INDEPENDENT VERIFICATION SURVEY REPORT FOR THE OFFSITE PORTION OF THE POTENTIAL RELEASE SITE-7 ABANDONED SANITARY LINE, MIAMISBURG CLOSURE PROJECT, MIAMISBURG, OHIO

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Prepared for the
U.S. Department of Energy

ORISE

Oak Ridge Institute for Science and Education

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MIAMISBURG CLOSURE PROJECT
MIAMISBURG, OHIO**

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FINAL REPORT

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ABBREVIATIONS AND ACRONYMS

b_i	number of background counts in the interval
BKG	background
d'	index of sensitivity
μg	micrograms
$\mu\text{R/h}$	microroentgens per hour
$\mu\text{rem/h}$	microrem per hour
Ac-227	actinium-227
Am-241	americium-241
ARC	Accelerated Remediation Company
BKG	background
BWXT0	Babcock and Wilcox Technical Services of Ohio
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
cm^2	square centimeter
Co-60	cobalt-60
COC	contaminants of concern
cpm	counts per minute
Cs-137	cesium-137
DOE	U.S. Department of Energy
DQOs	data quality objectives
EPA	Environmental Protection Agency
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FSS	final status survey
g	gram
GMR	Great Miami River
GPS	global positioning system
IEAV	Independent Environmental Assessment and Verification
ISM	Integrated Safety Management
ITP	Intercomparison Testing Program
IV	Independent Verification
IVT	Independent Verification Team
JHA	job hazard analysis
keV	kiloelectron volts
kg	kilogram
m	meter
mg	milligram
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCP	Mound Closure Project
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
MERP	Mound Environmental Restoration Program
MeV	million electron volts
MH	manhole

ABBREVIATIONS AND ACRONYMS (continued)

m ²	square meter
min	minute
mm	millimeter
MRC	Monsanto Research Corporation
mrem	millirem
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NPL	National Priorities List
NRIP	NIST Radiochemistry Intercomparison Program
OEPA	Ohio Environmental Protection Agency
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
OU	Operable Units
Pa-231	protactinium-231
Pb-210	lead-210
pCi/g	picocuries per gram
PRS	Potential Release Site
PSP	project-specific plan
Pu-238/239	Plutonium 238/239
Ra-226	Radium-226
SORs	sum of the ratios
SOW	Statement of Work
sec	second
Th-230/232	Thorium-230/232
TAP	total absorption peak
VSAP	Verification Sampling and Analysis Plan
U-238	uranium-238
yr	year
yd ³	cubic yard

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INTRODUCTION AND SITE HISTORY

The Mound Plant was constructed in the 1940s for the production of nuclear weapons components. The original site was run by the Monsanto Research Corporation (MRC) whose primary mission was to determine the chemical and metallurgical properties of polonium, beginning in 1948 (BWXT0 1999). In 1949, research involving other radionuclides began and over the course of its 50 years of operation, the facility produced detonators, recovered and purified tritium, and constructed plutonium heat generators for satellites. Mound was the first permanent facility in support of atomic weapons research for the U.S. Department of Energy (DOE) and, prior to 1996, it was a supplier of stable isotopes to the DOE.

In 1989 the Mound Site was placed on the National Priorities List (NPL) because of chemical contamination in the site groundwater (BWXT0 1999). The DOE, U.S. Environmental Protection Agency (EPA), and the Ohio Environmental Protection Agency (OEPA), the DOE “core team”, developed a procedural framework for the remediation of the site under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In an effort to improve efficiency and streamline operations a decision-making process known as the “The Mound 2000 Approach” was developed by the Mound Environmental Restoration Program (MERP). This process resulted in dividing the Miamisburg Closure Project (MCP) site area into 19 release blocks which contained over 400 Potential Release Sites (PRSs) that required some level of evaluation. Eventually, the PRSs were grouped into nine operable units (OUs) (DOE 1997). Approximately 200 of the PRSs were contaminated soil areas and the remaining PRSs were contaminated buildings (BWXT0 1999).

The PRS-7 Abandoned Sanitary Line (herein, referred to as PRS-7) serviced the Mound property during previous operations. Removal of the PRS-7 lining and various access manhole points has been initiated. The DOE contractor Accelerated Remediation Company (ARC) removed the PRS-7 line from the Mound property to its discharge point at the Great Miami River (GMR) (Figure A-1). The PRS-7 remediation project impacted critical public areas; therefore, for the safety of the public, no excavations were allowed to remain open.

The U.S. Department of Energy-Mound Closure Project Office (DOE-MCP) is responsible for oversight of the remedial action and final status survey (FSS) activities at the MCP. It is the policy of the DOE to perform independent (third party) verification of FSS activities (DOE 2006). The purpose of independent verification is to confirm that remedial actions have been effective in meeting established guidelines and that documentation accurately and adequately describes the final site conditions. DOE-MCP requested the Oak Ridge Institute for Science and Education (ORISE) to perform independent verification. Through a third party, DOE can provide a level of assurance to the stakeholders that the as-left radiological concentration in PRS-7 will be below the approved remediation guidelines.

In April of 2008, ORISE conducted independent verification of the remediation process through document reviews and field verification to confirm that the FSS sampling results could be independently verified. To do so, ORISE implemented various survey activities to evaluate portions of the PRS-7 between Old U. S. Highway 25 and the 001 Outfall at the Great Miami River (ARC 2007a and DOE 2008).

OBJECTIVE

The ORISE objective was to confirm that the remedial action process implemented by the contractor was in accordance with the PRS-7 Work Package. Following removal of the sanitary line, the soil beneath the line would be sampled to determine if remediation was required (ARC 2007a). The primary radionuclides of concern for off-site properties are Pu-238 and Th-230 (ARC 2007a). However, samples are screened for the radionuclides listed in Table B-1. ORISE reviewed the available contractor documentation to ensure that the final status radiological condition of the MCP PRS-7 has been successfully achieved.

DOCUMENT REVIEW

Work conducted by ARC at PRS-7 followed the procedures used in supporting OU-1 remediation and FSS activities. ARC personnel followed the approved sampling guidance as defined in the Verification Sampling and Analysis Plan (VSAP) (ARC 2007b). An ORISE Independent Verification Team (IVT) reviewed a work package in preparation for performing survey and sampling activities. The document review was primarily concerned with the implementation of survey methodology, instrumentation detection capabilities and calibration, and final survey data.

Information obtained in this process was used in the preparation of a project-specific plan (PSP) for conducting independent verification.

PROCEDURES

On April 29 and April 30, 2008, an ORISE team implemented actions as stated in the PSP (ORISE 2008a). During this period, ORISE observed the contractor's performance of remediation and sampling at an off-site portion of PRS-7; between Manhole (MH) 318 to 001 Outfall at the GMR, west of the levy (Figure A-1). Additionally, ORISE performed walkover gamma scan surveys and obtained judgmental soil samples from the excavations opened by the contractor. ORISE activities were conducted in accordance with the Statement of Work (SOW), the Independent Environmental Assessment and Verification (IEAV) Survey Procedures Manual, and the IEAV Quality Program Manual (ORISE 2008b and c, and ORAU 2007).

REFERENCE SYSTEM

ORISE used a global positioning system (GPS) for documenting survey area boundaries and tracking data. The specific reference system used was the Ohio State Plane South. Static measurements collected using the GPS were accurate to within one meter.

GAMMA SURFACE SCANS

Surface scans were performed to identify locations of residual elevated direct gamma radiation along the offsite portion of PRS-7 (Figures A-2 and A-3). Scans of the excavated trench between MH 318 and the GMR were limited or could not be performed by personnel due to the instability of the trench sidewalls and floor. Two different types of instrument detector combinations were used. The Field Instrument for the Detection of Low Energy Radiation (FIDLER) detector was used to detect low-energy gamma radiation. For the detection of mid- to higher-energy gamma radiation, 2-inch by 2-inch sodium iodide (NaI) scintillation detectors were used. Both the NaI and FIDLER detectors were coupled to ratemeters with audible output and GPS units. Detectors were held at a nominal height of 5 cm above the ground surface when performing scans.

Additionally, ORISE performed a low energy gamma walkover scan of a small area between MH 312 and MH 314, adjacent to the access driveway (Figure A-4). The contractor identified measurable radioactivity above background. The contractor identified this area during their initial

characterization. The on-site screening results of soil samples identified Th-232 in concentrations well above background. This had not been the case with soil samples associated with the PRS-7 line excavation on-site. It appears that the area had been disturbed. Although not part of the scope of work for this survey trip, ORISE scanned the area. A FIDLER detector was used with the intent to only “bound” the area or any hotspots as a means of having some background information about the potential for low energy gamma activity. The data would be used to verify selected contractor final status results of this area (Figure A-4).

SOIL SAMPLING

Eleven judgmental samples were collected along the length of the excavation between MH B5 and the GMR (Figure A-5). Verification sampling was performed after the removal of the pipe and contaminated soils based upon field measurement of detectable residual gamma radiation levels. Because of the depth and instability of the trench, caused by water infiltration, soil samples often had to be collected from along the bottom and sidewalls of the excavated trench or obtained from the excavator bucket.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Soil samples were maintained in accordance with formal chain-of-custody procedures. Samples designated for radiological analyses were returned to the ORISE laboratory in Oak Ridge, Tennessee. Radiological analyses were performed in accordance with the ORISE Laboratory Procedures Manual (ORISE 2008d). Each sample was analyzed by gamma and alpha spectroscopy. The gamma spectra were reviewed for all identifiable photopeaks and the gamma-emitting contaminants of concern (COCs) specified in the Mound 2000 Process and PRS-7 work package; Ac-227, Am-241, Cs-137, Co-60, Pb-210, Pu-238, Pu-239, Ra-226, Th-230, Th-232, and U-238 (DOE 1997 and ARC 2007a). Alpha spectroscopy was performed to determine the concentrations of Ac-227, Am-241, Pu-238, Pu-239/240, and Th-230. All sample results were reported in units of picocuries per gram (pCi/g).

APPLICABLE SITE GUIDELINES

The applicable cleanup guidelines for primary radiological COCs identified at the MCP are provided in Table B-1. The goal for remediating the PRS-7 was to remove the pipe and affected soil detected in the area where the pipe was removed, such that the final site condition would be less than these stated guideline levels. The sum-of-ratios (SORs) were calculated in accordance with the following equation:

$$\frac{Conc_{Am-241}}{DCGL_{Am-241}} + \frac{Conc_{Pu-238}}{DCGL_{Pu-238}} + \frac{Conc_{Pu-239/240}}{DCGL_{Pu-239/240}} + \frac{Conc_{Th-230}}{DCGL_{Th-230}} + \frac{Conc_{Th-232}}{DCGL_{Th-232}} \leq 1$$

CONTROL OF MEASUREMENT EQUIPMENT

Radiological survey instruments were adjusted and standardized for gamma radiation in accordance with IEAV Survey Procedures Manual requirements (ORISE 2008c). The FIDLER was specifically windowed on the Am-241 energy at 59 keV photopeak. Laboratory equipment procedures included electronic and NIST-traceable source calibrations. Field equipment has a minimum of twice daily operational check outs. Lab equipment operational check-outs are performed at least once daily. Additional information concerning major instrumentation, sampling equipment, and analytical procedures has been provided in Appendices C and D.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ORISE reviewed the PRS-7 work package for the purpose of preparing a survey and sampling approach for PRS-7. The PRS-7 work package was developed using the radiological controls and procedures that were reviewed by ORISE for the OU-1 remediation project. Documentation of the FSS of PRS-7 had not been provided to ORISE prior to issuing this report. Project remediation and sampling activities were in the final stages.

GAMMA SCANS

Excavation at the outfall was extensive such that the infiltration of water prevented access by personnel. The width of the outfall area excavation moved well beyond the location of the PRS-7 line. Gamma scans of the excavation sidewalls and overburden, using both FIDLER and NaI detectors, identified elevated gamma radiation. Gamma scans continued to detect elevated radioactivity in the soil towards another pipe located slightly to the north of PRS-7. The pipe may have recently been installed by the City of Miamisburg considering the composition of the soil. The contractor suspended excavating at that point because the City controls access to the property and the infiltration of water into the trench had become a significant issue in controlling the potential for contamination. The contractor backfilled the excavation after samples were collected.

The ambient background gamma radiation levels for the 2-inch by 2-inch NaI detector ranged from 3,200 to 3,600 counts per minute (cpm). Gamma scans of the PRS-7 area between the levy and highway ranged from 4,000 to 11,000 cpm and averaged 7,200 cpm (Figure A-6). The ambient background for the FIDLER ranged from 400 to 590 cpm and scan results in this area ranged from 300 to 2,400 cpm (Figure A-7).

RADIONUCLIDE CONCENTRATIONS IN SOIL

The radionuclide concentration ranges in soil samples S001 to S011 as determined by gamma spectroscopy are provided in Table 1. The highest gamma results were noted for Th-230 concentrations.

TABLE 1 RANGE OF RADIONUCLIDE CONCENTRATION IN SOIL BY GAMMA AND ALPHA SPECTROSCOPY											
Radionuclide Concentrations in Soil Samples (pCi/g)											
	Ac-227	Am-241	Pa-231	Pb-210	Ra-226	Th-228	Th-230	Th-232	U-238	Pu-238	Pu 239/24
Gamma	-0.10 to 0.09	-0.14 to 0.04	-0.11 to 0.39	0.48 to 2.14	0.50 to 1.09	0.35 to 1.87	-3.0 to 9.0	0.32 to 1.87	0.31 to 1.38	--- ^a	---
Alpha	---	0.00 to 0.02	---	---	---	---	0.74 to 8.7	0.37 to 1.89	---	0.03 to 0.46	-0.002 to 0.008

^a ---Not Applicable

Table B-2 provides the individual sample radionuclide concentrations by gamma spectroscopy. A review of the data identified samples S001 and S007 had measurable qualitative results for Th-230 with concentrations of 4.0 pCi/g and 9.0 pCi/g, respectively after a one hour count. Alpha spectroscopy was performed to determine the quantitative radionuclide concentration of specific alpha emitters including; Am-241, Pu-238, Pu-239/240, Th-230, and Th-232. The results are provided in Table B-3. The Th-230 concentration in sample S007 was 8.7 pCi/g.

COMPARISON OF RESULTS WITH GUIDELINES

ORISE collected and analyzed eleven judgmental soil samples from the excavation between MH-B5 to the GMR. A review of the gamma spectroscopy results indicated that most COCs were below the cleanup guidelines; with the exception of Th-230. Alpha spectroscopy analysis was performed to quantify the concentration of thorium for each sample. Th-230 ranged from 0.74 to 8.7 pCi/g and Th-232 ranged from 0.37 to 1.89 pCi/g. The highest Th-230 concentrations were identified in samples S006 and S007 at 3.21 and 8.7 pCi/g, respectively. However, only sample S007 had a net concentration that exceeded both the individual cleanup objectives and the SOR. Sample 007 was collected from the excavated area closest to the 001 Outfall (Figure A-5). ORISE did not define a reference background area; however, ARC made available to ORISE soil background concentrations for each COC. These backgrounds were subtracted when calculating the net SORs.

CONCLUSION

As part of the Miamisburg Closure Project, the Accelerated Remediation Company is remediating the Potential Release Site 7 Abandoned Sanitary Line that previously serviced the Mound Site. The PRS-7 line emptied into the Great Miami River at 001 Outfall. On April 29 and 30, 2008, an Independent Verification Team with Oak Ridge Institute for Science and Education conducted a variety of verification efforts associated with a portion of the PRS-7 line between the Old U. S. Highway 25 to the 001 Outfall at the GMR. ORISE conducted gamma scans of the area between the highway and levy and collected soil samples from the excavation located between Manhole B5 and 001 Outfall. Laboratory analyses verified Th-230 to be the major contaminant found in the soil. The soil sample analytical result for sample S007 identified a Th-230 concentration that exceeded the cleanup objectives and was determined to be greater than the SOR of 1. ORISE's review of the ARC-provided backgrounds identified some minor discrepancies in the reported background

concentrations. However, these discrepancies did not affect the conclusions of the verification results.

Assessment of the PRS-7 by the contractor continues and a final status survey report of the project will be submitted to DOE.

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APPENDIX A

FIGURES

Figure A-1: Mound Closure Project Potential Release Site 7 Plot Plan

Figure A-2: Potential Release Site 7 Sodium Iodide Gamma Walkover Scan-East Portion
Pre-remediation

Figure A-3: Potential Release Site 7 Sodium Iodide Gamma Walkover Scan-West Portion
Pre-remediation

Figure A-4: Potential Release Site 7 FIDLER Walkover Scan—Pre-remediation

Figure A-5: Potential Release Site 7 Judgmental Soil Sample Locations

Figure A-6: Sodium Iodide Gamma Scan Count Rate Histogram—Pre-remediation

Figure A-7: FIDLER Scan Count Rate Histogram—Pre-remediation

APPENDIX B

TABLES

TABLE B-1: APPLICABLE RADIOLOGICAL SOIL GUIDELINES¹	
Radionuclide	Cleanup Guideline Values (pCi/g)
U-235 + daughters (D) ^a	0.57
U-238 + D	1.3
U-234	1.1
Bi-210m	1.1
Pu-238	29.13
Pu-239/240	29.18
Am-241	19
Ra-226 + D	2.13
Ac-227 + D	0.81
Pa-231 + D	0.71
Pb-210 + D	4.2
Th-230	2.0
Th-232 + D	1.48

¹ARC 2007: Soils Verification Sampling and Analysis Plan Mound Operable Unit 1 Landfill Area Appendix E Table 1.

TABLE B-2
RADIONUCLIDE CONCENTRATIONS IN SOIL
BY GAMMA SPECTROSCOPY
POTENTIAL RELEASE SITE 7 ABANDONED OUTFALL
MIAMISBURG CLOSURE PROJECT
MIAMISBURG, OHIO

ORISE Sample ID ^a	Radionuclide Concentrations in Soil Samples (pCi/g)										SOR ^d
	Ac-227	Am-241	Pa-231	Pb-210	Ra-226	Th-228	Th-230	Th-232	Total Th ^c	U-238	
0486S0001	-0.04 ± 0.05 ^b	0.03 ± 0.05	0.00 ± 0.39	1.02 ± 0.42	0.73 ± 0.08	0.49 ± 0.05	4.0 ± 4.5	0.58 ± 0.11	1.07 ± 0.12	0.52 ± 0.48	-0.47
0486S0002	0.04 ± 0.08	-0.14 ± 0.06	-0.11 ± 0.33	0.51 ± 0.41	0.53 ± 0.07	0.35 ± 0.04	0.7 ± 3.8	0.32 ± 0.08	0.67 ± 0.09	0.78 ± 0.54	-1.81
0486S0003	-0.08 ± 0.08	0.02 ± 0.04	0.03 ± 0.31	0.84 ± 0.38	0.87 ± 0.07	0.66 ± 0.06	1.1 ± 4.3	0.67 ± 0.12	1.33 ± 0.13	1.25 ± 0.40	-1.11
0486S0004	0.04 ± 0.06	0.03 ± 0.02	0.17 ± 0.39	2.14 ± 1.09	0.85 ± 0.08	0.69 ± 0.06	-3.0 ± 5.6	0.65 ± 0.15	1.34 ± 0.16	1.04 ± 0.29	-2.44
0486S0005	0.01 ± 0.12	0.02 ± 0.02	0.39 ± 0.50	1.07 ± 0.52	0.85 ± 0.10	0.75 ± 0.07	0.7 ± 5.5	0.77 ± 0.15	1.52 ± 0.16	0.95 ± 0.80	-1.21
0486S0006	-0.10 ± 0.09	0.01 ± 0.05	-0.03 ± 0.34	1.00 ± 0.49	0.77 ± 0.09	0.58 ± 0.06	-0.1 ± 5.9	0.58 ± 0.15	1.16 ± 0.16	1.00 ± 0.50	-1.73
0486S0007	-0.07 ± 0.10	0.03 ± 0.05	0.14 ± 0.60	1.51 ± 0.54	1.01 ± 0.08	1.23 ± 0.17	9.0 ± 2.5	1.23 ± 0.17	2.47 ± 0.20	1.01 ± 0.26	2.04
0486S0008	0.09 ± 0.10	0.04 ± 0.07	0.01 ± 0.54	1.36 ± 0.54	1.09 ± 0.09	1.87 ± 0.24	1.8 ± 6.8	1.87 ± 0.16	3.72 ± 0.28	1.38 ± 0.70	-0.05
0486S0009	-0.10 ± 0.10	0.03 ± 0.05	0.26 ± 0.44	1.14 ± 0.45	0.83 ± 0.09	0.66 ± 0.06	1.5 ± 5.0	0.67 ± 0.12	1.33 ± 0.14	0.99 ± 0.45	-1.00
0486S0010	-0.06 ± 0.09	-0.05 ± 0.05	-0.06 ± 0.45	0.53 ± 0.48	0.74 ± 0.09	0.58 ± 0.06	1.5 ± 5.5	0.56 ± 0.13	1.14 ± 0.14	0.61 ± 0.56	-1.41
0486S0011	-0.01 ± 0.05	0.02 ± 0.03	0.02 ± 0.30	0.48 ± 0.24	0.50 ± 0.05	0.38 ± 0.03	0.5 ± 2.6	0.38 ± 0.07	0.76 ± 0.08	0.31 ± 0.25	-2.05
Background	0.11	0	0.11	1.2	2	1.5	1.9	1.4	N/A ^e	1.2	N/A

^aRefer to Figure A-5 for sample locations.

^bUncertainties represent the 95% confidence level based on total propagated uncertainties.

^cTotal Thorium calculation used ($\text{Th}_{228} + \text{Th}_{232} = \text{Total Th}$).

^dTotal Th not included in SOR calculation.

^eN/A not applicable.

TABLE B-3
RADIONUCLIDE CONCENTRATIONS IN SOIL
BY ALPHA SPECTROSCOPY
POTENTIAL RELEASE SITE 7 ABANDONED OUTFALL
MIAMISBURG CLOSURE PROJECT
MIAMISBURG, OHIO

ORISE ^a Sample ID	Radionuclide Concentrations in Soil Samples (pCi/g)					
	Am-241	Pu-238	Pu239/240	Th-230	Th-232	SOR
0486S0001	0.00 ± 0.01 ^b	0.04 ± 0.02	0.004 ± 0.006	0.92 ± 0.14	0.48 ± 0.08	-1.12
0486S0002	0.01 ± 0.01	0.34 ± 0.04	0.005 ± 0.004	0.74 ± 0.10	0.40 ± 0.06	-1.25
0486S0003	0.02 ± 0.03	0.04 ± 0.03	-0.002 ± 0.007	1.26 ± 0.18	0.70 ± 0.11	-0.80
0486S0004	0.01 ± 0.01	0.06 ± 0.02	0.002 ± 0.004	1.25 ± 0.17	0.62 ± 0.09	-0.86
0486S0005	00.0 ± 0.01	0.07 ± 0.02	0.005 ± 0.004	1.28 ± 0.17	0.69 ± 0.10	-0.80
0486S0006	0.00 ± 0.02	0.03 ± 0.02	-0.002 ± 0.009	3.21 ± 0.44	0.59 ± 0.10	0.10
0486S0007	0.01 ± 0.02	0.45 ± 0.07	0.005 ± 0.008	8.7 ± 1.1	1.24 ± 0.18	3.30
0486S0008	0.00 ± 0.03	0.03 ± 0.02	0.006 ± 0.008	1.49 ± 0.21	1.89 ± 0.26	0.12
0486S0009	0.01 ± 0.01	0.23 ± 0.03	0.008 ± 0.005	1.84 ± 0.24	0.71 ± 0.10	-0.50
0486S0010	0.00 ± 0.02	0.10 ± 0.03	0.004 ± 0.008	1.39 ± 0.21	0.65 ± 0.11	-0.77
0468S0011	0.02 ± 0.01	0.46 ± 0.06	0.004 ± 0.005	1.22 ± 0.17	0.37 ± 0.06	-1.03
Background	0	0.13	0.18	1.9	1.4	N/A ^c

^aRefer to Figure A-5 for sample locations.

^bUncertainties represent the 95% confidence level based on total propagated uncertainties.

^cN/A not applicable.

APPENDIX C
MAJOR INSTRUMENTATION

APPENDIX C

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

SCANNING INSTRUMENT/DETECTOR COMBINATIONS

Gamma

Ludlum Ratemeter-Scaler Model 2221

coupled to

Ludlum NaI Scintillation Detector Model SPA-3, Crystal: 2 inch x 2 inch

(Ludlum Measurements, Inc., Sweetwater, TX)

coupled to

Trimble GeoXH Receiver and Data Logger (Trimble Navigation Limited, Sunnyvale, CA)

Ludlum Ratemeter-Scaler Model 2221

coupled to

Bicron Field Instrument Detector for Low Energy Radiation (FIDLER) Model G5

(Bicron Corporation, Newburg, OH)

coupled to

Trimble GeoXH Receiver and Data Logger (Trimble Navigation Limited, Sunnyvale, CA)

LABORATORY ANALYTICAL INSTRUMENTATION

Alpha Spectrometry System

Tennelec Model 256

(Canberra, Meriden, CT)

Used in conjunction with:

Ion Implanted Detectors

(Canberra, Meriden, CT) and

Multichannel Analyzer

DEC ALPHA Workstation

(Canberra, Meriden, CT)

Alpha Spectrometry System

Canberra Model 7401VR

(Canberra, Meriden, CT)

Used in conjunction with:

Ion Implanted Detectors and

Multichannel Analyzer

DEC ALPHA Workstation

(Canberra, Meriden, CT)

Laboratory Analytical Instrumentation (continued)

High-Purity Germanium Detector
Model GMX-30-P4, 30% Eff.
(AMETEK/ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5
(AMETEK/ORTEC, Oak Ridge, TN)
used in conjunction with:
Lead Shield Model SPG-16-K8
(Nuclear Data)
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
CANBERRA/Tennelec Model No: ERVDS30-25195
(Canberra, Meriden, CT)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

APPENDIX D

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX D

SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

The survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in current job hazard analyses (JHAs). All survey and laboratory activities were conducted in accordance with ORISE health and safety and radiation protection procedures.

Pre-survey activities included an overview of potential health and safety issues. Representatives with the Accelerated Remediation Company provided site-specific safety awareness for the ORISE survey activities. In-process and verification surveys were performed according to the ORISE generic health and safety plan, site-specific integrated safety management (ISM) pre-job hazard checklist, and safety procedures discussed during the on-site training.

QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following ORAU and ORISE documents:

- Survey Procedures Manual
- Laboratory Procedures Manual
- Quality Program Manual

The procedures contained in these manuals were developed to meet the requirements of 10 CFR 830 Subpart A, Quality Assurance Requirements, Department of Energy Order 414.1C, Quality assurance, and the U.S. Nuclear Regulatory Commission *Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards* and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in MAPEP, NRIP, and ITP Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

CALIBRATION

Calibration of laboratory instrumentation was based on standards/sources, traceable to the National Institute of Standards and Technology (NIST), when such standards/sources were available. In cases where they were not available, standards of an industry-recognized organization were used.

SURVEY PROCEDURES

Surface Scans

Scans for elevated gamma radiation were performed by passing the detector slowly over the surface. The distance between the detector and surface was maintained at a nominal of about 1 to 5 cm. A NaI scintillation detector and a low-energy photon FIDLER detector with a detector area 127 cm² were coupled to GPS units that enabled real-time recording of position in one-second intervals. Identification of elevated radiation levels was based on increases in the audible signal from the instrument. Positioning data files were downloaded from field data loggers for plotting using commercially available software (http://trl.trimble.com/docushare/dsweb/Get/Document-261826/GeoExpl2005_100A_GSG_ENG.pdf).

The scan minimum detectable concentrations (MDCs) for the NaI scintillation detector for the contaminants of concern in surface soil were obtained directly from NUREG-1507 when available or estimated using the calculational approach described in NUREG-1507¹. A typical NaI detector MDC for Am-241 is 44.6 pCi/g, 2.8 pCi/g for Th-232, 60 pCi/g for U-238, and 115 pCi/g for

¹NUREG-1507. Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. U.S. Nuclear Regulatory Commission. Washington, DC; June 1998.

natural Uranium. ORISE used the FIDLER for qualitative measurements. An audible increase in the activity rate was investigated by ORISE. It is standard procedure for the ORISE staff to pause and investigate any locations where gamma radiation is distinguishable from background levels.

SOIL SAMPLING

Approximately 0.5 to 1 kg of soil was collected at each sample location. Collected samples were placed in plastic bags, sealed, and labeled in accordance with ORISE survey procedures.

RADIOLOGICAL ANALYSIS

DETECTION LIMITS

Detection limits, referred to as MDC, were based on 3 plus 4.65 times the standard deviation of the background count $[3 + (4.65 (\text{BKG})^{1/2})]$. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

Alpha Spectroscopy

Soil samples were homogenized then dissolved by a combination of potassium hydrogen fluoride and pyrosulfate fusions. The fusion cakes were dissolved and all alpha emitters are co-precipitated on barium sulfate. The barium sulfate was re-dissolved and the COC is separated from the other actinides by extraction chromatography using Eichrom resins, re-precipitated with a cerium fluoride carrier, and analyzed using ion implanted detectors, alpha spectrometers, and multichannel analyzer.

An alpha spectroscopy detector system calculated an MDC for each individual isotope per sample based on the detector background, counting efficiency, yield, and quantity. An MDC was printed out with each sample results. The typical MDC for a 1,000-minute count time was 0.02 pCi/g.

Gamma Spectroscopy

Samples of soil were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in a 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and

the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All total absorption peaks (TAP) associated with the radionuclides of concern were reviewed for consistency of activity. Total absorption peaks used for determining the activities of radionuclides of concern and the typical associated MDCs for a one-hour count time were:

Radionuclide	TAP (MeV)	MDC (pCi/g)
U-238 (from Th-234)	0.063	0.21
U-235	0.143	0.06
Am-241	0.059	0.06
Pa-231	0.284	1.1
Ra-226 (from Pb-214)	0.351	0.19
Pb-210	0.046	0.54
Th-230	0.678	7.0
Th-232 (from Ac-228)	0.911	0.05
Ac-227 (from Th-227)	0.256	0.05

Spectra were also reviewed for other identifiable TAPs.

Uncertainties

The uncertainties associated with the analytical data presented in the tables of this report represent the total propagated uncertainties for that data. These uncertainties represent the 95% confidence level and were calculated based on both the gross sample count levels and the associated background count levels.