 | NA | NA |
| Cesium 137 | 2.00E+06 | 1090 | 160 | 151 | 22 | 171 | 27 | 1440 | 210 | 399 | 58 | 1460 | 210 | 696 | 97 | NA | NA |
| Cobalt 57 | 10,000 | ND | 0.21 | ND | 0.10 | ND | 0.11 | ND | 0.32 | ND | 0.12 | ND | 0.23 | ND | 0.18 | NA | NA |
| Cobalt 60 | 1000 | 1.06 | 0.25 | ND | 0.067 | ND | 0.056 | ND | 0.053 | ND | 0.041 | 5.78 | 0.84 | 0.43 | 0.12 | NA | NA |
| Europium 152 | 4.00E+05 | ND | 0.73 | ND | 0.34 | ND | 0.38 | ND | 0.09 | ND | 0.32 | ND | 0.97 | ND | 0.40 | NA | NA |
| Europium 154 | 5,000 | ND | 0.76 | ND | 0.23 | ND | 0.39 | ND | 0.89 | ND | 0.36 | ND | 1.1 | ND | 0.46 | NA | NA |
| Europium 155 | 5,000 | ND | 0.75 | ND | 0.40 | ND | 0.39 | ND | 1.2 | ND | 0.41 | ND | 0.80 | ND | 0.64 | NA | NA |
| Manganese 54 | 10,000 | ND | 0.065 | ND | 0.047 | ND | 0.047 | ND | 0.11 | ND | 0.045 | ND | 0.13 | ND | 0.054 | NA | NA |
| Sodium 22 | 10,000 | ND | 0.069 | ND | 0.044 | ND | 0.056 | ND | 0.058 | ND | 0.05 | ND | 0.087 | ND | 0.048 | NA | NA |
| Zinc 65 | 5000 | ND | 0.21 | ND | 0.12 | ND | 0.13 | ND | 0.18 | ND | 0.11 | ND | 0.25 | ND | 0.11 | NA | NA |
| Potassium 40 | 5000 | 5.5 | 1.5 | 6.3 | 1.6 | 9.9 | 2.3 | 6.1 | 1.6 | 6.9 | 1.5 | 5.6 | 1.4 | ND | 1.5 | NA | NA |
| Plutonium 238 | 500 | ND | 0.11 | ND | 0 | ND | 0.0 | ND | 0.0 | ND | 0.12 | ND | 0.1 | 0.64 J | 0.19 | NA | NA |
| Plutonium 239/240 | 1000 | 0.99 | 0.33 | ND | 0.17 | ND | 0.0 | ND | 0.063 | ND | 0 | .150 J | 0.089 | 48.8 | 4.1 | NA | NA |
| Strontium 90 | 25,000 | 3.36 | 0.62 | 0.0 J | 0.0 | 6.03 | 0.84 | 2.73 | 0.66 | 5.6 | 1.6 | ND | 1.0 | 104 | 11 | NA | NA |

Concentrations in µCi/g

Detectable concentrations in bold

J- Result is greater than sample detection limit but less than stated reporting limit.

TABLE 3-12
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
Radiological Analyses

| Parameter | Maximum Allowable Conc. | WCS17 | Uncertainty (+/-) | WCS18 | Uncertainty (+/-) | WCS19 | Uncertainty (+/-) | WCS20 | Uncertainty (+/-) | WCS21 | Uncertainty (+/-) | WCS22 | Uncertainty (+/-) | WCS23 | Uncertainty (+/-) | WCS24 | Uncertainty (+/-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Americium 241 | 5000 | ND | 0.61 | ND | 0.44 | ND | 0.29 | ND | 0.3 | ND | 0.72 | ND | 0.66 | ND | 0.12 | ND | 0.65 |
| Beryllium 7 | 5000 | ND | 5.2 | ND | 3.8 | ND | 2.4 | ND | 0.22 | ND | 6.4 | ND | 5.5 | ND | 0.61 | ND | 5.0 |
| Cesium 134 | 15,000 | ND | 0.31 | ND | 0.23 | ND | 0.15 | ND | 0.52 | ND | 0.39 | ND | 0.36 | ND | 0.06 | ND | 0.29 |
| Cesium 137 | 2.00E+06 | **800** | 120 | **505** | 78 | **228** | 35 | **500** | 4 | **1450** | 230 | **1270** | 200 | **11.3** | 1.8 | **770** | 110 |
| Cobalt 57 | 10,000 | ND | 1.9 | ND | 1.4 | ND | 0.91 | ND | 0.23 | ND | 2.3 | ND | 2.1 | ND | 0.28 | ND | 1.9 |
| Cobalt 60 | 1000 | ND | 0.027 | ND | 0.038 | ND | 0.042 | ND | 74 | ND | 0.056 | ND | 0.046 | ND | 0.038 | ND | 0.042 |
| Europium 152 | 4.00E+05 | ND | 1.4 | ND | 1.0 | ND | 0.65 | ND | 1.6 | ND | 1.7 | ND | 1.5 | ND | 0.19 | ND | 1.3 |
| Europium 154 | 5,000 | ND | 0.53 | ND | 0.45 | ND | 0.34 | ND | 0.062 | ND | 1.7 | ND | 1.5 | ND | 0.25 | ND | 0.64 |
| Europium 155 | 5,000 | ND | 0.85 | ND | 0.63 | ND | 0.41 | ND | 1.1 | ND | 1.0 | ND | 0.96 | ND | 0.14 | ND | 0.85 |
| Manganese 54 | 10,000 | ND | 0.065 | ND | 0.057 | ND | 0.038 | ND | 0.092 | ND | 0.2 | ND | 0.18 | ND | 0.019 | ND | 0.086 |
| Sodium 22 | 10,000 | ND | 0.049 | ND | 0.043 | ND | 0.025 | ND | 0.079 | ND | 0.12 | ND | 0.10 | ND | 0.04 | ND | 0.059 |
| Zinc 65 | 5000 | ND | 0.14 | ND | 0.13 | ND | 0.090 | ND | 0.16 | ND | 0.31 | ND | 0.25 | ND | 0.10 | ND | 0.15 |
| Potassium 40 | 5000 | **6.6** | 1.8 | **5.0** | 1.4 | ND | 1.4 | **4.3** | 0.5 | **4.0** | 1.2 | **3.8** | 1.1 | **4.1** | 0.6 | **3.5** | 1.0 |
| Plutonium 238 | 500 | ND | 0.12 | ND | 0.0 | ND | 0.12 | ND | 0.15 | ND | 0.45 | ND | 0 | ND | 0.14 | ND | 0.38 |
| Plutonium 239/240 | 1000 | ND | 0.069 | **0.093** | 0.073 | ND | 0.088 | **.32 J** | 0.07 | ND | 0.22 | ND | 0.33 | ND | 0.0 | ND | 0.29 |
| Strontium 90 | 25,000 | **0.91 J** | 0.43 | **0.73** | 0.52 | **1.27** | 0.7 | **12.9** | 0.9 | ND | 0.91 | ND | 0.86 | **26.9** | 2.9 | **16.6** | 1.9 |

| Parameter | Maximum Allowable Conc. | WCS25 | Uncertainty (+/-) | WCS26 | Uncertainty (+/-) | WC27 | Uncertainty (+/-) | WCS28 | Uncertainty (+/-) | WCS29 | Uncertainty (+/-) | WCS30 | Uncertainty (+/-) | WCS31 | Uncertainty (+/-) | WCS32 | Uncertainty (+/-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Americium 241 | 8200 | ND | 1.6 | ND | 1.0 | ND | 0.87 | ND | 0.78 | ND | 0.51 | ND | 1.0 | **7.3** | 1.5 | ND | 0.75 |
| Beryllium 7 | 5000 | ND | 14 | ND | 0.76 | ND | 6.9 | ND | 6.5 | ND | 4.1 | ND | 8.5 | ND | 6.7 | ND | 6.0 |
| Cesium 134 | 15,000 | ND | 0.84 | ND | 6.7 | ND | 0.38 | ND | 0.39 | ND | 0.26 | ND | 0.53 | ND | 0.41 | ND | 0.34 |
| Cesium 137 | 2.00E+06 | **4390** | 670 | **1410** | 0.41 | **1220** | 180 | **1130** | 170 | **500** | 0.78 | **2260** | 350 | **1420** | 220 | **1100** | 160 |
| Cobalt 57 | 10,000 | ND | 4.6 | ND | 220 | ND | 2.5 | ND | 2.2 | ND | 1.5 | ND | 3.0 | ND | 2.3 | ND | 2.1 |
| Cobalt 60 | 1000 | ND | 0.13 | **1.17** | 2.3 | **1.34** | 0.28 | **1.80** | 0.36 | ND | 0.038 | ND | 0.060 | ND | 0.08 | ND | 0.042 |
| Europium 152 | 4.00E+05 | ND | 3.5 | ND | 0.26 | ND | 1.8 | ND | 1.6 | ND | 1.1 | ND | 2.2 | ND | 1.8 | ND | 1.6 |
| Europium 154 | 5,000 | ND | 3.5 | ND | 1.8 | ND | 1.2 | ND | 1.1 | ND | 0.48 | ND | 1.9 | ND | 1.6 | ND | 0.90 |
| Europium 155 | 5,000 | ND | 2.1 | ND | 1.6 | ND | 1.1 | ND | 0.997 | ND | 0.67 | ND | 1.4 | ND | 1.1 | ND | 0.99 |
| Manganese 54 | 10,000 | ND | 0.43 | ND | 1.1 | ND | 0.13 | ND | 0.12 | ND | 0.067 | ND | 0.23 | ND | 0.2 | ND | 0.12 |
| Sodium 22 | 10,000 | ND | 0.26 | ND | 0.20 | ND | 0.094 | ND | 0.088 | ND | 0.059 | ND | 0.12 | ND | 0.12 | ND | 0.075 |
| Zinc 65 | 5000 | ND | 0.64 | ND | 0.12 | ND | 0.22 | ND | 0.23 | ND | 0.14 | ND | 0.33 | ND | 0.30 | ND | 0.18 |
| Potassium 40 | 5000 | **10.6** | 2.8 | **5.4** | 1.3 | **5.8** | 1.6 | **5.7** | 1.6 | **5.6** | 1.7 | **7.6** | 1.8 | ND | 1.5 | **5.9** | 1.5 |
| Plutonium 238 | 500 | ND | 0.0 | ND | 0.0 | ND | 0.43 | ND | 4.0 | ND | 0.21 | ND | 0.24 | **.57 J** | 0.35 | ND | 0.14 |
| Plutonium 239/240 | 1000 | **3.20** | 0.90 | **6.7 J** | 1.8 | **3.5 J** | 1.3 | ND | 3.4 | **.42 J** | 0.21 | ND | 0.17 | **66.5** | 9.1 | **.37 J** | 0.19 |
| Strontium 90 | 25,000 | **102** | 10 | **7.4** | 1.2 | **8.6** | 1.3 | **17.6** | 2.3 | **3.16** | 0.70 | **4.48** | 0.75 | **63.6** | 6.6 | **3.82** | 0.67 |

Concentrations in pCi/g

Detectable concentrations in bold

J- Result is greater than sample detection limit but less than stated reporting limit.

## TABLE 3-12
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
Radiological Analyses

| Parameter | Maximum Allowable Conc. | WCS33 | Uncertainty (+/-) | WCS34 | Uncertainty (+/-) | WCS35 | Uncertainty (+/-) | WCS36 | Uncertainty (+/-) | WCS37 | Uncertainty (+/-) | WCS38 | Uncertainty (+/-) | WCS39 | Uncertainty (+/-) | WCS40 | Uncertainty (+/-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Americium 241 | 8200 | ND | 1.3 | ND | 0.19 | 1.58 J | 0.93 | 0.43 J | 0.34 | ND | 0.51 | 1.58 J | 0.38 | ND | 0.61 | 2.5 J | 1.0 |
| Beryllium 7 | 5000 | ND | 11 | ND | 2.1 | ND | 6.6 | ND | 3.4 | ND | 4.1 | ND | 3.1 | ND | 5.3 | ND | 8.1 |
| Cesium 134 | 15,000 | ND | 0.70 | ND | 0.15 | ND | 0.37 | ND | 0.18 | ND | 0.23 | ND | 0.23 | ND | 0.32 | ND | 0.46 |
| Cesium 137 | 2.00E+06 | 3370 | 520 | 157 | 25 | 848 | 93 | 445 | 55 | 402 | 59 | 326 | 51 | 960 | 150 | 1660 | 240 |
| Cobalt 57 | 10,000 | ND | 3.8 | ND | 0.68 | ND | 2.3 | ND | 0.96 | ND | 1.5 | ND | 1.2 | ND | 1.9 | ND | 3.0 |
| Cobalt 60 | 1000 | ND | 0.083 | .138 J | 0.078 | 0.51 | 0.17 | ND | 0.079 | ND | 0.045 | ND | 0.043 | ND | 0.061 | ND | 0.090 |
| Europium 152 | 4.00E+05 | ND | 2.9 | ND | 0.53 | ND | 1.7 | ND | 0.81 | ND | 1.1 | ND | 0.86 | ND | 1.4 | ND | 2.1 |
| Europium 154 | 5,000 | ND | 2.8 | ND | 0.34 | ND | 1.1 | ND | 0.65 | ND | 0.48 | ND | 0.47 | ND | 1 | ND | 1.5 |
| Europium 155 | 5,000 | ND | 1.7 | ND | 0.29 | ND | 1.1 | ND | 0.42 | ND | 0.69 | ND | 0.52 | ND | 0.87 | ND | 1.4 |
| Manganese 54 | 10,000 | ND | 0.33 | ND | 0.043 | ND | 0.12 | ND | 0.077 | ND | 0.056 | ND | 0.061 | ND | 0.13 | ND | 0.18 |
| Sodium 22 | 10,000 | ND | 0.20 | ND | 0.052 | ND | 0.090 | ND | 0.072 | ND | 0.053 | ND | 0.046 | ND | 0.091 | ND | 0.095 |
| Zinc 65 | 5000 | ND | 0.49 | ND | 0.12 | ND | 0.23 | ND | 0.14 | ND | 0.093 | ND | 0.11 | ND | 0.20 | ND | 0.27 |
| Potassium 40 | 5000 | 8.4 | 2.3 | 7.8 | 1.9 | 7.6 J | 2.2 | 6.5 | 1.6 | 5.0 | 1.5 | 5.8 | 1.6 | 6.8 | 1.6 | 5.2 | 1.5 |
| Plutonium 238 | 500 | ND | 0.11 | ND | 0.0 | ND | 0.17 | ND | 0.17 | ND | 0.150 | ND | -0.19 | ND | 0.52 | ND | 0.22 |
| Plutonium 239/240 | 1000 | 0.41 | 0.19 | .60 J | 0.22 | 6.7 | 1.0 | 3.96 | 0.66 | ND | 0.087 | ND | 0.10 | .45 J | 0.35 | 14.3 | 2.0 |
| Strontium 90 | 25,000 | 1.31 J | 0.47 | ND | 0.46 | 398 | 40 | 17.0 | 1.9 | 0.0 J | 0.0 | 0.0 J | 0.0 | 0.0 J | 0.0 | 6.43 | 0.9 |

| Parameter | Maximum Allowable Conc. | WCS41 | Uncertainty (+/-) | WCS42 | Uncertainty (+/-) | WCS43 | Uncertainty (+/-) | WCS44 | Uncertainty (+/-) | WCS45 | Uncertainty (+/-) | WCS46 | Uncertainty (+/-) | WCS47 | Uncertainty (+/-) | WCS48 | Uncertainty (+/-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Americium 241 | 8200 | ND | 0.2 | ND | 2.0 | ND | 0.28 | ND | 0.65 | ND | 0.22 | ND | 0.22 | ND | 0.79 | ND | 0.99 |
| Beryllium 7 | 5000 | ND | 1.3 | ND | 17 | ND | 3.2 | ND | 5.3 | ND | 1.8 | ND | 1.9 | ND | 6.4 | ND | 8.2 |
| Cesium 134 | 15,000 | ND | 0.095 | ND | 0.98 | ND | 0.18 | ND | 0.29 | ND | 0.12 | ND | 0.11 | ND | 0.35 | ND | 0.46 |
| Cesium 137 | 2.00E+06 | 53.4 | 8.2 | 6440 | 950 | 348 | 59 | 710 | 100 | 109 | 17 | 116 | 18 | 1090 | 160 | 1460 | 210 |
| Cobalt 57 | 10,000 | ND | 0.5 | ND | 5.8 | ND | 1.1 | ND | 1.9 | ND | 0.65 | ND | 0.68 | ND | 2.3 | ND | 2.9 |
| Cobalt 60 | 1000 | ND | 0.034 | ND | 0.190 | ND | 0.049 | ND | 0.067 | ND | 0.048 | ND | 0.059 | 0.82 | 0.2 | ND | 0.077 |
| Europium 152 | 4.00E+05 | ND | 0.35 | ND | 4.2 | ND | 0.8 | ND | 1.3 | ND | 0.49 | ND | 0.5 | ND | 1.6 | ND | 2.1 |
| Europium 154 | 5,000 | ND | 0.32 | ND | 5.4 | ND | 0.38 | ND | 0.7 | ND | 0.34 | ND | 0.4 | ND | 0.98 | ND | 1.3 |
| Europium 155 | 5,000 | ND | 0.25 | ND | 2.5 | ND | 0.47 | ND | 0.9 | ND | 0.3 | ND | 0.31 | ND | 1 | ND | 1.3 |
| Manganese 54 | 10,000 | ND | 0.04 | ND | 0.65 | ND | 0.048 | ND | 0.077 | ND | 0.037 | ND | 0.035 | ND | 0.12 | ND | 0.17 |
| Sodium 22 | 10,000 | ND | 0.037 | ND | 0.36 | ND | 0.037 | ND | 0.051 | ND | 0.039 | ND | 0.047 | ND | 0.072 | ND | 0.072 |
| Zinc 65 | 5000 | ND | 0.097 | ND | 0.93 | ND | 0.08 | ND | 0.15 | ND | 0.096 | ND | 0.13 | ND | 0.18 | ND | 0.24 |
| Potassium 40 | 5000 | 4.9 | 1.6 | ND | ND | 6.1 | 1.6 | 5.3 | 1.5 | 7.8 | 1.7 | 6.6 | 1.7 | 5.4 | 1.5 | 6.1 | 1.7 |
| Plutonium 238 | 500 | ND | 0.09 | ND | -0.18 | ND | 0.13 | ND | 0 | ND | 0.15 | ND | 0.15 | ND | 0.17 | ND | 0.37 |
| Plutonium 239/240 | 1000 | .85 J | 0.3 | 0.48 J | 0.3 | .18 J | 0.14 | .51 J | 0.22 | 0.31 J | 0.17 | .68 J | 0.26 | .32 J | 0.17 | ND | 0.2 |
| Strontium 90 | 25,000 | 52.7 | 5.4 | 7.4 | 1.2 | 0.48 | 0.43 | 0.57 | 0.43 | 1.01 J | 0.56 | 2.39 J | 0.56 | 2.01 J | 0.64 | 4.73 | 0.69 |

Concentrations in pCi/g

Detectable concentrations in bold

J- Result is greater than sample detection limit but less than stated reporting limit.

**TABLE 3-12**
Former Hazardous Waste Management Facility
Waste Confirmation Sample Results
Radiological Analyses

| Parameter | Maximum Allowable Conc. | WCS49 | Uncertainty (+/-) | WCS50 | Uncertainty (+/-) | WCS51 | Uncertainty (+/-) | WCS52 | Uncertainty (+/-) | WCS53 | Uncertainty (+/-) | WCS54 | Uncertainty (+/-) | WCS55 | Uncertainty (+/-) | WCS56 | Uncertainty (+/-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Americium 241 | 8200 | ND | 0.5 | ND | 0.2 | ND | 0.4 | ND | 0.3 | ND | 0.3 | ND | 0.2 | ND | 0.2 | ND | 0.2 |
| Beryllium 7 | 5000 | ND | 4.4 | ND | 1.5 | ND | 3.3 | ND | 2.8 | ND | 2.2 | ND | 1.8 | ND | 1 | ND | 1.7 |
| Cesium 134 | 15,000 | ND | 0.28 | ND | 0.098 | ND | 0.18 | ND | 0.17 | ND | 0.12 | ND | 0.13 | ND | 0.07 | ND | 0.1 |
| Cesium 137 | 2.00E+06 | 600 | 92 | 55.3 | 8.2 | 240 | 35 | 273 | 42 | 137 | 20 | 133 | 21 | 26.8 | 4 | 108 | 17 |
| Cobalt 57 | 10,000 | ND | 1.6 | ND | 0.6 | ND | 1.2 | ND | 1.0 | ND | 0.8 | ND | 0.7 | ND | 0.4 | ND | 0.7 |
| Cobalt 60 | 1000 | ND | 0.036 | ND | 0.043 | ND | 0.050 | ND | 0.042 | ND | 0.036 | ND | 0.037 | ND | 0.036 | ND | 0.054 |
| Europium 152 | 4.00E+05 | ND | 1.1 | ND | 0.38 | ND | 0.82 | ND | 0.74 | ND | 0.57 | ND | 0.51 | ND | 0.26 | ND | 0.47 |
| Europium 154 | 5,000 | ND | 0.55 | ND | 0.3 | ND | 0.35 | ND | 0.41 | ND | 0.27 | ND | 0.33 | ND | 0.35 | ND | 0.32 |
| Europium 155 | 5,000 | ND | 0.72 | ND | 0.26 | ND | 0.53 | ND | 0.47 | ND | 0.37 | ND | 0.31 | ND | 0.2 | ND | 0.3 |
| Manganese 54 | 10,000 | ND | 0.072 | ND | 0.044 | ND | 0.059 | ND | 0.052 | ND | 0.041 | ND | 0.034 | ND | 0.041 | ND | 0.038 |
| Sodium 22 | 10,000 | ND | 0.044 | ND | 0.034 | ND | 0.066 | ND | 0.016 | ND | 0.035 | ND | 0.044 | ND | 0.046 | ND | 0.035 |
| Zinc 65 | 5000 | ND | 0.12 | ND | 0.1 | ND | 0.13 | ND | 0.099 | ND | 0.1 | ND | 0.095 | ND | 0.13 | ND | 0.074 |
| Potassium 40 | 5000 | 4.4 | 1.4 | 7.8 | 1.8 | 6.6 | 1.8 | 6.1 | 1.6 | 6 | 1.5 | 5.6 | 1.3 | 7.3 | 1.7 | 4.5 | 1.3 |
| Plutonium 238 | 500 | ND | 0.13 | ND | 0.24 | ND | 0.19 | ND | 0.18 | ND | 0.05 | ND | 0.12 | ND | 0.11 | ND | 0.19 |
| Plutonium 239/240 | 1000 | .17 J | 0.1 | .22 J | 0.2 | .26 J | 0.2 | .23 J | 0.2 | ND | 0.1 | ND | 0.1 | ND | 0.1 | 0.16 J | 0.1 |
| Strontium 90 | 25,000 | 2.36 | 0.6 | .61 J | 0.5 | 5.66 | 0.8 | 1.38 J | 0.5 | 0.81 J | 0.5 | 0.79 J | 0.4 | 0.92 J | 0.5 | ND | 0.4 |

| Parameter | Maximum Allowable Conc. | WCS57 | Uncertainty (+/-) | WCS58 | Uncertainty (+/-) | WCS59 | Uncertainty (+/-) | WCS60 | Uncertainty (+/-) | WCS61 | Uncertainty (+/-) | WCS62 | Uncertainty (+/-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Americium 241 | 8200 | ND | 0.4 | ND | 0.6 | ND | 1.0 | ND | 0.3 | ND | 0.24 | ND | 0.23 |
| Beryllium 7 | 5000 | ND | 2.8 | ND | 5.3 | ND | 7.4 | ND | 2 | ND | 1.9 | ND | 0.6 |
| Cesium 134 | 15,000 | ND | 0.16 | ND | 0.33 | ND | 0.43 | ND | 0.13 | ND | 0.13 | ND | 0.06 |
| Cesium 137 | 2.00E+06 | 226 | 33 | 1100 | 170 | 1630 | 240 | 110 | 17 | 106 | 16 | 121 | 19 |
| Cobalt 57 | 10,000 | ND | 1.0 | ND | 2.0 | ND | 2.9 | ND | 0.7 | ND | 0.69 | 0.81 | 0.69 |
| Cobalt 60 | 1000 | ND | 0.050 | 0.5 | 0.140 | ND | 0.056 | 0.263 | 0.096 | ND | 0.057 | 0.99 | 0.21 |
| Europium 152 | 4.00E+05 | ND | 0.72 | ND | 1.4 | ND | 1.9 | ND | 0.52 | ND | 0.51 | ND | 0.52 |
| Europium 154 | 5,000 | ND | 0.33 | ND | 1.3 | ND | 1.5 | ND | 0.38 | ND | 0.30 | ND | 0.43 |
| Europium 155 | 5,000 | ND | 0.46 | ND | 0.9 | ND | 1.3 | ND | 0.34 | ND | 0.32 | ND | 0.32 |
| Manganese 54 | 10,000 | ND | 0.04 | ND | 0.16 | ND | 0.17 | ND | 0.049 | ND | 0.040 | ND | 0.058 |
| Sodium 22 | 10,000 | ND | 0.035 | ND | 0.087 | ND | 0.086 | ND | 0.044 | ND | 0.076 | ND | 0.040 |
| Zinc 65 | 5000 | ND | 0.1 | ND | 0.24 | ND | 0.23 | ND | 0.14 | ND | 0.035 | ND | 0.11 |
| Potassium 40 | 5000 | 5.2 | 1.5 | 3.3 | 1 | ND | - | 6.4 | 1.7 | ND | - | 5.3 | 1.4 |
| Plutonium 238 | 500 | ND | 0.17 | ND | 0.00 | ND | 0.07 | ND | 0.07 | ND | 0.072 | ND | 0.08 |
| Plutonium 239/240 | 1000 | ND | 0.1 | 0.62 J | 0.2 | .57 J | 0.2 | 0.29 J | 0.2 | 0.28 J | 0.15 | 0.29 | 0.15 |
| Strontium 90 | 25,000 | ND | 0.3 | 9.2 | 1.2 | 2.5 J | 0.6 | 2.27 J | 0.6 | 4.56 | 0.83 | 3.56 | 0.63 |

Concentrations in pCi/g

Detectable concentrations in bold

J- Result is greater than sample detection limit but less than stated reporting limit.

**TABLE 3-13**

Site Restoration Materials

TAGM 4046 Recommended soil cleanup objectives

Volatile Organic Contaminants

| Contaminant | Rec. Soil Cleanup Objective (ppm)[1] | Topsoil Results (ppm) | On-site Fill Results (ppm) |
|---|---|---|---|
| Acetone | 0.2 | 0.007 | ND |
| Benzene | 0.06 | ND | ND |
| Benzoic Acid | 2.7 | ND | ND |
| 2-Butanone | 0.3 | ND | ND |
| Carbon Disulfide | 2.7 | ND | ND |
| Carbon Tetrachloride | 0.6 | ND | ND |
| Chlorobenzene | 1.7 | ND | ND |
| Chloroethane | 1.9 | ND | ND |
| Chloroform | 0.3 | ND | ND |
| Dibromochloro-methane | N/A | ND | ND |
| 1,2-Dichloro-benzene | 7.9 | ND | 0.001 |
| 1,3-Dichloro-benzene | 1.6 | ND | ND |
| 1,4-Dichloro-benzene | 8.5 | ND | ND |
| 1,1-Dichloroethane | 0.2 | ND | ND |
| 1,2-Dichloroethane | 0.1 | ND | ND |
| 1,1-Dichloroethene | 0.4 | ND | ND |
| 1,2-Dichloroethene (trans) | 0.3 | ND | ND |
| 1,3 dichloropropane | 0.3 | ND | ND |
| Ethylbenzene | 5.5 | ND | ND |
| 113 Freon (1,1,2 Trichloro-1,2,2 Trifluoroethane) | 6 | ND | ND |
| Methylene chloride | 0.1 | ND | 0.005 |
| 4-Methyl-2-Pentanone | 1 | ND | ND |
| Tetrachloroethene | 1.4 | ND | ND |
| 1,1,1-Trichloroethane | 0.8 | ND | ND |
| 1,1,2,2-Tetrachloro-ethane | 0.6 | ND | ND |
| 1,2,3-trichloro-propane | 0.4 | ND | ND |
| 1,2,4-trichloro-benzene | 3.4 | ND | ND |
| Toluene | 1.5 | ND | ND |
| Trichloroethene | 0.7 | ND | ND |
| Vinyl chloride | 0.2 | ND | ND |
| Xylenes | 1.2 | ND | ND |

[1]As per TAGM #4046, Total VOCs < 10 ppm.

ND Not Detected

<u>TABLE 3-14</u>

Site Restoration Materials
TAGM 4046 Recommended soil cleanup objectives
Semi-Volatile Organic Contaminants

| Contaminant | Rec. Soil Cleanup Objective (ppm) 1 | Topsoil Results (ppm) | On-site Fill Results (ppm) |
|---|---|---|---|
| Acenaphthene | 50.0[1] | ND | ND |
| Acenaphthylene | 41 | ND | ND |
| Aniline | 0.1 | ND | ND |
| Anthracene | 50.0[1] | ND | ND |
| Benzo(a) anthracene | 0.224 or MDL | ND | ND |
| Benzo (a) pyrene | 0.061 or MDL | ND | ND |
| Benzo (b) fluoranthene | 1.1 | ND | ND |
| Benzo (g,h,i) perylene | 50.0[1] | ND | ND |
| Benzo (k) fluoranthene | 1.1 | ND | ND |
| bis(2-ethylhexyl) phthalate | 50.0[1] | 10 | ND |
| Butylbenzylphthlate | 50.0[1] | ND | ND |
| Chrysene | 0.4 | ND | ND |
| 4- Chloroaniline | 0.220 or MDL | ND | ND |
| 4-Chloro-3-methylphenol | 0.240 or MDL | ND | ND |
| 2-Chlorophenol | 0.8 | ND | ND |
| Dibenzofuran | 6.2 | ND | ND |
| Dibenzo(a,h) anthracene | 0.014 or MDL | ND | ND |
| 3,3'-Dichlorobenzidine | N/A | ND | ND |
| 2,4-Dichlorophenol | 0.4 | ND | ND |
| 2,4-Dinitrophenol | 0.200 or MDL | ND | ND |
| 2,6 Dinitrotoluene | 1 | ND | ND |
| Diethylphthlate | 7.1 | ND | ND |
| Dimethylphthlate | 2 | ND | ND |
| Di-n-butyl phthalate | 8.1 | ND | ND |
| Di-n-octyl phthlate | 50.0[1] | ND | ND |
| Fluoranthene | 50.0[1] | 0.4 | ND |
| Fluorene | 50.0[1] | ND | ND |
| Hexachlorobenzene | 0.41 | ND | ND |
| Indeno (1,2,3-cd)pyrene | 3.2 | ND | 0.24 |
| Isophorone | 4.4 | ND | ND |
| 2-methylnaphthalene | 36.4 | ND | ND |
| 2-Methylphenol | 0.100 or MDL | ND | ND |
| 4-Methylphenol | 0.9 | ND | ND |
| Naphthalene | 13 | ND | ND |
| Nitrobenzene | 0.200 or MDL | ND | ND |
| 2-Nitroaniline | 0.430 or MDL | ND | ND |
| 2-Nitrophenol | 0.330 or MDL | ND | ND |
| 4-Nitrophenol | 0.100 or MDL | ND | ND |
| 3-Nitroaniline | 0.500 or MDL | ND | ND |
| Pentachlorophenol | 1.0 or MDL | ND | ND |
| Phenanthrene | 50.0[1] | 0.24 | ND |
| Phenol | 0.03 or MDL | ND | ND |
| Pyrene | 50.0[1] | 0.33 | ND |
| 2,4,5-Trichlorophenol | 0.1 | ND | ND |

**[1]As per TAGM #4046, Total VOCs < 10 ppm., Total Semi-VOCs < 500ppm**

**ND Not Detected**

**TABLE 3-15**

Site Restoration Materials

TAGM 4046 Recommended soil cleanup objectives

Organic Pesticides / Herbicides and PCBs

| Contaminant | Rec. Soil Cleanup Objective (ppm) | Topsoil Fill Results (ppm) | On-site Fill Results (ppm) |
|---|---|---|---|
| Aldrin | 0.041 | 0.0035 | ND |
| alpha- BHC | 0.11 | ND | ND |
| beta - BHC | 0.2 | ND | ND |
| delta - BHC | 0.3 | ND | ND |
| Chlordane | 0.54 | 0.22 | ND |
| 2,4-D | 0.5 | ND | ND |
| 4,4'- DDD | 2.9 | ND | ND |
| 4,4'-DDE | 2.1 | 0.024 | 0.002 |
| 4,4'-DDT | 2.1 | 0.0014 | 0.001 |
| Dibenzo-P-dioxins (PCDD) 2,3,7,8 TCDD | N/A | Not tested | Not tested |
| Dieldrin | 0.044 | ND | ND |
| Endosulfan I | 0.9 | 0.008 | ND |
| Endosulfan II | 0.9 | ND | ND |
| Endosulfan Sulfate | 1 | ND | ND |
| Endrin | 0.1 | ND | ND |
| Endrin keytone | N/A | ND | ND |
| gamma - BHC (Lindane) | 0.06 | ND | ND |
| gamma - chlordane | 0.54 | 0.026 | ND |
| Heptachlor | 0.1 | ND | ND |
| Heptachlor epoxide | 0.02 | 0.0072 | ND |
| Methoxychlor | *** | ND | ND |
| Mitotane | N/A | Not tested | Not tested |
| Parathion | 1.2 | ND | ND |
| PCBs | 1.0 (Surface)<br>10 (sub-surf) | 0.013[1] | ND |
| Polychlorinated dibenzo-furans (PCDF) | N/A | Not tested | Not tested |
| Silvex | 0.7 | ND | ND |
| 2,4,5-T | 1.9 | ND | ND |

[1]Aroclor 1260 only, all other Aroclor's ND

ND Not Detected

**TABLE 3-16**
Site Restoration Materials
TAGM 4046 Recommended soil cleanup objectives
Heavy Metals

| Contaminants | Eastern USA Background (ppm) | * CRDL (mg/kg or ppm) | Rec. Soil Cleanup Objective (ppm)[1] | Topsoil Fill Results (mg/kg) | On-site Fill Results (mg/kg) |
|---|---|---|---|---|---|
| Aluminum | 33,000 | 2.0 | SB | 5080 | 4730 |
| Antimony | N/A | 0.6 | SB | ND | ND |
| Arsenic | 3-12[2] | 0.1 | 7.5 or SB | 4.4 | ND |
| Barium | 15-600 | 2.0 | 300 or SB | 26.6 | 13.3 |
| Beryllium | 0-1.75 | 0.05 | 0.16 (HEAST) or SB | ND | ND |
| Cadmium | 0.1-1 | 0.05 | 1 or SB | ND | ND |
| Calcium | 130 - 35,000[2] | 50.0 | SB | 5100 | 249 |
| Chromium | 1.5 - 40[2] | 0.1 | 10 or SB | 13 | 5.3 |
| Cobalt | 2.5 - 60[2] | 0.5 | 30 or SB | 2.5 | 2.0 |
| Copper | 1 - 50 | 0.25 | 25 or SB | 14.8 | 3.7 |
| Cyanide | N/A | 0.1 | See Note[3] | ND | ND |
| Iron | 2,000 - 550,000 | 1.0 | 2,000 or SB | 6840 | 6500 |
| Lead | See Note[4] | 0.03 | SB[4] | 19.2 | 3.7 |
| Magnesium | 100 - 5,000 | 50.0 | SB | 1490 | 765 |
| Manganese | 50 - 5,000 | 0.15 | SB | 159 | 76.6 |
| Mercury | 0.001 - 0.2 | 0.002 | 0.1 | 0.057 | ND |
| Nickel | 0.5 -25 | 0.4 | 13 or SB | 6 | 3.4 |
| Potassium | 8,500 - 43,000[2] | 50.0 | SB | 1110 | 226 |
| Selenium | 0.1 - 3.9 | 0.05 | 2 or SB | ND | ND |
| Silver | N/A | 0.1 | SB | ND | ND |
| Sodium | 6,000 - 8,000 | 50.0 | SB | 107 | 46.0 |
| Thallium | N/A | 0.1 | SB | ND | ND |
| Vanadium | 1-300 | 0.5 | 150 or SB | 11.5 | 9.3 |
| Zinc | 9-50 | 0.2 | 20 or SB | 42.4 | 12.6 |

**SB is site background**
**N/A is not available**
**[1]Recommended soil cleanup objectives are average background concentrations as reported in a 1984 survey of reference material by E. Carol McGovern, NYSDEC.**
**ND Not Detected**

Table 4-1
Quality Assurance/Quality Control Sample Results

| Sample ID | STL Results (pCi/g) | | |
|---|---|---|---|
| | Cs-137 | Sr-90 | Ra-226 |
| SS05A109 | 16.90 | 1.07 | 0.43 |
| SS05A109-DUP | 2.40 | 0.86 | 0.28 |
| SS05C112 | 3.22 | 0.41 | 0.64 |
| SS05C112-DUP | 2.84 | 0.52 | 0.17 |
| SS05C119 | 0.20 | 0.18 | 0.47 |
| SS05C119-DUP | 0.10 | 0.38 | 0.18 |
| SS05C207 | 2.89 | 0.18 | 0.73 |
| SS05C207-DUP | 0.42 | 0.26 | 0.99 |
| SS05C217 | 2.48 | 0.72 | 0.48 |
| SS05C217-DUP | 0.84 | 1.04 | 0.42 |
| SS05C307 | 27.00 | 3.79 | 0.53 |
| SS05C307-DUP | 27.00 | 4.09 | 0.46 |
| SS05D105 | 1.11 | 0.44 | 0.44 |
| SS05D105-DUP | 1.03 | 0.26 | 0.41 |
| SS05D223 | 2.39 | 3.22 | 1.28 |
| SS05D223-DUP | 1.54 | 2.85 | 0.64 |
| SS05D348 | 1.71 | 1.11 | 0.51 |
| SS05D348-DUP | 1.08 | 0.88 | 0.60 |
| SS05D459 | 7.30 | 3.49 | 0.63 |
| SS05D459-DUP | 3.90 | 2.81 | 0.63 |
| SS05D579 | 0.37 | 0.11 | 0.35 |
| SS05D579-DUP | 0.27 | 0.10 | 0.28 |
| SS05D697 | 0.99 | 0.38 | 0.45 |
| SS05D697-DUP | 1.53 | 0.38 | 0.18 |
| SS05L113 | 44.60 | 0.35 | 0.64 |
| SS05L113-DUP | 45.70 | 0.46 | 0.27 |
| SS05Z105 | 2.64 | 0.62 | 0.32 |
| SS05Z105-DUP | 2.60 | 1.04 | 0.38 |
| SS05Z210 | 10.10 | 1.97 | 0.36 |
| SS05Z210-DUP | 12.60 | 2.49 | 0.29 |
| SS05K107 | 0.30 | 0.00 | 0.97 |
| SS05K107-DUP | 0.16 | 0.00 | 0.90 |
| SS05K218 | 0.10 | 0.12 | 0.48 |
| SS05K218-DUP | 0.12 | 0.15 | 0.55 |
| SS05K317 | 3.74 | 0.34 | 0.08 |
| SS05K317-DUP | 3.81 | 0.83 | 0.35 |
| SS05Z313 | 3.65 | 1.08 | 0.85 |
| SS05Z313-DUP | 2.87 | 0.13 | 0.71 |