Animal/Chemical Pits and Glass Holes Remedial Action Closure Report Addendum

September 2005

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APPENDICES

Appendix A: Gamma Walkover Survey Maps of the Glass Holes and Animal/Chemical Pits
Appendix B: ER Operations Procedures Manual, 4.18, *Gamma Survey of Contaminated Soils Using the Eberline E-600 Meter and NaI Detector*
Appendix C: Environmental Monitoring Procedure, EM –SOP-601, *Collection of Soil Samples*

LIST OF ACRONYMS

BNL	Brookhaven National Laboratory
EWMSD	Environmental and Waste Management Services Division
LLRW	Low Level Radioactive Waste
mg/kg	milligram per kilogram
MLLRW	Mixed Low Level Radioactive Waste
OPM	Operations Procedure Manual
OU	Operable Unit
pCi/g	pico curie per gram
QA/QC	Quality Assurance/Quality Control
ROD	Record of Decision
SPSS	Sulfur Polymer Stabilization/Solidification

1.0 SITE BACKGROUND

The Animal/Chemical Pits and Glass Holes (collectively identified herein as the "Chemical Holes") were excavated in 1997 under Remedial Action VI. A Closure Report was issued for the Remedial Action and submitted to the Unite States Department of Energy, the United States Environmental Protection Agency, and the New York State Department of Environmental Conservation. All cleanup goals for the remedial action were met. Excavation of the Chemical Holes is documented in the *Animal/Chemical Pits and Glass Holes Remedial Action Closure Report* (BNL, 1997). Figure 1 is a site plan illustrating the location of the Chemical Holes Area.

The purpose of this Closure Report Addendum is to:

- Document the waste disposal activities resulting from the excavation of the Chemical Holes in 1997;
- Document the additional excavation activities performed in 2005 to meet the cleanup objectives identified in the Operable Unit (OU) I Record of Decision (ROD) after the waste disposal activities were completed; and
- Document the restoration of the Chemical Holes area and the existing site conditions.

It should be noted that during 2004/2005, the western part of the Animal/Chemical Pits was used as a sediment staging area and drying bed lay down for the OU V Peconic River Project. The Animal/Chemical Pits area was utilized for this purpose due to similarity in the contaminants of concern (i.e., mercury).

2.0 CHEMICAL HOLES WASTE DISPOSAL

Wastes generated during the Chemical Holes removal action were characterized and disposed of between 1997 and 2005. Various waste streams were generated as a result of the removal action. Wastes generated included:

- Low level radioactive waste (LLRW)
    - Soil
    - Debris
    - Biological
    - Liquid
    - Cylinders
- Mixed low level radioactive waste (MLLRW) - primarily mercury
    - Soil
    - Debris
    - Biological
    - Liquid
    - Chemical Solids

- Non-hazardous, Non-radioactive waste
    - Soil
    - Debris

BNL's Environmental and Waste Management Services Division (EWMSD) documented all disposal activities. All records concerning the disposition of wastes are contained in the EWMSD waste database.

2.1 Low Level Radioactive Waste

Soil

Approximately 10,000 cubic yards (yd^3) of LLRW soil were generated during the 1997 Chemical Holes excavation. Soil was transported to Envirocare of Utah for disposal as LLRW.

In addition, as described in Section 3.3, approximately 1,500 yd^3 of soil were excavated from the eastern portion of the Animal/Chemical Pits in 2005, following disposal of the wastes excavated in 1997, and shipped via rail to Envirocare of Utah for disposal as low-level radioactive waste.

Debris

Approximately 1,500 yd^3 of debris were generated during the 1997 Chemical Holes excavation. Debris consisted primarily of metal, wood, plastic and glass. Debris was transported to Envirocare of Utah for disposal as LLRW.

Biological

Approximately 2,700 pounds (lbs) of biological waste (animal carcasses) were generated during the 1997 excavation activities. Duratek Federal Services incinerated radiological wastes at their facility in Oak Ridge, TN. The ash generated from the incineration was transported to Envirocare of Utah for disposal as LLRW.

Cylinders

Approximately 320 intact cylinders were recovered from the 1997 excavation of the Chemical Holes. The valves on the cylinders were removed and the contents of the cylinders were sampled by Integrated Environmental Services. Approximately 300 of the cylinders were either empty of any gas or contained inert gases such as argon. The empty cylinders were either released to the Brookhaven National Laboratory (BNL) suspect metal scrap yard by BNL Radiological Control Division personnel or transported to Envirocare of Utah for disposal as LLRW. Integrated Environmental Services treated the remaining (approximately 20) cylinders containing hazardous or radioactive gas and the empty cylinders transported to Envirocare for disposal.

2.2 Mixed Low Level Radioactive Waste (MLLRW)

Soil

Approximately 5 yd^3 of soil from the 1997 Chemical Holes excavation was treated for disposal as a MLLRW due to its mercury content. Soil was treated by one of two methods; sulfur polymer stabilization/solidification (SPSS) or retort. Treated soil was then transported to Envirocare of Utah for disposal as a MLLRW.

Debris

Approximately 2 yd^3 of mercury contaminated debris from the 1997 Chemical Holes excavation was transported to Envirocare of Utah for treatment and disposal. The debris underwent macro-encapsulation and was then disposed of a MLLRW.

Biological

Approximately 100 lbs of biological waste from the 1997 Chemical Holes excavation was treated for mercury contamination using retort treatment conducted by Sepradyne, Inc. Residual ash was stabilized and transported for disposal as LLRW at Envirocare of Utah. Collected elemental mercury was stabilized using SPSS technology and transported to Envirocare of Utah for disposal as a MLLRW.

Liquids

Intact recovered liquids from the 1997 Chemical Holes excavation were characterized and bulked by compatibility. Bulked liquid waste was transported to off-site treatment vendors for solidification (Permafix or Waste Control Specialists). Solidified liquid wastes were then transported to Envirocare of Utah for disposal as MLLRW. A total of approximately 150 gallons of MLLRW liquids were treated and disposed of at Envirocare of Utah.

Chemical Solids

Intact recovered chemical solids from the 1997 Chemical Holes excavation were characterized and bulked by compatibility. Bulked solid waste was transported to off-site treatment vendors for solidification (Permafix or Waste Control Specialists). Chemical solid wastes were then transported to Envirocare of Utah for disposal as MLLRW. A total of approximately 1 yd^3 of MLLRW solids were treated and disposed of at Envirocare of Utah.

Elemental Mercury

Approximately 200 lbs of elemental mercury were stabilized at BNL using SPSS technology. The solidified mercury was transported to Envirocare of Utah for disposal as MLLRW.

2.3 Non-hazardous, Non-radioactive Waste

Soil

Approximately 2,500 yd^3 of soil from the 1997 excavation was transported for disposal at GROWS Landfill, a Subtitle D Facility.

In addition, as described in Section 3.3, approximately 2,300 yd^3 of soil were excavated from the Glass Holes and the western portion of the Animal/Chemical Pits in 2005, following disposal of the wastes excavated in 1997, and shipped via rail to the Niagara Falls Landfall Facility for disposal as non-hazardous waste.

3.0 POST WASTE DISPOSAL SCOPE – RELEASE OF THE CHEMICAL HOLES AREA FROM RADIOLOGICAL CONTROLS

Following waste disposal of the LLRW and MLLRW from the Chemical Holes excavation and the sediments from the Peconic River project, several rounds of detailed sampling and excavation of soils were performed within the Chemical Holes project area to remove residual radioactivity and mercury remaining in the surface soils, and release the area from radiological controls. The sampling and excavation activities are detailed in the following subsections.

The radiological walkover surveys and surface soil sampling were performed to ensure that the areas met the OU I cleanup goals. The cleanup goals, as identified in the OU I ROD for the Chemical Holes, include 1.84 mg/kg for mercury, and individual radionuclides, as listed on Table 1:

TABLE 1

Cleanup Goals for Radionuclides

Radionuclide	Remediation Goal[2] (pCi/g)
Cs-137	23
Sr-90	15
Ra-226	5

3.1 Initial Sampling of the Chemical Holes - Post Waste Disposal

To determine the extent of the residual contamination left from the waste disposal activities and the Peconic River project, both the Glass Holes and the Animal/Chemical Pits areas were marked in a 60-foot by 60-foot grid system for sampling (Figures 2 and 3). Sampling was performed in accordance with the "Work Plan for the Release of the Chemical Holes Area from Radiological

Controls", October 2003. Surface soil samples were collected at a frequency of one sample per grid and analyzed for total mercury analysis to identify areas that did not meet the cleanup goals. In the eastern portion of the Animal/Chemical Pits, samples were also collected at a frequency of one sample per grid and analyzed for radiological analyses.

Prior to radiological sampling at the Glass Holes and the western portion of the Animal/Chemical Pits, two 6-inch lifts were removed from the areas and a full radiological walkover survey was performed. Results from the walkover surveys are included in Appendix A. Based on the results of the walkover survey the frequency of radiological sampling was limited to a minimum of one sample for every three grids.

3.2 Initial Sampling of the Chemical Holes - Results

Glass Holes and Western Animal/Chemical Pits

Based on the sampling discussed in Section 3.1, grids in the Glass Holes and the western portion of the Animal/Chemical Pits were determined to exceed the cleanup goals only for mercury, but satisfied the requirements for radionuclides. Results are included as Table 2 (Glass Holes Area Results), and Table 3 (Western Portion of the Animal/Chemical Pits Results).

The areas described above were used for drying the Peconic River sediment and the analytical data of the soil fell within the total volume and characteristics of waste authorized for release to the Niagara Falls Landfill. The document entitled "Technical Basis for the Derivation of Authorized Limits for Peconic River Soils and Sediments from Brookhaven National Laboratory", April 2004, was amended to include the Chemical Holes soil ("Addendum to the Technical Basis for the Derivation of Authorized Limits for Peconic River Soils and Sediments from Brookhaven National Laboratory for the Addition of Chemical Holes Area Soils", February, 2005). The soil was subjected to the same level of confirmatory sampling as the Peconic River sediment and all of the samples were within the Authorized Release Limits. At the conclusion of the shipments to the Niagara Falls Landfill, a final analysis of the volume and total curie content of the waste was performed to verify that the criteria established in the Authorized Release were not exceeded.

Eastern Animal/Chemical Pits

The grids in the eastern portion of the Animal/Chemical Pits exceeded the cleanup goals for both mercury and cesium-137. Results are included as Table 4 (Eastern Portion of the Animal/Chemical Pits Results).

3.3 Soil Excavation – Post Waste Disposal

Glass Holes and Western Animal/Chemical Pits

Soil in the grids that exceeded the cleanup goal for mercury in the Glass Holes and the western portion of the Animal/Chemical Pits was excavated to a depth of approximately six inches. After the excavation, surface soil samples were collected to determine if additional excavation was

required. In several grids additional soil was excavated to meet the cleanup goal for mercury. This additional excavation resulted in 2,300 yd^3 of non-hazardous, non-radioactive waste soil (as described in Section 2.3).

Eastern Animal/Chemical Pits

Soil in the grids that exceeded the cleanup goal for mercury and radionuclides in the eastern portion of the Animal/Chemical Pits was excavated to a depth of approximately six inches. After the excavation, surface soil samples were collected to determine if the cleanup goals were met. In several grids additional soil was excavated until all samples met the cleanup goals for both radionuclides and mercury. This additional excavation resulted in 1,500 yd^3 of LLRW soil (as described in Section 2.1).

3.4 Final Radiological Survey – Post Waste Disposal

After all excavation was completed, final radiological walkover surveys were performed as described in OPM procedure 4.18 "Gamma Survey of Contaminated Soils Using The Eberline E-600 Meter and NaI Detector". The final radiological surveys are included as Appendix A.

3.5 Final Endpoint Surface Soil Sampling – Post Waste Disposal

Endpoint surface soil samples were collected after the final excavation was completed based on a 60-foot by 60-foot grid system (one sample for every 3600 ft^2). The grids are identified on Figures 2 and 3. Samples were collected in accordance with EM-SOP-601 "Collection of Soil Samples, Rev. 1". Severn Trent Laboratory Laboratory analyzed all endpoint samples. Endpoint samples in the Glass Holes and western Animal/Chemical Pits were analyzed for total mercury. Endpoint sample results for the Glass Holes area are included as Table 5. Endpoint sample results for the western Animal/Chemical Pits are included as Table 6.

Endpoint samples from the eastern Animal/Chemical Pits were analyzed for total mercury, gross alpha, gross beta, strontium-90, and gamma spectroscopy. Endpoint sample results for the eastern portion of the Animal/Chemical Pits are included as Table 7.

Quality assurance/quality control (QA/QC) samples were collected in accordance with the "Work Plan for Release of the Chemical Holes Area from Radiological Control", October 2003.

4.0 SITE RESTORATION

Following the release of the Chemical Holes from radiological control, the areas were graded and seeded with native grass. All equipment and materials were demobilized from the site. The railcar loading dock remains intact.

5.0 REFERENCES

Brookhaven National Laboratory (BNL), Environmental Restoration, *Operable Unit I Record of Decision*, August 1999.

BNL, "Technical Basis for the Derivation of Authorized Limits for Peconic River Soils and Sediments from Brookhaven National Laboratory", April 28, 2004

BNL, "Addendum to the Technical Basis for the Derivation of Authorized Limits for Peconic River Soils and Sediments from Brookhaven National Laboratory for the Addition of Chemical Holes Area Soils", February 15, 2005

BNL, *Work Plan for Release of the Chemical Holes Area from Radiological Control*, October 2003

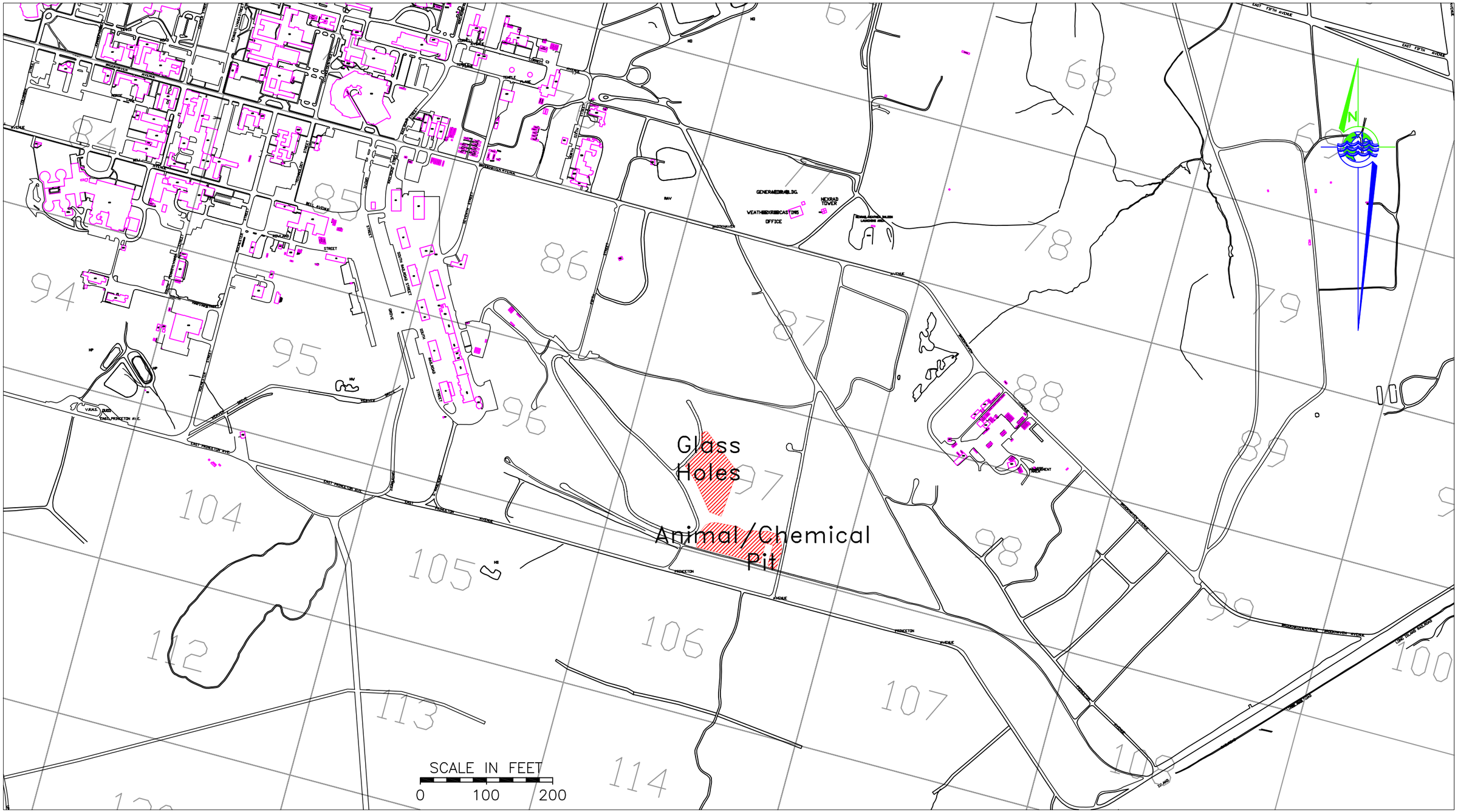
BNL, Environmental Restoration, *Animal/Chemical Pits and Glass Holes Remedial Action Closure Report* October 1997.

BNL, Environmental Restoration, *Waste Characterization Report for the Animal/Chemical Pits and Glass Holes Remedial* July 2001.

BNL, Radiological Controls Division, *Instrumentation and Calibration Training and Qualifications Plan or Agreement*, http://intranet.bnl.gov/rcd/ic/Quality Assurance/TQ/training.pdf, dated May 2000.

BNL, *Radiological Control Manual*, https://sbms.bnl.gov/program/pd01/pd01t011.htm, as amended.

FIGURES



BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL MANAGEMENT DIRECTORATE

TITLE:

SITE PLAN
Animal/Chemical Pits and Glass Holes Remedial Action Closure Report Addendum

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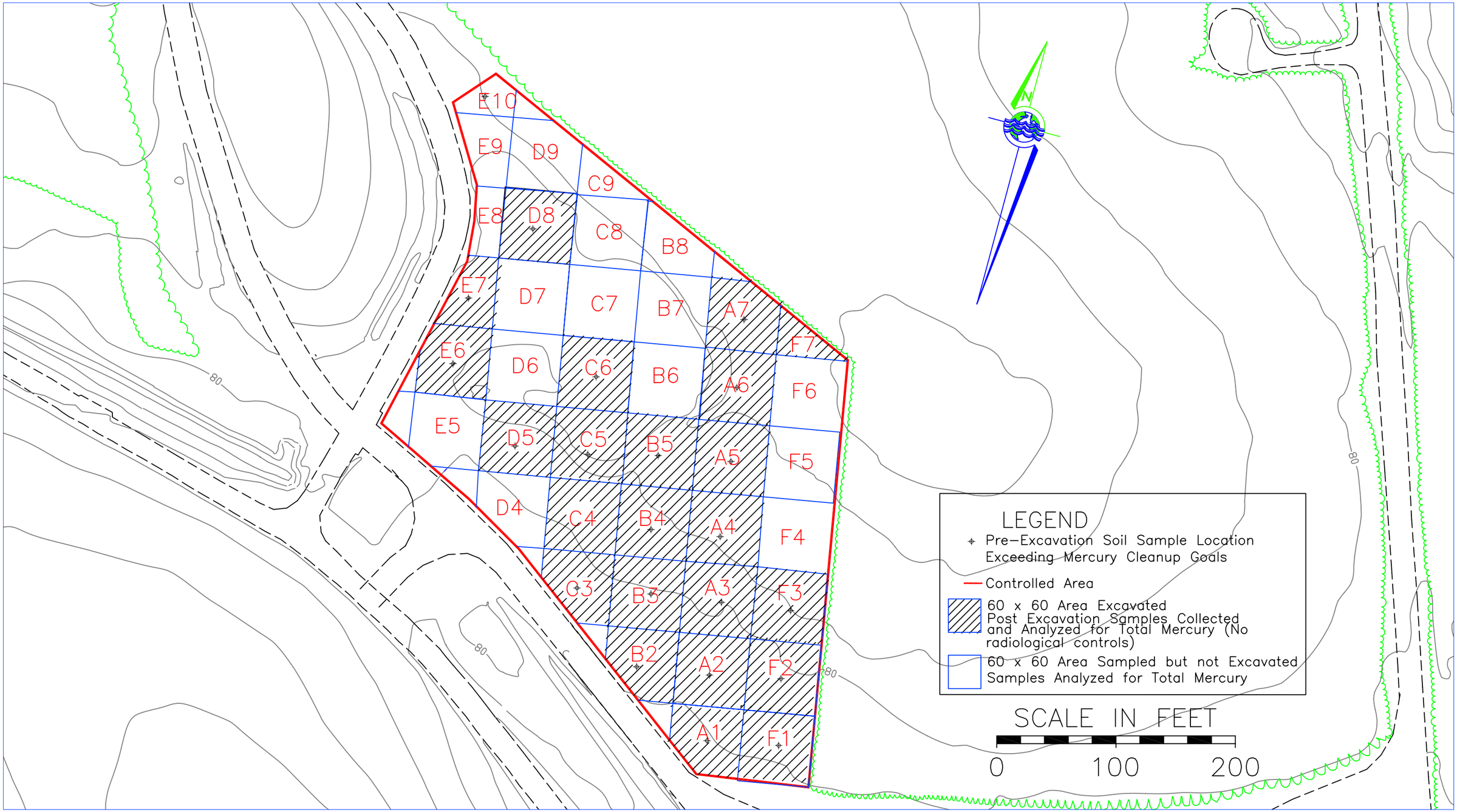

BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL MANAGEMENT DIRECTORATE

TITLE:

Glass Holes Exavation Limits
Animal/Chemical Pits and Glass Holes Remedial Action Closure Report Addendum

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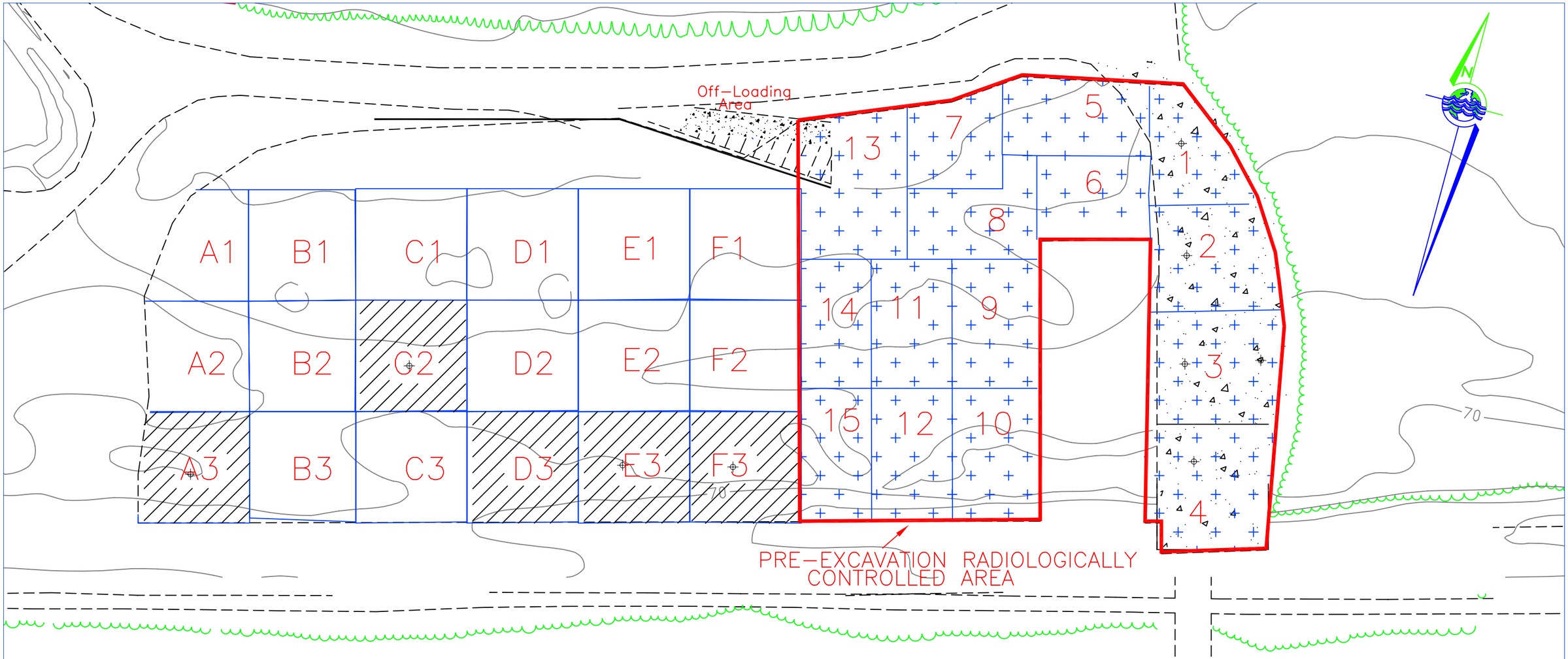

SCALE IN FEET

0 100 200

LEGEND

- Pre-Excavation Soil Sample Location Exceeding Mercury Cleanup Goals
- Pre-Excavation Radiologically Controlled Area
- C2 — 60 x 60 Area Excavated. Post Excavation Samples Collected and Analyzed for Total Mercury and Gamma.
- 2 — Pre-Excavation Radiologically Controlled Area Post Excavation Samples Collected and Analyzed for Total Mercury and Gamma
- C3 — 60 x 60 Area Sampled but not Excavated Samples Analyzed for Total Mercury and Gamma

BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL MANAGEMENT DIRECTORATE

TITLE:

Animal / Chemical Pit Surface Soil Excavation Limits
Animal/Chemical Pits and Glass Holes Remedial Action Closure Report Addendum

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TABLES

Table 2
Pre-Excavation
Glass Holes Area Sample Results

Compound	A1-CH	A2-CH	A3-CH	A4-CH	A5-CH	A6-CH	A7-CH	B2-CH	B3-CH
Mercury	8.8	10.7	9.5	6.8	12.6	26.7	2.7	2.2	6.2
Americium-241	U	0.34	0.47	NS	NS	NS	NS	NS	0.184
Actinium-228	U	U	U	NS	NS	NS	NS	NS	U
Beryllium-7	U	U	U	NS	NS	NS	NS	NS	U
Cesium-134	U	U	U	NS	NS	NS	NS	NS	U
Cesium-137	0.129	0.105	0.14	NS	NS	NS	NS	NS	0.135
Cobalt-57	U	U	U	NS	NS	NS	NS	NS	U
Cobalt-60	U	U	U	NS	NS	NS	NS	NS	U
Europium-152	U	U	U	NS	NS	NS	NS	NS	U
Europium-154	U	U	U	NS	NS	NS	NS	NS	U
Europium-155	U	U	U	NS	NS	NS	NS	NS	U
Lead-212	U	U	U	NS	NS	NS	NS	NS	U
Lead-214	U	U	U	NS	NS	NS	NS	NS	U
Manganese-54	U	U	U	NS	NS	NS	NS	NS	U
Potassium-40	5.4	5.3	6	NS	NS	NS	NS	NS	5
Radium-226	U	1.77	U	NS	NS	NS	NS	NS	U
Sodium-22	U	U	U	NS	NS	NS	NS	NS	U
Thorium-228	0.34	0.5	0.48	NS	NS	NS	NS	NS	0.45
Thorium-230	U	U	U	NS	NS	NS	NS	NS	U
Thorium-232	0.38	0.73	0.57	NS	NS	NS	NS	NS	0.79
Thorium-234	U	U	U	NS	NS	NS	NS	NS	0.87
Uranium-234	0.22	0.39	0.34	NS	NS	NS	NS	NS	0.38
Uranium-235	U	U	U	NS	NS	NS	NS	NS	U
Uranium-238	U	U	U	NS	NS	NS	NS	NS	0.87
Zinc-65	U	U	U	NS	NS	NS	NS	NS	U
Strontium-90	0.6	U	U	NS	NS	NS	NS	NS	U
Gross Alpha	23	40.3	28.8	NS	NS	NS	NS	NS	31.5
Gross Beta	19.8	19.2	17.2	NS	NS	NS	NS	NS	30.1

Notes:

U = Not detected

NS = Not sampled

Mercury results in mg/kg

Radionuclide results in pCi/g

Table 2
Pre-Excavation
Glass Holes Area Sample Results

Compound	B4-CH	B5-CH	B6-CH	B7-CH	B8-CH	C3-CH	C4-CH	C5-CH
Mercury	5.1	4.9	0.34	NS	NS	5.3	5.6	5.5
Americium-241	NS	NS	U	NS	NS	NS	NS	NS
Actinium-228	NS	NS	U	NS	NS	NS	NS	NS
Beryllium-7	NS	NS	U	NS	NS	NS	NS	NS
Cesium-134	NS	NS	U	NS	NS	NS	NS	NS
Cesium-137	NS	NS	U	NS	NS	NS	NS	NS
Cobalt-57	NS	NS	U	NS	NS	NS	NS	NS
Cobalt-60	NS	NS	U	NS	NS	NS	NS	NS
Europium-152	NS	NS	U	NS	NS	NS	NS	NS
Europium-154	NS	NS	U	NS	NS	NS	NS	NS
Europium-155	NS	NS	U	NS	NS	NS	NS	NS
Lead-212	NS	NS	0.61	NS	NS	NS	NS	NS
Lead-214	NS	NS	U	NS	NS	NS	NS	NS
Manganese-54	NS	NS	U	NS	NS	NS	NS	NS
Potassium-40	NS	NS	5.9	NS	NS	NS	NS	NS
Radium-226	NS	NS	1.26	NS	NS	NS	NS	NS
Sodium-22	NS	NS	U	NS	NS	NS	NS	NS
Thorium-228	NS	NS	0.61	NS	NS	NS	NS	NS
Thorium-230	NS	NS	U	NS	NS	NS	NS	NS
Thorium-232	NS	NS	0.46	NS	NS	NS	NS	NS
Thorium-234	NS	NS	U	NS	NS	NS	NS	NS
Uranium-234	NS	NS	0.49	NS	NS	NS	NS	NS
Uranium-235	NS	NS	U	NS	NS	NS	NS	NS
Uranium-238	NS	NS	U	NS	NS	NS	NS	NS
Zinc-65	NS	NS	U	NS	NS	NS	NS	NS
Strontium-90	NS	NS	U	NS	NS	NS	NS	NS
Gross Alpha	NS	NS	25.6	NS	NS	NS	NS	NS
Gross Beta	NS	NS	13.6	NS	NS	NS	NS	NS

Notes:

U = Not detected

NS = Not sampled

Mercury results in mg/kg

Radionuclide results in pCi/g

Table 2
Pre-Excavation
Glass Holes Area Sample Results

Compound	C6-CH	C7-CH	C8-CH	C9-CH	D4-CH	D5-CH	D6-CH	D7-CH	D8-CH
Mercury	2.2	NS	NS	0.069	0.67	5.7	0.94	0.41	26.8
Americium-241	NS	NS	NS	NS	NS	U	NS	NS	0.172
Actinium-228	NS	NS	NS	NS	NS	U	NS	NS	U
Beryllium-7	NS	NS	NS	NS	NS	U	NS	NS	U
Cesium-134	NS	NS	NS	NS	NS	U	NS	NS	U
Cesium-137	NS	NS	NS	NS	NS	0.123	NS	NS	0.089
Cobalt-57	NS	NS	NS	NS	NS	U	NS	NS	U
Cobalt-60	NS	NS	NS	NS	NS	U	NS	NS	U
Europium-152	NS	NS	NS	NS	NS	U	NS	NS	U
Europium-154	NS	NS	NS	NS	NS	U	NS	NS	U
Europium-155	NS	NS	NS	NS	NS	U	NS	NS	U
Lead-212	NS	NS	NS	NS	NS	U	NS	NS	U
Lead-214	NS	NS	NS	NS	NS	U	NS	NS	U
Manganese-54	NS	NS	NS	NS	NS	U	NS	NS	U
Potassium-40	NS	NS	NS	NS	NS	4.6	NS	NS	3.83
Radium-226	NS	NS	NS	NS	NS	1.32	NS	NS	U
Sodium-22	NS	NS	NS	NS	NS	U	NS	NS	U
Thorium-228	NS	NS	NS	NS	NS	0.51	NS	NS	0.406
Thorium-230	NS	NS	NS	NS	NS	U	NS	NS	U
Thorium-232	NS	NS	NS	NS	NS	0.69	NS	NS	0.62
Thorium-234	NS	NS	NS	NS	NS	U	NS	NS	U
Uranium-234	NS	NS	NS	NS	NS	0.45	NS	NS	0.255
Uranium-235	NS	NS	NS	NS	NS	U	NS	NS	U
Uranium-238	NS	NS	NS	NS	NS	U	NS	NS	U
Zinc-65	NS	NS	NS	NS	NS	U	NS	NS	U
Strontium-90	NS	NS	NS	NS	NS	U	NS	NS	U
Gross Alpha	NS	NS	NS	NS	NS	28.7	NS	NS	51
Gross Beta	NS	NS	NS	NS	NS	21.1	NS	NS	17.6

Notes:

U = Not detected

NS = Not sampled

Mercury results in mg/kg

Radionuclide results in pCi/g

Table 2
Pre-Excavation
Glass Holes Area Sample Results

Compound	D9-CH	E5-CH	E6-CH	E7-CH	E8-CH	E9-CH	E10-CH	F1-CH
Mercury	0.13	0.021	3.1	5.9	0.17	NS	NS	23.4
Americium-241	NS	NS	U	0.23	NS	NS	NS	0.57
Actinium-228	NS	NS	U	U	NS	NS	NS	U
Beryllium-7	NS	NS	U	U	NS	NS	NS	U
Cesium-134	NS	NS	U	U	NS	NS	NS	U
Cesium-137	NS	NS	0.101	U	NS	NS	NS	2.55
Cobalt-57	NS	NS	U	U	NS	NS	NS	U
Cobalt-60	NS	NS	U	U	NS	NS	NS	U
Europium-152	NS	NS	U	U	NS	NS	NS	U
Europium-154	NS	NS	U	U	NS	NS	NS	U
Europium-155	NS	NS	U	U	NS	NS	NS	U
Lead-212	NS	NS	0.51	U	NS	NS	NS	U
Lead-214	NS	NS	0.46	U	NS	NS	NS	U
Manganese-54	NS	NS	U	U	NS	NS	NS	U
Potassium-40	NS	NS	5.1	4.3	NS	NS	NS	5.6
Radium-226	NS	NS	U	U	NS	NS	NS	2.22
Sodium-22	NS	NS	U	U	NS	NS	NS	U
Thorium-228	NS	NS	0.51	0.48	NS	NS	NS	0.54
Thorium-230	NS	NS	U	U	NS	NS	NS	U
Thorium-232	NS	NS	0.5	0.77	NS	NS	NS	0.5
Thorium-234	NS	NS	U	U	NS	NS	NS	U
Uranium-234	NS	NS	0.46	0.43	NS	NS	NS	0.42
Uranium-235	NS	NS	U	U	NS	NS	NS	U
Uranium-238	NS	NS	U	U	NS	NS	NS	U
Zinc-65	NS	NS	U	U	NS	NS	NS	U
Strontium-90	NS	NS	U	U	NS	NS	NS	3
Gross Alpha	NS	NS	22.1	32.8	NS	NS	NS	31.9
Gross Beta	NS	NS	19.7	20.9	NS	NS	NS	36.7

Notes:

U = Not detected

NS = Not sampled

Mercury results in mg/kg

Radionuclide results in pCi/g

Table 2
Pre-Excavation
Glass Holes Area Sample Results

Compound	F2-CH	F3-CH	F4-CH	F5-CH	F6-CH	F7-CH
Mercury	14.4	10.6	0.24	1.3	0.36	2.2
Americium-241	0.23	0.22	NS	NS	U	NS
Actinium-228	U	U	NS	NS	1.58	NS
Beryllium-7	U	U	NS	NS	U	NS
Cesium-134	U	U	NS	NS	U	NS
Cesium-137	0.284	0.217	NS	NS	U	NS
Cobalt-57	U	U	NS	NS	U	NS
Cobalt-60	U	U	NS	NS	U	NS
Europium-152	U	U	NS	NS	U	NS
Europium-154	U	U	NS	NS	U	NS
Europium-155	U	U	NS	NS	U	NS
Lead-212	0.7	0.84	NS	NS	0.95	NS
Lead-214	U	U	NS	NS	U	NS
Manganese-54	U	U	NS	NS	U	NS
Potassium-40	4.2	5.9	NS	NS	8.5	NS
Radium-226	U	U	NS	NS	1.9	NS
Sodium-22	U	U	NS	NS	U	NS
Thorium-228	0.7	0.84	NS	NS	0.95	NS
Thorium-230	U	U	NS	NS	U	NS
Thorium-232	0.67	0.74	NS	NS	1.58	NS
Thorium-234	U	U	NS	NS	U	NS
Uranium-234	0.46	0.5	NS	NS	0.71	NS
Uranium-235	U	U	NS	NS	U	NS
Uranium-238	U	U	NS	NS	U	NS
Zinc-65	U	U	NS	NS	U	NS
Strontium-90	U	U	NS	NS	U	NS
Gross Alpha	23.4	59	NS	NS	22.6	NS
Gross Beta	23.4	28.9	NS	NS	26.8	NS

Notes:

U = Not detected

NS = Not sampled

Mercury results in mg/kg

Radionuclide results in pCi/g

Table 3
Pre-Excavation
Animal/Chemical Pits Sample Results
Western Portion

Compound	ACP-SS-A1	ACP-SS-A2	ACP-SS-A3	ACP-SS-B1	ACP-SS-B2	ACP-SS-B3	ACP-SS-C1	ACP-SS-C2	ACP-SS-C3
Mercury	1.8 N	0.19 N	4.1 N	0.6 N	0.74 N	0.39 N	0.52 N	2.4 N	1.5 N
Americium-241	U	NS	NS	NS	NS	U	U	U	NS
Beryllium-7	U	NS	NS	NS	NS	U	U	U	NS
Cesium-134	U	NS	NS	NS	NS	U	U	U	NS
Cesium-137	0.49	NS	NS	NS	NS	2.24	U	5.74	NS
Cobalt-57	U	NS	NS	NS	NS	U	U	U	NS
Cobalt-60	U	NS	NS	NS	NS	U	U	U	NS
Europium-152	U	NS	NS	NS	NS	U	U	U	NS
Europium-154	U	NS	NS	NS	NS	U	U	U	NS
Europium-155	U	NS	NS	NS	NS	U	U	U	NS
Manganese-54	U	NS	NS	NS	NS	U	U	U	NS
Potassium-40	NA	NS	NS	NS	NS	U	4.6	5.8	NS
Radium-226	U	NS	NS	NS	NS	U	U	U	NS
Sodium-22	U	NS	NS	NS	NS	U	U	U	NS
Thorium-228	0.36	NS	NS	NS	NS	0.67	0.4	0.52	NS
Thorium-230	U	NS	NS	NS	NS	U	U	U	NS
Thorium-232	0.65	NS	NS	NS	NS	0.77	0.45	0.63	NS
Uranium-234	0.37	NS	NS	NS	NS	0.51	0.28	0.35	NS
Uranium-235	U	NS	NS	NS	NS	U	U	U	NS
Uranium-238	U	NS	NS	NS	NS	1.07	U	U	NS
Zinc-65	U	NS	NS	NS	NS	U	U	U	NS
Strontium-90	1.45 J	NS	NS	NS	NS	1.88 J	NA	2.14 J	NS
Gross Alpha	23.8	NS	NS	NS	NS	27.5	NA	31.4	NS
Gross Beta	24.8	NS	NS	NS	NS	34.2	NA	29.9	NS

Notes:

U = Not detected

NA = Not analyzed

NS = Not Sampled

J = Estimated result

ND = Not Detected

N = Spiked analyte recovery
is outside stated control limits

Mercury results in mg/kg

Radionuclide results in pCi/g

Table 3
Pre-Excavation
Animal/Chemical Pits Sample Results
Western Portion

Compound	ACP-SS-D1	ACP-SS-D2	ACP-SS-D3	ACP-SS-E1	ACP-SS-E2	ACP-SS-E3	ACP-SS-F1	ACP-SS-F2	ACP-SS-F3
Mercury	ND	0.59 N	4.8 N	0.06 N	0.18 N	7.9 N	0.23 N	0.18 N	0.47 N
Americium-241	NS	NS	0.127	NS	U	0.16	U	U	NS
Beryllium-7	NS	NS	U	NS	U	U	U	U	NS
Cesium-134	NS	NS	U	NS	U	U	U	U	NS
Cesium-137	NS	NS	1.18	NS	2.23	1.65	6.28	1.92	NS
Cobalt-57	NS	NS	U	NS	U	U	U	U	NS
Cobalt-60	NS	NS	U	NS	U	U	U	U	NS
Europium-152	NS	NS	U	NS	U	U	U	U	NS
Europium-154	NS	NS	U	NS	U	U	U	U	NS
Europium-155	NS	NS	U	NS	U	U	U	U	NS
Manganese-54	NS	NS	U	NS	U	U	U	U	NS
Potassium-40	NS	NS	5.9	NS	4.5	U	U	4.3	NS
Radium-226	NS	NS	U	NS	U	U	U	U	NS
Sodium-22	NS	NS	U	NS	U	U	U	U	NS
Thorium-228	NS	NS	0.47	NS	0.56	0.49	0.43	0.6	NS
Thorium-230	NS	NS	U	NS	U	U	U	U	NS
Thorium-232	NS	NS	U	NS	0.92	0.82	U	0.72	NS
Uranium-234	NS	NS	0.28	NS	0.58	0.64	U	0.36	NS
Uranium-235	NS	NS	U	NS	U	U	U	U	NS
Uranium-238	NS	NS	U	NS	U	U	U	U	NS
Zinc-65	NS	NS	U	NS	U	U	U	U	NS
Strontium-90	NS	NS	1.75 J	NS	NA	2.14 J	1.91 J	NA	NS
Gross Alpha	NS	NS	14.9	NS	NA	31.4	18.4	NA	NS
Gross Beta	NS	NS	17.9	NS	NA	29.9	34.9	NA	NS

Notes:

U = Not detected

NA = Not analyzed

NS = Not Sampled

J = Estimated result

ND = Not Detected

N = Spiked analyte recovery
is outside stated control limits

Mercury results in mg/kg

Radionuclide results in pCi/g

Table 4
Pre-Excavation
Animal/Chemical Pits Sample Results
Eastern Portion

Compound	Grid 1	Grid 2	Grid 3	Grid 4	Grid 5	Grid 6	Grid 7	Grid 8	Grid 9
Mercury	2.78	1.22	0.301	1.34	0.419	0.026	1.45	1.77	0.988
Americium-241	0.0488 J	U	U	U	U	0.28 J	U	0.642 J	U
Beryllium-7	0.106 J	U	U	0.0953 DL	0.452 DL	U	0.135 DL	U	U
Cesium-134	0.0276 J-UI	0.0223 J-UI	U	0.0264 J-UI	U	0.0389 J-UI	0.0313 J-UI	0.0194 J-UI	U
Cesium-137	1.2 J	5.85	2.23 J	17.9	12.9	1.99 J	19.4	244	1.88 J
Cobalt-57	U	U	U	0.00861 DL	U	U	0.00591 DL	0.024 DL	U
Cobalt-60	U	0.0296 J	U	U	U	U	0.0212 J-UI	U	U
Europium-152	U	U	U	U	U	U	U	U	U
Europium-154	U	U	U	U	U	U	U	U	U
Europium-155	0.0345 J-UI	U	U	U	U	U	U	U	U
Manganese-54	U	U	U	U	U	U	U	U	U
Sodium-22	U	U	U	U	U	U	U	U	U
Thorium-228	0.654	0.438 J	0.379 J	0.427 J	0.945	0.669	0.56	0.461 J	0.484 J
Thorium-230	0.366 J	0.28 J	0.266 J	0.275 J	0.586	0.47 J	0.276 J	0.432 J	0.293 J
Thorium-232	0.648	0.433 J	0.374 J	0.422 J	0.939	0.665	0.557	0.458 J	0.481 J
Uranium-234	0.442 J	0.333 J	0.29 J	0.363 J	0.543 J	0.443 J	0.359 J	0.496 J	0.359 J
Uranium-235	U	U	U	U	U	U	U	U	U
Uranium-238	0.43 J	U	U	0.468 DL	0.597 J	U	0.611 DL	0.823 DL	U
Vanadium-48	U	U	U	U	U	U	U	U	U
Zinc-65	U	U	U	U	U	U	U	U	U

Notes:

U = Not detected

NA = Not analyzed

UI = (Uncertain identification for gamma spectroscopy) - Radionuclide peaks that are detected but fail to meet the positive identification criteria.

DL = Detection limit requirements not met. Data quality objectives may not be met

J = Estimated result

ND = Not Detected

N = Spiked analyte recovery
is outside stated control limits

Mercury results in mg/kg

Radionuclide results in pCi/g

Table 4
Pre-Excavation
Animal/Chemical Pits Sample Results
Eastern Portion

Compound	Grid 10	Grid 11	Grid 12	Grid 13	Grid 14	Grid 15
Mercury	2.97	2.75	4.37	0.0413	1.65	0.474
Americium-241	U	U	U	0.0969 J	U	U
Beryllium-7	U	0.119 DL	U	0.0743 DL	0.116 DL	U
Cesium-134	0.0243 J-UI	0.0195 J-UI	0.027 J-UI	0.0259 J-UI	0.0265 J-UI	0.0228 J-UI
Cesium-137	12	34.4	16.5	27.7	33.4	1.19 J
Cobalt-57	0.0182 J-UI	0.0001 DL	U	0.00465 DL	0.00543 J-UI	U
Cobalt-60	U	U	U	U	U	U
Europium-152	U	U	U	U	U	U
Europium-154	U	U	U	U	U	U
Europium-155	U	U	U	U	U	U
Manganese-54	U	U	U	U	U	U
Sodium-22	U	U	U	U	U	U
Thorium-228	0.397 J	0.371 J	0.523	0.593	0.465 J	0.638
Thorium-230	0.272 J	0.28 J	0.295 J	0.349 J	0.283 J	0.354 J
Thorium-232	0.394 J	0.369 J	0.52	0.589	0.462 J	0.634
Uranium-234	0.321 J	0.352 J	0.366 J	0.483 J	0.324 J	0.394 J
Uranium-235	U	U	U	U	U	0.101 J
Uranium-238	0.594 DL	0.954 DL	0.803 DL	U	0.765 DL	0.432 J
Vanadium-48	U	U	U	U	U	U
Zinc-65	U	U	U	U	U	0.0316 J-UI

Notes:

U = Not detected

NA = Not analyzed

UI = (Uncertain identification fo

DL = Detection limit requiremer

J = Estimated result

ND = Not Detected

N = Spiked analyte recovery
is outside stated control limits

Mercury results in mg/kg

Radionuclide results in pCi/g

Table 5
Post-Excavation
Glass Holes Area Sample Results

Compound	Mercury
A1-CH	0.52
A2-CH	0.31
A3-CH	0.3
A4-CH	0.48
A5-CH	0.11
A6-CH	0.8
A7-CH	0.8
B2-CH	0.4
B3-CH	0.004
B4-CH	0.1
B5-CH	0.16
C4-CH	0.23 J
C3-CH	0.21
C5-CH	0.38
C6-CH	0.39
D5-CH	0.19
D8-CH	0.25
E6-CH	0.67
E7-CH	0.1
F1-CH	0.5
F2-CH	0.93
F3-CH	0.072
F7-CH	0.047

Notes:
Mercury results in mg/kg
J = Estimated Result

Table 6
Post-Excavation
Animal/Chemical Pits Sample Results*
Western Portion

Compound	Mercury
ACP-SS-A3	0.58
ACP-SS-C2	0.14
ACP-SS-D3	< 0.48*
ACP-SS-E3	0.012
ACP-SS-F3	0.018

Notes:
Mercury results in mg/kg
* 23 samples were collected by Envirocon post-scraping in addition to BNL's sampling.
All samples collected by Envirocon were less than 0.48 mg/kg

Table 7
Post-Excavation
Animal/Chemical Pits Sample Results
Eastern Portion

Compound	Grid 1	Grid 2	Grid 3	Grid 4	Grid 5	Grid 6	Grid 7	Grid 8	Grid 9	Grid 10
Mercury	1.2 N	1.22	0.301	1.34	1.7 N	0.24	0.17 N	0.71 N	1.4 N	0.21
Americium-241	U	U	U	U	U	U	0.14 J	U	0.26 J	U
Beryllium-7	U	U	U	U	U	U	U	U	U	U
Cesium-134	U	U	U	U	U	U	U	U	U	U
Cesium-137	7.2	5.85	2.23 J	17.9	16.4	13.8	5.15	0.088 J	8.4	U
Cobalt-57	U	U	U	U	U	U	U	U	U	U
Cobalt-60	U	0.0296 J	U	U	U	U	U	U	U	U
Europium-152	U	U	U	U	U	U	U	U	U	U
Europium-154	U	U	U	U	U	U	U	U	U	U
Europium-155	U	U	U	U	U	U	U	U	U	U
Manganese-54	U	U	U	U	U	U	U	U	U	U
Radium-226	U	NA	NA	NA	U	U	U	U	0.31 J	0.31 J
Sodium-22	U	U	U	U	U	U	U	U	U	U
Thorium-228	0.48 J	0.438 J	0.379 J	0.427 J	0.75	0.41 J	0.78	0.35 J	0.35 J	0.44 J
Thorium-230	U	0.280 J	0.266 J	0.275 J	U	U	U	U	0.39 J	0.36 J
Thorium-232	0.79	0.433 J	0.374 J	0.422 J	0.97	0.6	0.97	U	0.29 J	0.44 J
Uranium-234	0.32 J	0.333 J	0.290 J	0.363 J	0.47 J	U	0.51	0.25 J	1.23	0.27 J
Uranium-235	U	U	U	U	U	U	U	U	U	U
Uranium-238	U	U	U	U	U	U	U	U	0.48 J	0.20 J
Vanadium-48	U	U	U	U	U	U	U	U	U	U
Zinc-65	U	U	U	U	U	U	U	U	U	U
Strontium-90	0.62 J	NA	NA	NA	U	U	0.64 J	U	U	U
Potassium-40	5	U	U	U	7	4.1	8.2	4.2	5.2	5.7
Actinium-228	0.79	U	U	U	U	U	U	U	U	U
Lead 214	U	U	U	U	U	U	U	U	U	U
Gross Alpha	21.1	NA	NA	NA	21.2	30.3	26.9	27.2	34.7	24
Gross Beta	37	NA	NA	NA	59.6	72.9	56.9	27.3	71	23.3

Notes:
Results are in pCi/g
U = Result is less than
the sample detection limit
J = Result is greater than
the sample detection limit
but less than the stated reporting limit
NA = Not Analyzed

Table 7
Post-Excavation
Animal/Chemical Pits Sample Results
Eastern Portion

Compound	Grid 11	Grid 12	Grid 13	Grid 14	Grid 15
Mercury	0.52 N	0.034 B	0.014 BN	0.39 N	0.0085 B
Americium-241	U	U	U	U	U
Beryllium-7	U	U	U	U	U
Cesium-134	0.41	U	U	0.207	U
Cesium-137	U	U	U	U	U
Cobalt-57	U	U	U	U	U
Cobalt-60	U	U	U	U	U
Europium-152	U	U	U	U	U
Europium-154	U	U	U	U	U
Europium-155	U	U	U	U	U
Manganese-54	U	U	U	U	U
Radium-226	U	0.30 J	U	U	0.57 J
Sodium-22	U	U	U	U	U
Thorium-228	0.283 J	0.36 J	0.48 J	0.38 J	0.54 J
Thorium-230	U	0.29 J	U	U	0.35 J
Thorium-232	0.52	0.35 J	U	U	0.38 J
Uranium-234	0.247 J	0.28 J	0.24 J	0.38 U	0.202 J
Uranium-235	U	U	U	U	U
Uranium-238	U	0.29 J	U	U	0.154 J
Vanadium-48	U	U	U	U	U
Zinc-65	U	U	U	U	U
Strontium-90	U	U	U	U	U
Potassium-40	4.4	U	4.5	4.7	4.5
Actinium-228	U	U	U	U	U
Lead 214	U	U	U	0.38	U
Gross Alpha	16.3	19.8	29.7	17.3	12.2
Gross Beta	19.5	37.4	26.6	30.2	14

Notes:
Results are in pCi/g
U = Result is less than
the sample detection limit
J = Result is greater than
the sample detection limit
but less than the stated reporting
NA = Not Analyzed

APPENDIX A
Pre- and Post- Excavation Walkover Surveys

BNL RADIOLOGICAL SURVEY FORM

Date: 3-2-04	Time: 1630	Bldg. # N/A	Location: Glass-Holes

Reason for Survey
- ☐ ROUTINE
- ☒ SPECIAL Walk over
- ☐ RWP#
- ☐ WP#

INSTRUMENTS

MODEL	SERIAL #	Cal Due Date	Source Check (Y/N)
E-600	00651	2-11-05	Yes
Probe	2108	2-11-05	N/A
N/A	N/A	N/A	

COMMENTS: Survey Done on 3-2-04 put onto grided map.

DOSE RATES (HIGHEST)

CONTACT	N/A
GENERAL AREA	N/A

AIRBORNE CONTAMINATION

SAMPLE #	VOLUME	uCi/cc	%DAC
N/A	N/A	N/A	N/A

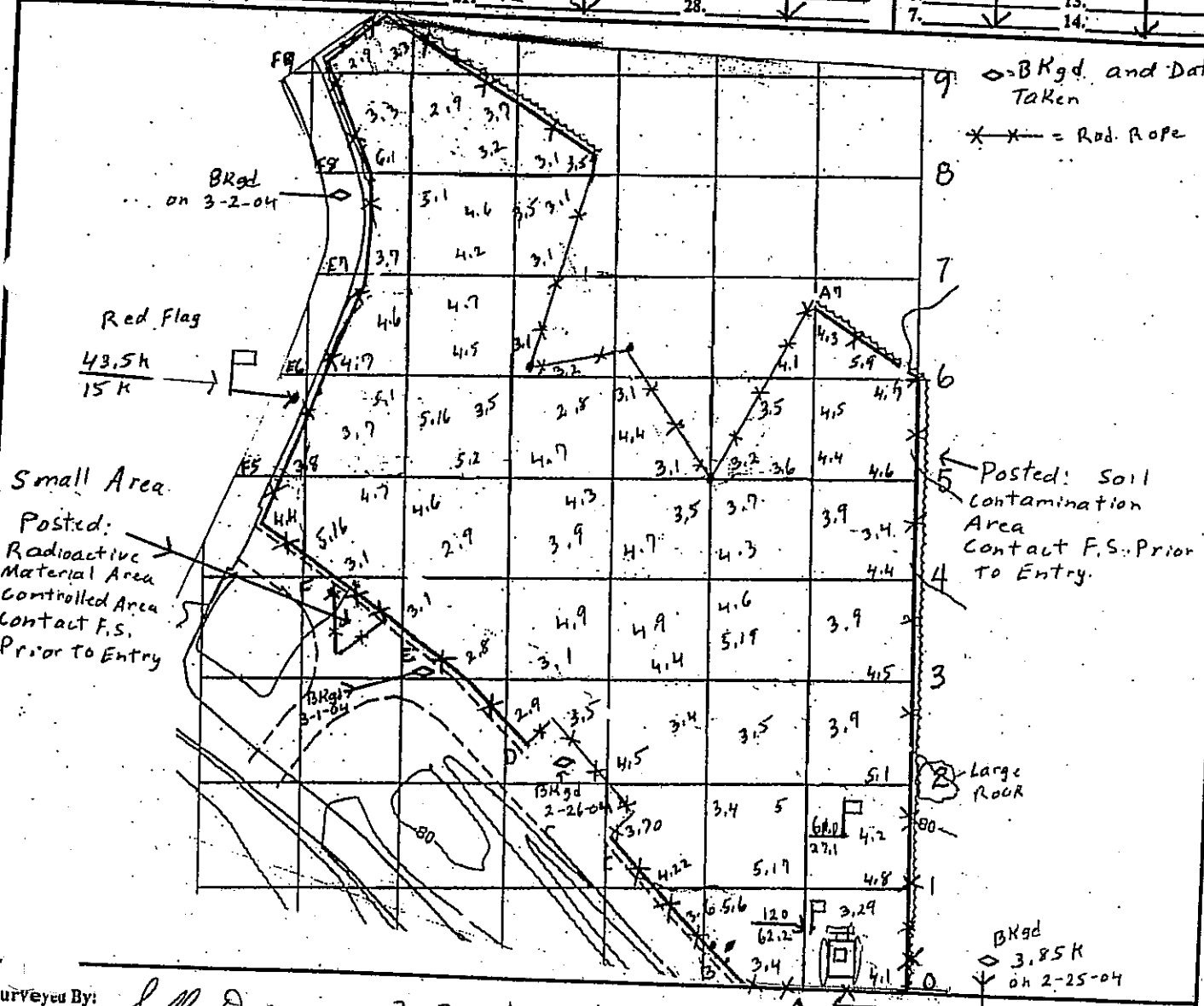
LEGEND
- O SMEAR SURVEY LOCATION
- ☐ MASSLINN SURVEY LOCATION
- Δ AIR SAMPLE LOCATION
- XXX Y = CONTACT READING
- ZZZ = READING @ 30 Cm
- Y = RADIATION TYPE

SMEAR SURVEY LOCATIONS (DPM/100 cm²) ^3H B-γ α (See Attached Printout for Survey Results)

1.	N/A	8.	N/A	15.	N/A	22.	N/A
2.		9.		16.		23.	
3.		10.		17.		24.	
4.		11.		18.		25.	
5.		12.		19.		26.	
6.		13.		20.		27.	
7.		14.		21.		28.	

MASSLINN SURVEY RESULTS (DPM)

1.	N/A	8.	N/A
2.		9.	
3.		10.	
4.		11.	
5.		12.	
6.		13.	
7.		14.	



Surveyed By: Sally Doray 3-2-04
Signature/Date

Reviewed By: [signature] 03-03-04
Signature/Date

BNL RADIOLOGICAL SURVEY FORM

Date: 12/19/03	Time: 1330	Bldg. # N/A	Location: Chem Holes

Reason for Survey
- ☐ ROUTINE
- ☐ SPECIAL
- ☒ RWP# ERD 03-26
- ☐ WP#

INSTRUMENTS

MODEL	SERIAL #	Cal Due Date	Source Check (Y/N)
E6-00	2108	3.3.04	yes
N/A	N/A	N/A	N/A

COMMENTS: 5th walkover Survey

DOSE RATES (HIGHEST)

CONTACT	N/A
GENERAL AREA	

AIRBORNE CONTAMINATION

SAMPLE #	VOLUME	uCi/cc	%DAC
N/A	N/A	N/A	N/A

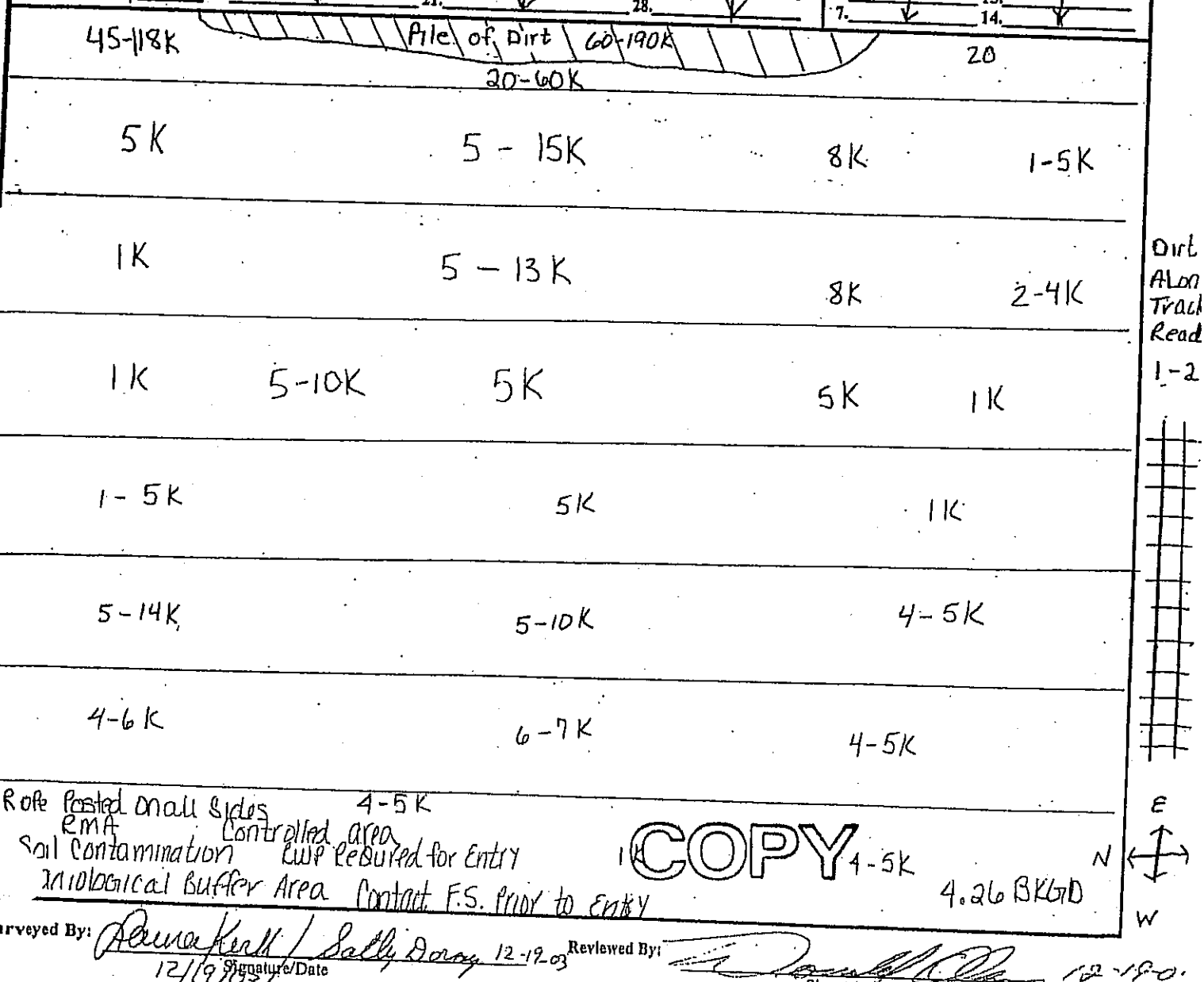
LEGEND
- ○ SMEAR SURVEY LOCATION
- □ MASSLINN SURVEY LOCATION
- △ AIR SAMPLE LOCATION
- XXX Y = XXX = CONTACT READING
- ZZZ = ZZZ = READING @ 30 Cm
- Y = RADIATION TYPE

SMEAR SURVEY LOCATIONS (DPM/100 cm²) ³H B γ α (See Attached Printout for Survey Results)

1. N/A	8. N/A	15. N/A	22. N/A
2.	9.	16.	23.
3.	10.	17.	24.
4.	11.	18.	25.
5.	12.	19.	26.
6.	13.	20.	27.
7.	14.	21.	28.

MASSLINN SURVEY RESULTS (DPM)

1. N/A	8. N/A
2.	9.
3.	10.
4.	11.
5.	12.
6.	13.
7.	14.



Surveyed By: Donna Kerk / Sally Dorsey 12-19-03 Signature/Date 12/19/03

Reviewed By: Signature/Date 12-19-03

BNL RADIOLOGICAL SURVEY FORM

Date: 2-10-04	Time: 1415	Bldg. # N/A	Location: Chemholes

Reason for Survey
- ☐ ROUTINE
- ☐ SPECIAL
- ☑ RWP# ERP 04-01
- ☐ WP#

INSTRUMENTS

MODEL	SERIAL #	Cal Due Date	Source Check (Y/N)
E-600 with	01625	5-15-04	Yes
Probe	726559	5-15-04	Yes
N/A	N/A	N/A	N/A
↓	↓	↓	↓

COMMENTS: Asfalt found in Both Areas Removed Asfalt with Dirt. Pre and Post survey

DOSE RATES (HIGHEST)	
CONTACT	N/A
GENERAL AREA	< 1 µR/hr

AIRBORNE CONTAMINATION			
SAMPLE #	VOLUME	uCi/cc	%DAC
N/A	N/A	N/A	N/A
↓	↓	↓	↓

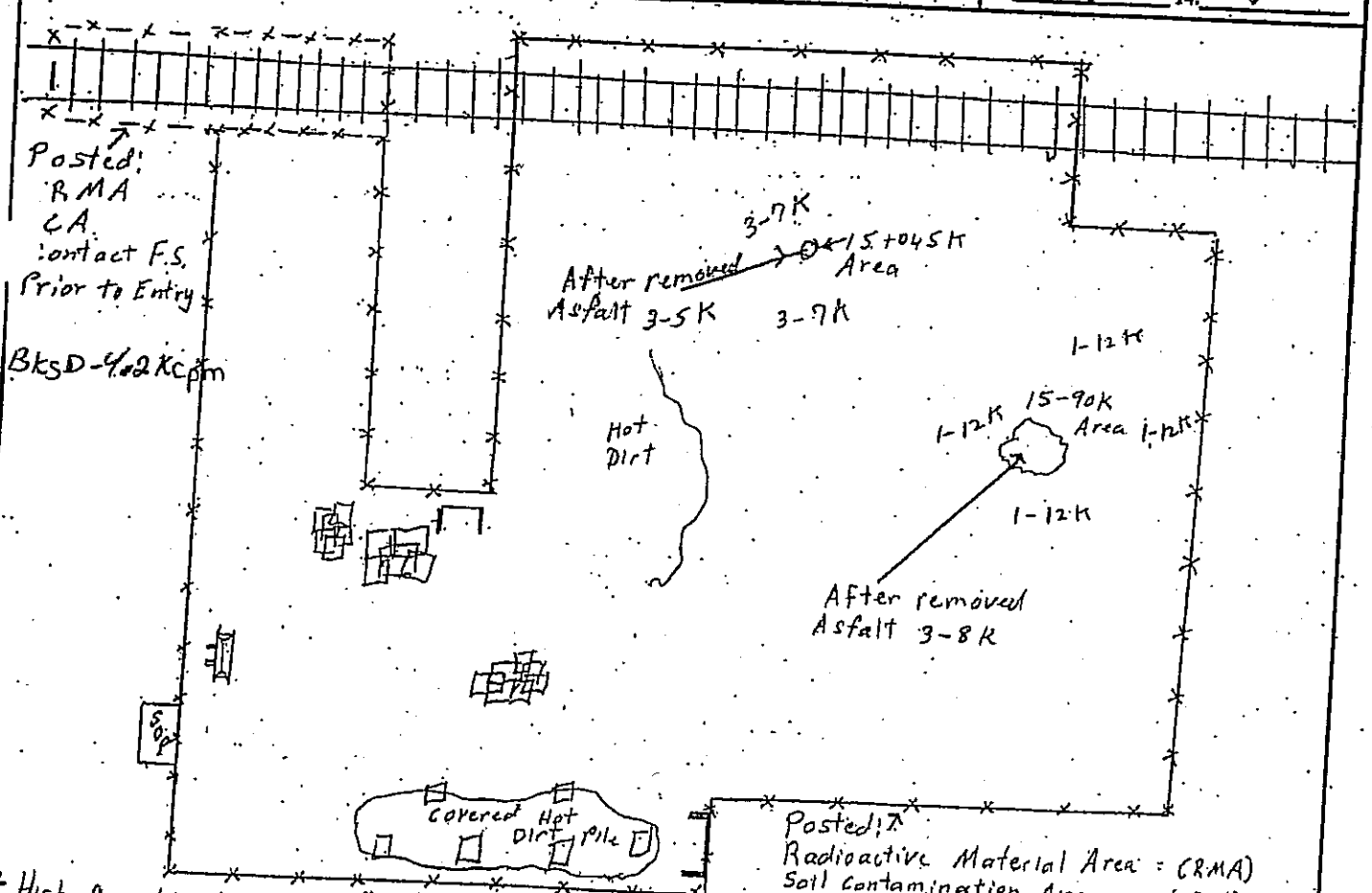
LEGEND
- O SMEAR SURVEY LOCATION
- □ MASSLINN SURVEY LOCATION
- Δ AIR SAMPLE LOCATION
- XXX Y
- ZZZ
- XXX = CONTACT READING
- ZZZ = READING @ 30 Cm
- Y = RADIATION TYPE

SMEAR SURVEY LOCATIONS (DPM/100 cm²) ^{3}H β-γ α (See Attached Printout for Survey Results)

1. N/A	8. N/A	15. N/A	22. N/A
2.	9.	16.	23.
3.	10.	17.	24.
4.	11.	18.	25.
5.	12.	19.	26.
6.	13.	20.	27.
7.	14.	21.	28.

MASSLINN SURVEY RESULTS (DPM).

1. N/A	8. N/A
2.	9.
3.	10.
4.	11.
5.	12.
6.	13.
7.	14.



* High count rate areas contained pieces of contaminated asphalt that were uncovered during soil sampling. All asphalt in all areas has not been removed from the surface. CEB

Surveyed By: Sally Doney 2-11-04
Signature/Date

Reviewed By: [signature] 2-11-04
Signature/Date

BNL RADIOLOGICAL SURVEY FORM

Date: 8/5/05 | Time: 1600 | Bldg. # N/A | Location: Chem holes

Reason for Survey
- ☐ ROUTINE
- ☒ SPECIAL Down Post
- ☐ RWP# 05-01
- ☐ WP#

INSTRUMENTS

MODEL	SERIAL #	Cal Due Date	Source Check (Y/N)
N/A	N/A	N/A	N/A

COMMENTS: N/A

DOSE RATES (HIGHEST)

CONTACT	N/A
GENERAL AREA	

AIRBORNE CONTAMINATION

SAMPLE #	VOLUME	uCi/cc	%DAC
N/A	N/A	N/A	N/A

LEGEND
- ○ SMEAR SURVEY LOCATION
- □ MASSLINN SURVEY LOCATION
- Δ AIR SAMPLE LOCATION
- XXX Y — XXX = CONTACT READING; ZZZ = READING @ 30 Cm; Y = RADIATION TYPE

SMEAR SURVEY LOCATIONS (DPM/100 cm²) ^{3}H β-γ α (See Attached Printout for Survey Results)

1.	N/A	8.	N/A	15.	N/A	22.	N/A
2.		9.		16.		23.	
3.		10.		17.		24.	
4.		11.		18.		25.	
5.		12.		19.		26.	
6.		13.		20.		27.	
7.		14.		21.		28.	

MASSLINN SURVEY RESULTS (DPM)

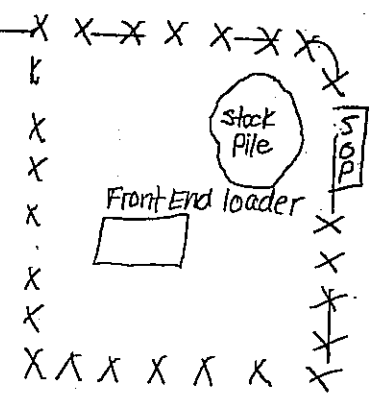
1.	N/A	8.	N/A
2.		9.	
3.		10.	
4.		11.	
5.		12.	
6.		13.	
7.		14.	

N↑

survey to show area Down Posted @ Chem holes

---- Indicates where Ropes were

XXX - Indicate where Ropes still exist.



This area was Down Posted after soil results and walk-overs were Completed. the remaining Area has a small Stock with Potential mercury. When this Pile is Removed the whole area will be down posted

Posted
RMA
SCA
RBA
FA
RWP Req.
Contact F.S.

Surveyed By: Anna Kuk 8/5/05
Signature/Date

Reviewed By:
Signature/Date

BNL RADIOLOGICAL SURVEY FORM

Date: 8/16/05 | Time: 1400 | Bldg. # N/A | Location: Chemholes

Reason for Survey
- ☐ ROUTINE
- ☒ SPECIAL Final-walk-over
- ☒ RWP# 05-01
- ☐ WP#

INSTRUMENTS

MODEL	SERIAL #	Cal Due Date	Source Check (Y/N)
ld 2221	211780	11-4-05	yes
probe	97082527	11-4-05	yes
		N	
			A

COMMENTS: N | A

DOSE RATES (HIGHEST)

CONTACT	N | A
GENERAL AREA	

AIRBORNE CONTAMINATION

SAMPLE #	VOLUME	uCi/cc	%DAC
		N	
			A

LEGEND
- O SMEAR SURVEY LOCATION
- ☐ MASSLINN SURVEY LOCATION
- Δ AIR SAMPLE LOCATION
- XXX Y — XXX = CONTACT READING
- ZZZ — ZZZ = READING @ 30 Cm
- Y = RADIATION TYPE

SMEAR SURVEY LOCATIONS (DPM/100 cm²) ³H B-γ α (See Attached Printout for Survey Results)

1.	8.	15.	22.		
2.	9.	16.	23.		
3.	10.	17.	24.	N	
4.	11.	18.	25.		
5.	12.	19.	26.		
6.	13.	20.	27.		
7.	14.	21.	28.		

MASSLINN SURVEY RESULTS (DPM)

1.	8.		
2.	9.		
3.	10.		
4.	11.		
5.	A	12.	
6.		13.	
7.		14.	

N ↑

Remaining Area that was roped of at Chem holes. Area was Posted as RMA

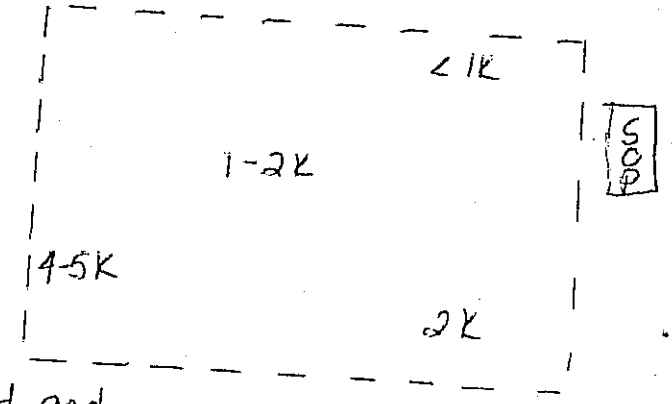
SCA

RBA

CA

RWP Req.

Contact F.S.

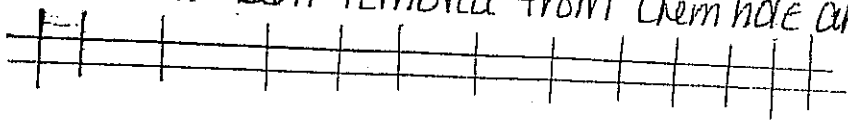


Remaining Stock Pile removed and all remaining Hoses and tools removed Area was Free of all Debris. A walk over survey with a 2x2 was used.

BKGND = 2.2K w/ Shielded Probe

BKGND was subtracted from all #'s and all #'s in C.P.M.

ALL Ropes have been removed from Chem hole area



By: [signature] 8/16/05
Signature/Date

Reviewed By:
Signature/Date

BNL RADIOLOGICAL SURVEY FORM

Date: 8/11/05	Time: 0930	Bldg. # N/A	Location: Glass Holes

Reason for Survey
- ☐ ROUTINE
- ☒ SPECIAL Walk - over Survey
- ☐ RWP#
- ☐ WP#

INSTRUMENTS

MODEL	SERIAL #	Cal Due Date	Source Check (Y/N)
Lud 2221	211780	11.4.05	YES
Probe	97082527	11.4.05	YES

COMMENTS: Walk-over survey w/ Lud 2221 - and 2x2 probe. (Shielded.)

DOSE RATES (HIGHEST)

CONTACT	N/A
GENERAL AREA	↓

AIRBORNE CONTAMINATION

SAMPLE #	VOLUME	uCi/cc	%DAC
N/A ↓	N/A ↓	N/A ↓	N/A ↓

LEGEND
- ○ SMEAR SURVEY LOCATION — XXX Y
- □ MASSLINN SURVEY LOCATION — ZZZ
- △ AIR SAMPLE LOCATION

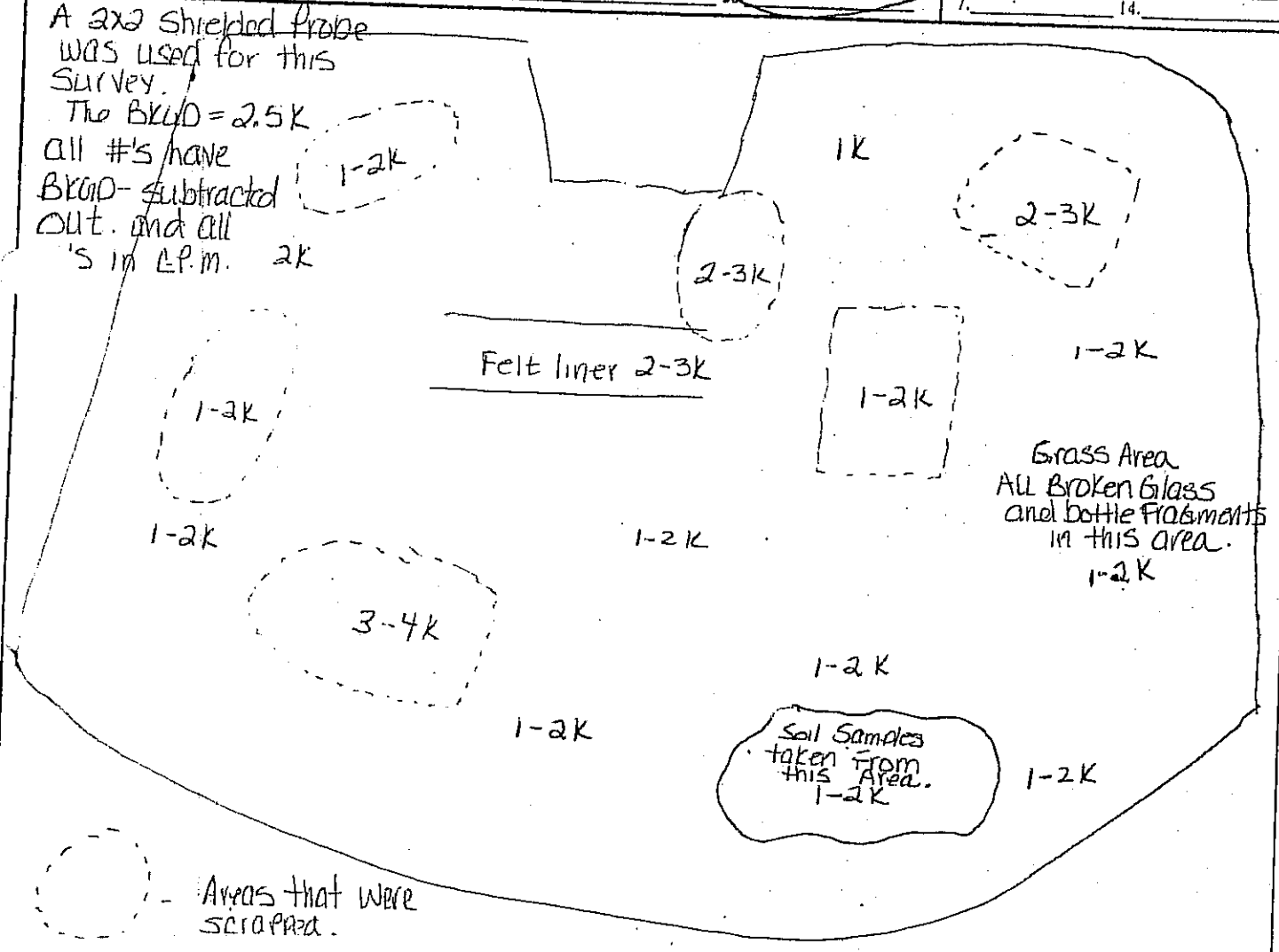
XXX = CONTACT READING; ZZZ = READING @ 30 Cm; Y = RADIATION TYPE

SMEAR SURVEY LOCATIONS (DPM/100 cm²) ³H B-γ α (See Attached Printout for Survey Results)

1.	8.	15.	22.
2.	9.	16.	23.
3.	10.	17.	24. N
4.	11.	18.	25.
5.	12.	19.	26.
6.	13.	20.	27.
7.	14.	21.	28.

MASSLINN SURVEY RESULTS (DPM)

1.	8.
2.	9.
3.	10.
4.	11.
5. A	12.
6.	13.
7.	14.



Surveyed By: Dana Kuk 8/11/05
Signature/Date

Reviewed By: _____
Signature/Date

COPY

Form FS-1000 FS-SOP-1000 File Code: HP3120

APPENDIX B
ER Operations Procedures Manual
4.18 *Gamma Survey of contaminated Soils using the Eberline E-600 Meter and Nal Detector*

ER Operations Procedures Manual

4.18 GAMMA SURVEY OF CONTAMINATED SOILS USING THE EBERLINE E-600 METER AND NaI DETECTOR

Text Pages 1 - 4
Attachment(s) 1

Approved: /s/ Richard Lykins Date: April 30, 2003
Richard Lykins
Environmental Restoration

Preparer: R. Pietrzak

ER-OPM-4.18, Revision 1

NSF-ISR
ENVIRONMENTAL MANAGEMENT SYSTEM REGISTERED TO ISO 14001:1996

4.18 GAMMA SURVEY OF CONTAMINATED SOILS USING THE EBERLINE E-600 METER AND NAI DETECTOR

1.0 PURPOSE AND SCOPE

A walkover surface survey of each area will be performed using a 2x2" sodium iodide (NaI) detector coupled with the Eberline E-600 ratemeter (or equivalent). This procedure describes the steps necessary for a gamma survey to locate areas of activity elevated above background. Instructions are provided for equipment setup, gamma survey and records management. The procedure addresses the operation of the Eberline E-600 meter coupled with a 2x2 inch sodium iodide detector (or equivalent).

Scanning is performed during radiological surveys to identify the presence of any location of elevated direct radiation. The NaI detectors have been correlated to measure Cs-137 concentration in the surface soil by comparing instrument response to location of elevated soil activity, which were then sampled and analyzed at an off-site laboratory by gamma spectroscopy. For the E-600 with the 2x2" NaI detector, 17500 counts per minute (cpm) or 17.5 kcpm is approximately equal to 23 pCi/g of Cs-137 for *in situ* soil. If an equivalent detector is utilized during the course of the project (ie: 3x3 instead of a 2x2 NaI), the 17500 cpm value will not necessarily apply to the 23 pCi/g cleanup criteria for Cs-137.

2.0 RESPONSIBILITIES

The operator is responsible for:

- Maintaining the instrument and accessories referred to in this procedure
- Ensuring that the instrument is operational, calibrated and the alarm level set by the Instrumentation Division for routine use.
- Reviewing the Field Sampling Plan to ensure knowledge of the survey objectives prior to performing the analysis.
- Maintaining a record of areas of elevated activity and sample location.

3.0 PREREQUISITES

3.1 Training

Personnel shall be familiar with the E-600 Portable Radiation Monitor Technical Manual and equipment (or equivalent). The health physics training needed is BNL Rad Worker I (RWT100) and Rad Worker II (RWT300 and 300a).

3.2 Equipment and Technical Requirements.

The E-600 meter and 2x2" NaI probe (or equivalent) shall be setup and calibrated by the Instrument and Equipment Calibration (I&EC) Group of the Radcon Division staff prior to use.

4.0 PRECAUTIONS AND LIMITATIONS

4.1 The system is a mobile instrument and can be taken to and used in locations with a variety of physical, environmental, health, and safety hazards. When performing in the field, the instrument operator should coordinate with BNL safety personnel and become familiar with any hazards and controls associated with the areas being surveyed.

4.2 The instrument may be powered by either alkaline or nickel-cadmium batteries, both of which contain heavy metals and other hazardous materials which must be handled and disposed of properly. Do not mix batteries of different types or charge states in the same instrument. Recharge only batteries specifically designated as rechargeable, and always follow manufacturer's charging recommendations. Do not puncture, mutilate or attempt to disassemble batteries. Do not heat cells above 100 C (212 F). Eberline recommends that batteries be recycled at appropriate recycling centers or disposed of as required by local ordinances and regulations.

For the E-600 only:

4.3 The E-600 is usually powered by three alkaline "C" batteries, which start out at a nominal 4.5 Volts when new. Operation will continue until this voltage falls to about 3.0 Volts. The battery icon on the display will come on when the batteries fall below 3.15 volts and will begin to flash at 3.08 Volts. Because batteries degrade rapidly once they fall below approximately 60% of their initial voltage, it is advisable to replace them soon after the battery icon first appears. Dead batteries may also leak, therefore, remove them from the instrument to prevent corrosion.

4.4 Potentials in excess of 2000 volts may be present on the probe connector. This voltage may remain for up to one minute after the probe is disconnected or the unit is turned off. Never insert fingers or metallic objects into the probe connector on the instrument or probe cable.

4.5 This instrument should never be disassembled except by a qualified technician who is experienced and familiar with the E-600 design.

4.6 When the E-600 is first powered on, the calibration due date stored in its memory is compared against the current date. If the instrument is past due for calibration, the Out of Calibration icon is turned on and normal operation is inhibited. In a similar manner, the probe's calibration due date is checked when the E-600 is powered on or when a new probe is connected.

5.0 PROCEDURE

Prior to performing this procedure, see Section 3.0, prerequisite knowledge and precautions.

The actual soil locations to be assessed are identified in the Work Plan and the Sampling and Analysis Plan (WP/SAP) that will be available to the instrument operator.

5.1. Determine the battery condition using the check mode. The batteries should be >60% of initial voltage.

5.2. The NaI detector and Eberline 600 (or equivalent) should be source checked daily before use in accordance with FS SOP 2010.

5.3. In the background mode determine the gamma background. Press the * button to save.

5.4. The meter should be turned on to the rate meter mode giving the net counts.

5.5. A surface scan is performed by holding the NaI detector 1 inch (2.5 cm) above the ground and moving it at a rate of about 0.5 m/s. A 100% surface scan of the survey areas shall be made moving in a side to side "snaking " pattern.

5.6. When the instrument audible alarm indicates a response of MDCR value above reference area background, the scan will be halted, and the position of highest response will be located, its lateral size determined.

5.7. A stationary reading will be performed for 4-5 seconds with the detector within 1 inch (2.5 cm) of the surface.

5.8. Plot the area of elevated gamma response between 1000 and 4000 cpm above the reference area background on the posting chart and reviewed for trends in elevated concentrations that may not be apparent from the reading themselves.

5.9. If the stationary count exceeds 4000 cpm above reference area background, a record of the grid location on the posting chart shall be made. Flag the area for ease of location and collect a soil sample for gamma spectroscopy analysis.

5.10. The data will be evaluated for possible excavation.

6.0 RECORDS

6.1 Posting chart: used to plot location and lateral size of areas 1000 to 4000 cpm above the reference area background.

7.0 REFERENCES

7.1 E-600 Portable Radiation Monitor Technical Manual, Eberline Thermo Instrument Systems Inc., Santa Fe, New Mexico, July 1998.

7.2 Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, NUREG-1507, December 1997.

7.3 FS-SOP 2010 Periodic Instrument Response Check.

8.0 ATTACHMENTS

8.1 Attachment 1 Determination of Scanning Sensitivity.

8.2 Attachment 2 Calibration curve under development.

9.0 DEFINITIONS

9.1 ***In situ:*** Performed in the natural or normal place: at the site of origin without invasive procedures or disruption of the media.

ATTACHMENT 1

DETERMINATION OF SCANNING SENSITIVITY

1.0 Introduction

Scanning is often performed during radiological surveys in support of decommissioning to identify the presence of any locations of elevated direct radiation. The probability of detecting residual contamination in the field is not only affected by the sensitivity of the survey instrumentation when used in the rate meter mode of operation, but also by the surveyor's ability. The surveyor must decide whether the signals represent only the background activity, or whether they represent residual contamination in excess of background.

The minimum detectable concentration of a scan survey (scan MDC) depends on the intrinsic characteristics of the detector (efficiency, window area, etc.), the nature (type and energy of emissions) and relative distribution of the potential contamination (point versus distributed source and depth of contamination), the scan rate and other characteristics of the surveyor. Some factors that may affect the surveyor's performance include the costs associated with various outcomes—e.g., cost of missed contamination versus cost of incorrectly identifying areas as being contaminated —and the surveyor's *a priori* expectation of the likelihood of contamination present. For example, if the surveyor believes that the potential for contamination is very low, as in an unaffected area, a relatively large signal may be required for the surveyor to conclude that contamination is present.

A discussion of the calculation of scanning minimum detectable concentration (MDC) and the scanning minimum detectable count rate (MDCR) is provided in the *MARSSIM*. More detail on signal detection theory and instrument response is provided in NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, December 1997, from which the following discussion is drawn.

1.1 Minimum Detectable Count Rate and Surveyor Efficiency

The framework for determining the scan sensitivity is based on the premise that there are two stages of scanning. That is, surveyors do not make decisions on the basis of a single indication, rather, upon noting an increased number of counts, they pause briefly and then decide whether to move on or take further measurements. Thus, scanning consists of two components: continuous monitoring and stationary sampling. In the first component, characterized by continuous movement of the probe, the surveyor has only a brief "look" at potential sources, determined by the scan speed. The surveyor's willingness to decide that a signal is present at this stage is likely to be liberal, in that the surveyor should respond positively on scant evidence, since the only "cost" of a false positive is a little time. The second component occurs only after a positive response was made at the first stage. This response is marked by the surveyor interrupting his scanning and holding the probe stationary for a period of time, while comparing the instrument output signal during that time to the background counting rate. Owing to the longer observation interval, sensitivity is relatively high. For this decision, the criterion should be more strict, since

the cost of a "yes" decision is to spend considerably more time taking a static measurement or a sample.

Since scanning can be divided into two stages, it is necessary to consider the survey's scan sensitivity for each of the stages. Typically, the minimum detectable count rate (MDCR) associated with the first scanning stage will be greater due to the brief observation intervals of continuous monitoring—provided that the length of the pause during the second stage is significantly longer. Typically, observation intervals during the first stage are on the order of 1 or 2 seconds, while the second stage pause may be several seconds long. The greater value of MDCR from each of the scan stages is used to determine the scan sensitivity for the surveyor.

The minimum detectable number of net source counts in the interval is denoted by s_i. Therefore, for an ideal observer, the number of source counts required for a specified level of performance can be arrived at by multiplying the square root of the number of background counts by the detectability value associated with the desired performance (as reflected in d') as shown in [Equation 6-8, MARSSIM]:

$$s_i = d' (b_i)^{1/2}$$

where the value of d' is selected from MARSSIM Table 6.5 based on the required true positive and false positive rates and b_i is the number of background counts in the interval.

The minimum detectable source count rate (*MDCR*), in cpm, detectable during the observation interval i, in seconds, by an "ideal" surveyor may be calculated by [Equation 6-9, MARSSIM]:

$$MDCR = s_i \times (60 / i)$$

For the case of real surveyors who are not equivalent to the "ideal" construct, MARSSIM recommends assuming an efficiency value at the lower end of the observed range of 0.75 – 0.50 *(i.e.*, p = 0.5) when making MDCR estimates. Thus, the required number of net source counts for the surveyor, $MDCR_{surveyor}$, is determined by dividing the MDCR by the square root of p.

Consider the calculation of the MDCR for the case of 2 inch by 2 inch NaI(Tl) scintillation detector used in the walkover scan performed in this project. The observed background level is 8,000 cpm. The desired level of performance, 95% correct detections and 60% false positive rate, results in a d' of 1.38 [Table 6-5, MARSSIM]. The scan rate of 0.5m/s at an observation interval of 1 to 2 seconds, results in a diameter of about 60 cm for the area of activity observed. The $MDCR_{surveyor}$ may be calculated assuming a surveyor efficiency (p) of 0.5 as follows:

1) b_i = (8,000 cpm) × (1 sec) × (1 min/60 sec) = 133 counts
2) MDCR = (1.38) × (133)$^{1/2}$ / (1 sec) × (60 sec/1 min) = 956 cpm
3) $MDCR_{surveyor}$ = 956 / (0.5)$^{1/2}$ = 1,352 cpm net above background

The minimum number of source counts required to support a given level of performance for the final detection decision (second scan stage) can be estimated using the same method. As explained earlier, the performance goal at this stage will be more demanding. The required rate of true positives remains high *(e.g.,* 95%), but fewer false positives *(e.g.,* 20%) can be tolerated, such that *d'* (from Table 6.5) is now 2.48. For this second stage of the scan survey, the surveyor typically stops the probe over a suspect location for about 4 seconds before making a decision,

1) b_i = (8,000 cpm) × (4 sec) × (1 min/60 sec) = 533 counts
2) MDCR = (2.48) × (533) $^{1/2}$ / (4 sec) × (60 sec/1 min) = 859 cpm
3) $MDCR_{surveyor}$ = 859 / (0.5) $^{1/2}$ = 1,215 cpm net above background

The greater of the calculated $MDCR_{surveyor}$ values is 1,352 cpm above background or approximately 9,350 cpm gross. This is the value chosen for the $MDCR_{surveyor}$.

1.2 Scanning Minimum Detectable Concentration

Having determined an estimate of the minimum instrument count rate detected by a real observer in the field, the count rate must be translated to the units corresponding to those of the DCGL (pCi/g). During remediation at BNL, the scanning survey may be performed with an Eberline E-600 ratemeter and a 2x2 NaI detector or equivalent. Data relating this instrument response to Cs-137 in surface soil are provided in Figure C-1. The greater of the $MDCR_{surveyor}$ values calculated in the previous section is 1,352 cpm above background or approximately 9,350 cpm gross. From the graph of the Figure C-1 and the correlation equation, it is seen that an instrument response of 9,350 cpm corresponds to a surface soil concentration of approximately 7 pCi/g Cs-137. This is then the scanning minimum detectable concentration that corresponds to the $MDCR_{surveyor}$.

Since the $MDCR_{surveyor}$, corresponding to a scanning MDC of 7 pCi/g, is less than the $DCGL_W$, it will be less than any $DCGL_{EMC}$, and the MARSSIM statistical method of number of samples for the systematic survey need not be adjusted. There is assurance that

1) the statistics of the method will demonstrate whether or not the residual activity in an area exceeds 23 pCi/g ($DCGL_W$) and
2) any areas of elevated residual radioactivity ($DCGL_{EMC}$ will be greater than 23 pCi/g) will not be missed during the final status survey.

For the case of BNL radioactive material remediation, the $DCGL_W$ for Cs-137 may be modified so that it can be used as a surrogate indicator for the presence of Sr-90. This value of $DCGL_{Mod}$ will be less than 23 pCi/g, and following remediation, a definitive value will be calculated from Cs-137 to Sr-90 ratios observed in the soils. The scanning MDC of 7 pCi/g is low, will be below realistic values of $DCGL_{Mod}$, and therefore it should not impact on the number of sample positions calculated for the systematic survey.

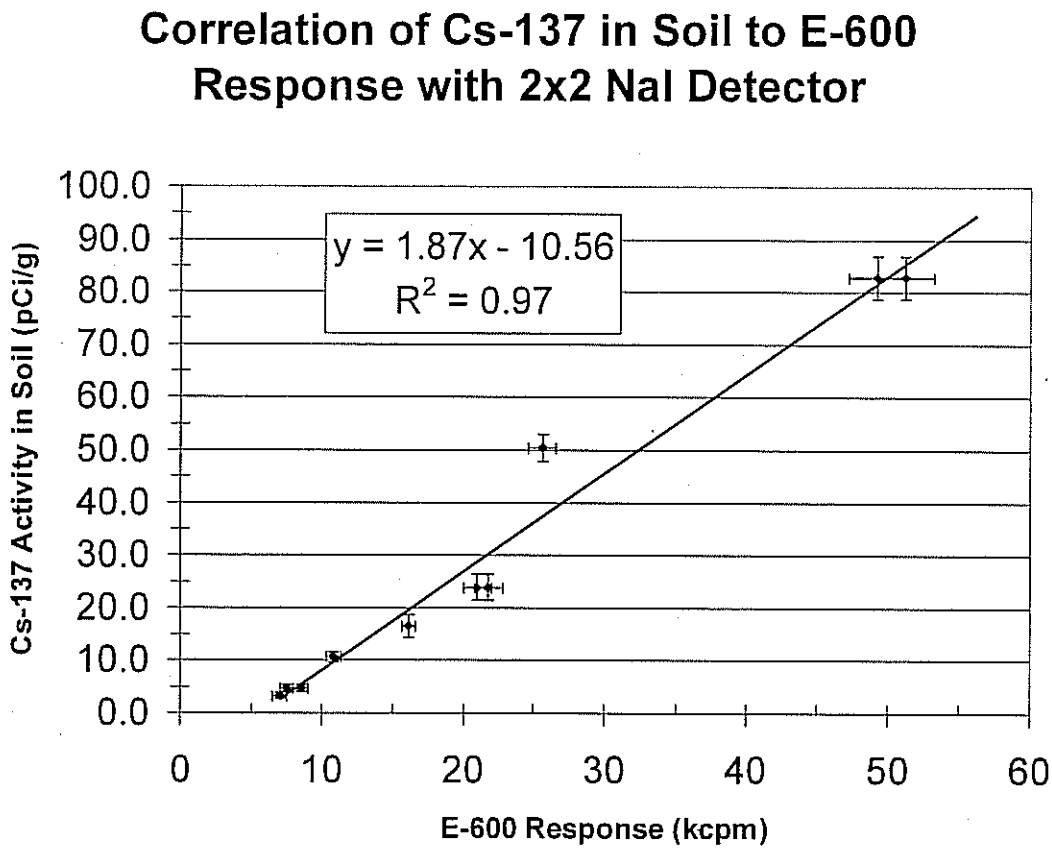


Figure C-1. Correlation of Cs-137 concentration in Surface soil to E-600 Response

PLEASE CLICK HERE TO COMPLETE READING ACKNOWELDGEMENT FORM

APPENDIX C
Environmental Monitoring Procedure, EM –SOP-601, *Collection of Soil Samples*

BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL MONITORING PROCEDURE

Collection of Soil Samples

1.0 PURPOSE AND SCOPE 2

2.0 RESPONSIBILITIES 2

3.0 DEFINITIONS 2

4.0 PREREQUISITES 2

5.0 PRECAUTIONS 3

6.0 PROCEDURE 5

7.0 IMPLEMENTATION AND TRAINING 8

8.0 REFERENCES 8

9.0 ATTACHMENTS 8

PREPARED BY:	REVIEWED BY:	APPROVED BY:
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Author/Date	QR/Date	G. Goode / 3/5/03
	D. Paquette / 3/4/03	EM Directorate/Date
	Subject Matter Expert/Date	R. Howe for L. Hill / 3/10/03
		EFFECTIVE DATE: Mar. 10, 2003
		REVIEW CYCLE: 3 YEARS
Filing Code: EC45ER.03		

1.0 PURPOSE AND SCOPE

The purpose of this procedure is to provide a standard methodology for collecting representative surface and core soil samples for radiological and non-radiological analysis. This procedure applies to the collection of surface soil samples, soil auger samples, soil cores, and cesspool soil samples.

2.0 RESPONSIBILITIES

It is the responsibility of the assigned field sampling personnel to collect representative soil samples and complete all documentation as described in this procedure. The project engineer, or hydrogeologist is responsible for developing a project specific sampling and analysis plan and a work permit using assistance from Industrial Hygiene Group, and /or Facility Support Services (for instruction on completing a Sample Request form, see EM-SOP-100). The Geoprobe® Coordinator is responsible for providing Geoprobe® sampling equipment, trained operators, and technical support. All records generated as results of this procedure are to be maintained in the appropriate project file in accordance with the ESH&Q Directorate Records Management procedure (DH-ADM-002).

3.0 DEFINITIONS

3.1 BNL – Brookhaven National Laboratory.

3.2 ER – Environmental Restoration Program.

3.3 ES- Environmental Surveillance Program.

3.4 Geoprobe®- A brand name of hydraulically powered machines that utilize both static force and percussion to advance sampling tools in the subsurface.

3.5 PE – Plant Engineering.

3.6 PPE – Personal Protective Equipment.

3.7 RWP – Radiation Work permit.

3.8 Subsurface Soil – Soil taken at a depth greater than 6 inches.

3.9 Surface Soil – Soil taken at a depth of 0 –6 inches.

3.10 VOC – Volatile organic compounds.

3.11 PETG – Polyethylene Terephthalte.

3.12 PVC – Polyvinyl Chloride.

4.0 PREREQUISITES

4.1 PPE as defined in the Work Permit.

4.2 Indelible black pens and markers.

4.3 Tape measure.

4.4 Stainless steel mixing bowls.

4.5 Stainless steel sampling spoons.

4.6 Distilled/deionized water.

4.7 Water sprayers.

4.8 Plastic bags and sheets.

4.9 Plastic 10 gal bucket.

4.10 Paper towels.

4.11 Cooler with.

4.12 Thermometer or a temperature bottle as required by the project manager.

4.13 Brushes and scrub pads.

4.14 Micro® wash cleaner.

4.15 Shovels.

4.16 Stainless steel core samplers with polyethylene liners.

4.17 Core sampler hammer attachment.

4.18 Core sampler thread on extension.

4.19 Stainless steel augers.

4.20 Field notebooks.

4.21 Sample containers.

4.22 Camera (optional).

4.23 Flags.

4.24 Metal detector.

4.25 BNL Chain of Custody Form.

4.26 Soil Sampling Log.

4.27 Sampling and Analysis Plan.

4.28 Work Permit.

4.29 Equipment as required in the Geoprobe® Technical Bulletins outlined in this procedure.

5.0 PRECAUTIONS

5.1 Check the Work Permit to see if a digging permit is required before sampling begins. If so, complete Plant Engineering Digging Permit.

5.2 If a digging permit is required, PE must mark all underground utility lines before soil sampling begins.

5.3 If work is to be performed in a Radiological Area, check with the Facility Support Services Representative to see if a RWP is required before work begins.

5.4 A trench or pit greater than five feet in depth must be sloped or protected by shoring system as required by OSHA if entry is required. Consult with the Construction Safety staff as necessary. The use of extension poles for augers and coring tools should be utilized when possible to prevent the need to enter such areas.

5.5 When using extension poles, be aware of overhead utilities and wire trays in the area.

5.6 All sampling equipment must be decontaminated and wrapped in foil before entering the field. If equipment is to be reused while in the field, it must be thoroughly decontaminated prior to its re-use (See EM-SOP-801).

5.7 All sampling equipment must be made of stainless steel or Teflon. No chrome plated equipment or other materials may be used unless approved by the project manager.

5.8 If safety issues are encountered at any time during sampling, stop work and notify supervisor.

5.9 To avoid cross-contamination of sampling equipment, cover an area of the ground with plastic sheets on which to place equipment.

5.10 At least two people should be present during any soil-sampling event.

5.11 Gloves must be changed between each sample to avoid cross contamination.

5.12 A clean soil recovery probe must be used for each core, unless a composite sample from the same sample site is being taken.

5.13 Soil samples collected with the Geoprobe® shall be collected in accordance with the either the Geoprobe® Large Bore Soil Sampler SOP (Technical Bulletin No. 93-660) or the Geoprobe® Macro-Core Soil (Sampler SOP Technical Bulletin No. 95-8500) and the Geoprobe® Safety Instructions

5.14 All samples collected for onsite analysis should be submitted the same day that the sample is collected. If samples cannot be submitted or shipped off site the same day, they must be placed inside a secured area and those requiring cooling placed inside a refrigerator or a cooler with sufficient ice to maintain the samples at the required temperature. The samples must then be submitted the next working day.

5.15 Samples for offsite analysis shall be transferred to the contract laboratory on the day of collection. If this is not possible or if the samples are to be shipped for analysis, they must be placed in a secured area and those requiring cooling placed in a refrigerator or a cooler with sufficient ice to maintain the samples at the required temperature. Samples collected for offsite analysis shall be shipped or transferred to the contract laboratory in a custody-sealed cooler along with the chain of custody.

5.16 At sample locations along roadways, use precaution when stationing vehicles and equipment as not to place personnel in danger with respect to passing traffic. The use of four-way flasher is required. Use traffic cones when necessary.

6.0 PROCEDURE

6.1 Pre-Sampling Preparation

6.1.1 Review the Sampling Request Form, or Site Specific Soil Sampling Plan before starting work. Read and sign the Work Permit and the RWP before starting work.

6.1.2 Obtain all equipment needed for the soil-sampling event. Inspect the equipment prior to use to ensure it is clean and in proper working order. All equipment checks will be preformed prior to entry into the contaminated area to reduce exposure to contaminants.

6.1.3 For all non-routine soil analyses, consult with the analytical lab to determine the type of bottle, volume of sample, and preservative needed for the collection of samples.

6.2 Field Preparation

6.2.1 Don the appropriate PPE before entering the work area and follow all precautions outlined in the Work Permit and/or RWP.

6.2.2 If the sampling plan contains a map with sample locations marked to scale, use it to identify and flag locations. If a sample location map is not provided, use a tape measure to accurately measure distances between sample locations and fixed landmarks (e.g., buildings, roadways, manhole covers, etc.), and mark the locations with flags. Sketch a map of the area in the field notebook.

6.3 Surface Soil Sample Collection (0 - 6")

6.3.1 Using a clean shovel, carefully remove the vegetation or undesirable debris from the top layer of soil to reach the desired sample depth determined from the sampling plan.

6.3.2 Using a clean spoon, remove and discard a thin layer of soil from the area that came in contact with the shovel. Place the spoon into a plastic bag for later decontamination.

6.3.3 Using a second pre-cleaned spoon collect the desired volume of soil from a horizon no more than six inches deep. Avoid digging in the vertical direction. Transfer sample into appropriate sample container(s).

6.3.4 Place soil sample for volatile organic compounds (VOC) analysis directly into the sample containers. Do not mix or composite samples. Cap immediately.

6.3.5 Mix soil for composite and duplicate sample (non-VOC analysis) until homogeneous and place in the appropriate container(s).

6.3.6 Label the sampling containers with the appropriate label(s). Place any sample(s) that need to be cooled in a cooler with ice.

6.3.7 Complete the Soil Sampling Log and BNL Chain of Custody Form. Submit the samples to the appropriate laboratory for analysis.

6.3.8 Record sample identification number, location, date, and any additional comments in the Field Log Notebook.

6.4 Soil Core Sampling (0-2 feet maxium)

6.4.1 Assemble an AMS® soil probe by inserting a polyethylene liner and screwing on the end cap. Attach extension rods as necessary.

6.4.2 Screw the slide hammer onto the recovery probe, making sure connection is tight.

NOTE: Caution should be used to avoid catching a finger between hammer and probe or hitting oneself when hammering up the probe.

6.4.3 Drive the soil recovery probe to the desired depth at the marked location. If the probe hits an obstacle, move probe over several inches and mark a new location.

6.4.4 Remove the soil recovery probe by driving the hammer up until the probe is removed from the ground.

6.4.5 Unscrew the hammer and end cap from the soil recovery probe. Remove the liner from the probe, being careful not to dislodge the sample inside.

6.4.6 Carefully place one end of the liner in the sample container and tap the side of the liner until the soil empties. If the soil will not come out, place the liner on a plastic sheet and cut it open with a new or decontaminated utility knife blade. Using a clean spoon, scoop out the soil and place it in the appropriate container.

6.4.7 If the first core does not provide a sufficient volume, additional cores may be taken no more than six inches from the original core.

6.4.8 Collect VOC samples directly from the liner and place in the sample container(s). Cap immediately.

6.4.9 For composite and duplicate samples (Non-VOC analyses), mix the soil until homogeneous, and then place into the appropriate container(s).

6.4.10 Label the sample containers with the appropriate labels. Place any sample(s) that need to be cooled in a cooler with ice.

6.4.11 Complete the Soil Sampling Log and BNL Chain of Custody Form. Submit the samples to the appropriate laboratory for analysis.

6.4.12 Record sample identification numbers, date, and any additional comments in the Field Log Notebook.

6.5 Soil Auger Sampling

6.5.1 Attach auger bit and "T" handle to extension rod.

6.5.2 Using a clean shovel clear an area approximately 6 inches in radius around sample area of any vegetation or debris.

6.5.3 Begin auguring, removing and depositing accumulated soil onto a clean plastic sheet. After reaching the desired depth, slowly remove the auger from the boring.

6.5.4 If a VOC sample is to be collected, it must be taken directly from the auger, transfer soil sample using a stainless steel spoon into an appropriate sample container. Cap immediately.

6.5.5 Composite (Non-VOC analysis) and duplicate samples should be mixed until homogeneous, and placed into the appropriate sample container.

6.5.6 If another sample is to be collected in the same auger sample hole, but at a greater depth, attach a clean auger with extension. If a core sample is required, follow the soil core sampling steps in section 6.4.

6.5.7 Label the sample containers with the appropriate labels. Place the sample(s) that need to be cooled in a cooler with ice packs.

6.5.8 Complete the Soil Sampling Log and BNL Chain of Custody Form. Submit the samples to the appropriate laboratory for analysis.

6.5.9 Record sample identification numbers, locations, date and additional comments in Field Log Notebook.

6.6 Cesspool Soil Sampling

6.6.1 Request that Plant Engineering Water Treatment Plant staff locate and remove cesspool covers.

6.6.2 Depending on the type of cesspool and the depth of the cesspool, follow section 6.3, 6.4 or 6.5 of this procedure when collecting soil from cesspool(s). Refer to the Sampling Request Form or Sampling Plan for any additional information.

6.6.3 Note the depth of the pool bottom and any physical characteristics of pool contents (i.e., liquid, sludge, and sand). If liquids or sludges are present, a sample of each may be required. Confirm with requestor.

6.6.4 After sampling is finished, have WTP personnel replace cesspool covers.

6.6.5 Complete the Soil Sampling Log and BNL Chain of Custody Form. Submit the samples to the appropriate laboratory for analysis.

6.6.6 Record sample identification numbers, location, date, and any additional comments in Field Log Notebook.

6.7 Geoprobe® Soil Core Sampling (Land surface to about 60 feet)

6.7.1 Soil sample collection with a Macro Core Sampler is conducted by following the instruction in Geoprobe® Technical Bulletin No. 95-8500. This sampling technique is similar to the method described in Section 6.5 above. The Macro Core sampler is a solid steel barrel 52 inches long with an outside diameter (OD) of 2.2 inches and collects up to 1300 ml volume of soil in a removable liner. Liners typically used are made of PETG, but stainless steel, Teflon and PVC are also available. Refer to the Sampling and Analysis plan for the appropriate liner. The Macro Core can operate as a continuous coring sampler or a closed piston system for discrete intervals.

6.7.2 Soil sample collection with a Large Bore Sampler is conducted by following the instruction in Geoprobe® Technical Bulletin No. 93-660. The Large Bore is a piston-sealed, direct push device for collecting discrete interval samples of unconsolidated materials at depth. The Large bore is approximately 30 inches long with an OD of 1.5 inches and collects up to 283 ml volume of soil in a removable liner. Liners are available in brass, stainless steel, Teflon™ and clear plastic (cellulose acetate butyrate). Refer to the Sampling and Analysis plan for the appropriate liner.

7.0 IMPLEMENTATION AND TRAINING

7.1 ES Monitoring Services, Field Sampling Team or Contract personnel shall implement this procedure for the collection of soil samples.

7.2 Staff responsible for implementing this procedure shall be thoroughly familiar with its contents and requirements. Each staff member shall document that they have read and understood the procedure

8.0 REFERENCES

8.1 U.S. EPA Environmental Response Team, Response Team SOP# 2012 Soil Sampling 11/16/94.

8.2 Geoprobe® Large Bore Soil Sampler SOP, Technical Bulletin No. 93-660, September 1996.

8.3 Geoprobe® Macro Core Soil Sampler SOP, Technical Bulletin No. 95-8500, September 1998.

8.4 Geoprobe® Safety Instructions from the Geoprobe Model 5400 Owner's Manual Section 3.0.

8.5 EM-SOP- 801, Decontamination of Sampling Equipment.

8.6 EM-SOP-201, Documentation of Field Activities.

8.7 DH-ADM-002, ESH&Q Directorate Records Management procedure.

9.0 ATTACHMENTS

9.1 Attachment 1 - Soil Sampling Log.

9.2 Attachment 2 – Plant Engineering Digging Permit.

COMMENTS ON THE CHEMICAL HOLES DRAFT CLOSURE REPORT ADDENDUM

COMMENT RESOLUTION FORM

Reviewer and Organization: Sy Robbins and Eileen Governale, SCDHS		
No.	**SCDHS Comment**	**BNL Response**
1	SCDHS Original Comment The SCDHS finds that the waste types and volumes removed correlate with the records from the 1997 pit excavations and waste storage. The soil sampling that was done post waste removal is satisfactory. However, the SCDHS would like a clarification as to how the soils in the eastern portion became rad and Hg contaminated; this was the area where soil stockpiles from the original glass hole excavations were kept, and the piles were supposedly designed to prevent infiltration. *SCDHS Follow-up Comment* *SCDHS' question was not answered sufficiently and was perhaps misunderstood. It does not pertain to the results of the closeout report and release findings: The question was if the original glass hole stockpiles in the eastern section were responsible for the rad and mercury surface contamination (prior to the use of the area for the FHWMF debris packaging)? This has relevance to our office because the stockpiles were specifically designed to prevent the formation of leachate and contaminated run-*	BNL Original Response When the stockpiles were loaded for transportation and disposal in 2003 the contaminated building debris from the former hazardous waste management facility was brought down to the eastern chemical holes for packaging efficiency. This was documented in the building D&D work plan and closeout report. *BNL Follow-up Response* *BNL did not mean to imply that the original stockpiles had failed. In the course of loading railcars, the stockpile liners were ripped and some contaminated soil was spread on the surface of the loading area. The majority of the radiological soil contamination was caused by the contaminated building material brought into the chemical holes to be blended with the soil for packaging efficiency. In the end, the site was surveyed and sampled to verify that the site was within the cleanup guidelines.*

COMMENT RESOLUTION FORM

	off, and our interest is how the stockpile design may have failed. Please refer to theOU1 Animal/Chemical Pits and Glass Holes Remedial Action Close-out report, Section 5: Waste Management, Figure 7.	
2	SCDHS Original Comment The western portion had Hg only, but this is where the Peconic River sediments were dried. The SCDHS would like a clarification as to whether there was some water drainage through the sediments that may have carried metals, including Hg, that impacted underlying soils. *SCDHS Follow-up Comment* *BNL's response to SCDHS original comment (2) does indicate that the stockpile design did actually fail. This office has no argument with the efficacy of the overall remedial effort, but maintains the comment that it appears that improved stockpile management from the start would have reduced the scope of the OU1 Soils Remediation Project. If this observation is correct, perhaps a note belongs in a 'Lessons learned' section.*	BNL Original Response The western portion of the chemical holes area was chosen to install the Peconic River drying beds because samples taken after the removal of the stockpiles still showed some residual levels of mercury that would have to be removed. The drying beds were constructed of 40-mil polyethylene and were slopped to a collection sump. At the completion of the Peconic River sediment load-out and removal of the drying beds, samples were taken to determine if additional remediation was required. The Chemical Holes Addendum documents those grids that required further excavation. *BNL Follow-up Response* *See response above. The most important lesson learned is that it is best to avoid lengthy stockpiling of excavated material. The waste management policies that are now in place do not allow the stockpiling of waste for extended periods of time.*

COMMENT RESOLUTION FORM

Reviewers and Organization: Becky Mitchell, Robert Snyder and Mike Soucie, NYSDOH		
#	**NYSDOH Comment**	**BNL Response**
1	Page 6, para 7 (last), "...The areas were graded and seeded with native grass." Was an ORISE confirmatory survey performed? Is BNL committed to further remediate areas it has already graded and seeded if the results of ORISE sampling indicate the need?	An ORISE confirmatory survey was not performed. The "Work Plan for Release of the Chemical Holes Area From Radiological Controls" was submitted to the regulatory agencies for review and comment on December 3, 2003. This work plan provided the final survey requirements for the completed work described in the Animal/Chemical Pits and Glass Holes Remedial Action Closure Report Addendum. The scope of this survey was negligible in comparison to that performed in connection with the original cleanup. Therefore, independent ORISE verification was not included in the scope of the work plan. There were no comments suggesting the need for or requiring ORISE involvement. The response to comments received from EPA concerning other matters was issued on March 12, 2004. In summary, final surveys were performed in accordance with an approved work plan, and this work plan did not require ORISE verification.