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Consolidated Site (CS) 022 Verification Survey at Former McClellan AFB, Sacramento, California

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Matthew W. Uelen

5d. PROJECT NUMBER

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
USAF School of Aerospace Medicine
Occupational & Environmental Health Dept
Consultative Services Division
2510 Fifth St.
Wright-Patterson AFB, OH 45433-7913

8. PERFORMING ORGANIZATION REPORT NUMBER

AFRL-SA-WP-CL-2015-0011

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14. ABSTRACT

At the request of the U.S. Air Force Radioisotope Committee Secretariat (RICS), the U.S. Air Force School of Aerospace Medicine, Consultative Services Division (USAFSAM/OEC), Radiation Health Consulting Branch performed an independent radiological verification survey of the CS 022 hazardous waste site, located on former McClellan AFB, California, on 29-31 July 2014. The purpose of this verification survey was to provide an independent evaluation of the final radiological conditions. USAFSAM/OEC surveyed the CS 022 site to measure residual surface activity and determine if radiation levels complied with criteria agreed upon between representatives of the State of California and the U.S. Air Force for unrestricted release. Radium-226 was the sole radionuclide of concern. Cabrera Services, Inc., under contract with URS Corporation, performed a Final Status Survey (FSS) and all radiological fieldwork previously in July 2014. This letter details the findings of this visit and will assist the RICS with evaluating the contractor's FSS report of this site

15. SUBJECT TERMS

USAF School of Aerospace Medicine (USAFSAM), former McClellan AFB, radium-226, verification survey, final status survey, independent radiological assessment

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a. REPORT	b. ABSTRACT	c. THIS PAGE			Col Krystal L. Murphy
U	U	U	SAR	39	19b. TELEPHONE NUMBER *(include area code)*

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DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
WRIGHT-PATTERSON AFB OH

31 March 2015

MEMORANDUM FOR AFMSA/SG3PB
ATTN: MAJ DANIEL SHAW
USAF RADIOISOTOPE COMMITTEE SECRETARIAT
AIR FORCE MEDICAL SUPPORT AGENCY
7700 ARLINGTON BOULEVARD, SUITE 5158
FALLS CHURCH VA 22042-5158

FROM: USAFSAM/OEC
2510 Fifth Street
Wright-Patterson AFB OH 45433-7913

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2015-0011, Consolidated Site (CS) 022 Verification Survey at Former McClellan AFB, Sacramento, California

1. INTRODUCTION:

a. *Purpose*: At the request of the U.S. Air Force Radioisotope Committee Secretariat (RICS), the U.S. Air Force School of Aerospace Medicine, Consultative Services Division (USAFSAM/OEC), Radiation Health Consulting Branch performed an independent radiological verification survey of the CS 022 hazardous waste site, located on former McClellan AFB, California, on 29-31 July 2014. The purpose of this verification survey was to provide an independent evaluation of the final radiological conditions at a decommissioned site. USAFSAM/OEC surveyed the CS 022 site to measure residual surface activity and determine if radiation levels complied with criteria agreed upon between representatives of the State of California and the U.S. Air Force for unrestricted release. Radium-226 (Ra-226) was the sole radionuclide of concern. Cabrera Services, Inc., under contract with URS Corporation, performed a Final Status Survey (FSS) and all radiological fieldwork previously in July 2014. This letter details the findings of this visit and will assist the RICS with evaluating the contractor's FSS report of this site. Personnel utilized techniques and procedures taken from Nuclear Regulatory Guide 1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, Rev 1.

b. *Background:* Site CS 022 is a former burial pit, 1 acre in size, located within the west McClellan District. Historical site information provided by URS Corporation indicated that between 1946 and the late 1960s the site was used as a burial pit for industrial waste, solvents, and ash from an industrial incinerator located near the site. Documentation from the contractor indicates that ash and waste from the incinerator are the primary source of Ra-226 contamination. During the 1990s, the site was enclosed with a fence and used as a storage yard for building materials, construction debris, sand, and gravel. The contractor opted to divide the CS 022 site into two separate survey unit areas. The first survey unit consists of two distinct trenched areas, the largest of which runs east to west along the northern area of the site. At the deepest point, the trench is approximately 50 feet below ground level. An intersecting trench, running north to south, is shallower and slopes into the first. The second survey unit contains surface contamination and surrounds the trench running north to south. This area is approximately 1 to 2 feet below ground level. This report includes a discussion and conclusion on only the first survey unit, as this was the only unit that had undergone an FSS at the time of this survey. See Figures 1 and 2 below.

Figure 1. CS 022 North/South Disposal Trench

Figure 2. CS 022 East/West Disposal Trench

c. *Survey Personnel*:

(1) Maj. Marcus Grant, Health Physicist, USAFSAM/OEC
(2) SSgt Michael Ames, Lead Health Physics Technician, USAFSAM/OEC

d. *Personnel Contacted*:

(1) Radiation Safety Officer, AFCEC/CIBW
(2) Base Realignment and Closure Program Management/Western Region, AFCEC/CIBW
(3) Radiation Project Manager, Cabrera Services, Inc.

e. *Equipment*: Ludlum Model 2221 with Scionix 76BRS76/2ME1-X 3x3 Sodium Iodide Detector, Meter SN 287511, Detector SN SAG420, Calibration date 16 Jun 2014

2. METHODOLOGY:

a. *Overview:* The verification survey consisted of soil sample collection and gamma walkover measurements. The goal of the walkover survey was to identify locations for soil sampling. This verification survey required scanning at least 10% of the trench floor area by the gamma walkover technique and soil sample collection of at least 10% of the total number of samples taken by Cabrera Services. Prior to the survey, the contractor identified 68 soil sampling locations from both survey units; therefore, at least 7 soil samples are necessary to meet the 10% minimum requirement. It should be noted that this requirement includes the survey unit not included in this report; therefore, the actual quantity needed is less than 7. Personnel used the gamma walkover data to qualitatively assess the site in terms of mean count rate and standard deviation. Minimum detectable concentration and the associated count rates were not calculated.

b. *Soil Sampling:* Each sample was taken from an area of approximately 8 square inches to a depth of 6 inches. The volume sampled was sufficient for laboratory analysis (approximately 1 quart). Survey personnel followed field soil sampling procedures to prevent cross contamination of samples. Personnel collected a background sample from uncontaminated soil in an adjacent area to the CS 022 site. The USAFSAM Radioanalytical Laboratory (OEA) at Wright-Patterson AFB, Ohio, analyzed soil samples by counting on a high purity germanium detector, using the appropriate in-growth method to determine Ra-226 levels in soil. Prior to the 28-day in-growth, OEA sifted the soil samples to remove any rocks and large debris and then dried to remove any moisture potentially affecting analysis. Attachment 1 contains laboratory analysis for the samples. An "x" within Attachment 2 indicates the locations of soil samples.

c. *Gamma Walkover Survey:* Scionix Model 76BRS76/3M-E1-X 3x3-inch thallium-doped sodium iodide (NaI) detectors and Ludlum Model 2221 ratemeter/scalers were the primary radiation detection instruments utilized to perform the gamma walkover survey. Survey personnel connected the instruments to a Trimble GeoXT handheld GPS unit via RS-232 serial cable. The Trimble GeoXT logged observed count rates with corresponding GPS coordinates every second. Survey personnel held the detectors at a height of 10 cm above the ground. The scan speed was approximately 0.5 meters per second, while scan lines were spaced approximately 0.5 meters apart. All field instruments were function checked at the start and end of each workday using a gamma-emitting check source. Personnel tested each instrument to ensure a 10% tolerance during field checks. Qualified staff calibrate the instruments annually. Attachment 3 contains the annual calibration certificates for all instruments used during this survey. Attachment 4 contains the quality control logs used to document instrument performance with a check source both before and after use.

3. RESULTS:

a. *Gamma Walkover Survey:* Scan coverage exceeded the minimum scan requirement of 10% of the trench floor. Some areas were inaccessible using the walkover technique, notably in areas that presented a climbing hazard. The team did not survey the sides of the trench. Personnel used the mean count rate as the background for the scanned area and did not survey a reference area. USAFSAM personnel calculated the mean and standard deviation of the dataset based on the instrument and the particular area surveyed. In some cases, USAFSAM also excluded data outside the background distribution (e.g., outlying data points, data generated due to software anomalies or equipment malfunctions). Personnel then compiled the data using commercial geospatial mapping software. The locations marked in green correspond to the lowest readings of the survey. Given the data collected, green dots represent all measured activity points below 1.5 standard deviations (SD) above the mean value [less than 26568 counts per minute (cpm)]. Yellow dots correspond to data points between 0.5 and 1.5 SD above the mean (between 26569 and 29972 cpm). Orange dots correspond to data points between 1.5 and 2.5 SD above the mean (between 29973 and 33377 cpm). Red dots represent all data points above 2.5 SD (greater than 33378 cpm). Survey personnel expect higher concentrations in areas not colored in green. The color scheme demonstrates a scale of instrument data based upon standard deviations from background radiation levels, where no regulatory values are implied. A table of statistics compiled from the dataset can be found in Attachment 5.

b. *Soil Sampling*: Survey personnel collected nine soil samples from CS 022: five samples within the survey unit consisting of the two trenched areas, three samples in the survey unit consisting of surface contamination, and one sample outside of CS 022 in an area of soil to be used as backfill for the site. The survey team used this backfill sample for background radiation comparison. None of the samples collected exceeded the cleanup goal of 2.0 pCi/g. Table 1 illustrates both the gross and background subtracted soil results and the associated GPS coordinates for each sample. When comparing results to the cleanup level of 2.0 pCi/g, utilize the gross (background included) results listed below. The uncertainties listed are at the 95% confidence level (2 SD). Laboratory staff determines concentrations of Ra-226 in the soil by gamma spectroscopy analysis of Ra-226 and the associated bismuth-214 / lead-213 daughters in secular equilibrium. The Ra-226 concentrations in the table below are labeled as "Ra_D_214" within Attachment 1.

Table 1. Soil Sample Results for CS 022

Lab Sample ID	GPS Coordinates (WGS1984, Decimal Degrees, N/E)	Gross Ra-226 Concentration (pCi/g)[1]	Net Ra-226 Concentration above Background (pCi/g)
GS-14-0001	38.656716324, -121.414152299	0.86 ± 0.04	0.15 ± 0.06
GS-14-0002	38.656796516, -121.414370919	0.62 ± 0.03	N/A
GS-14-0003	38.656347516, -121.413607583	0.50 ± 0.03	N/A
GS-14-0004[2]	38.656486001, -121.413954240	0.70 ± 0.04	N/A
GS-14-0005	38.656653653, -121.413278950	0.77 ± 0.04	0.06 ± 0.06
GS-14-0006	38.656799100, -121.413738387	0.82 ± 0.04	0.11 ± 0.06
GS-14-0007[2]	38.656192561, -121.413724655	0.68 ± 0.04	N/A
GS-14-0008[2,3]	38.657050529, -121.413165411	0.71 ± 0.04	N/A[1,2]
GS-14-0009[2]	38.656401249, -121.413416446	0.72 ± 0.04	0.01 ± 0.06

[1] Ra-226 concentrations with associated uncertainties from soil sample results.
[2] Sample taken outside the disposal pit survey unit.
[3] Background sample for CS 022.

4. DISCUSSION:

a. *Gamma Walkover Survey:* Walkover survey results indicated one area near the western edge of the site to be the most probable location for Ra-226 contamination. This area indicated count rates in excess of 3 SD above the mean, with the highest recorded gamma value of 35,742 cpm, approximately 10,000 cpm above the mean. During this survey, Cabrera field technicians also identified the same area as indicating elevated gamma count values during their walkover survey. Laboratory soil results indicate slightly elevated and detectable levels of various other naturally occurring radioactive materials in this sample, which survey personnel likely detected during the gamma walkover.

b. *Soil Sampling:* As a result of the gamma walkover survey results, one biased soil sample (S1408005-01A) was taken from the area to be most probable for Ra-226 contamination. The remaining four soil samples collected were random (unbiased) samples co-located at sampling locations previously selected by the contractor.

c. An FSS was completed for the survey unit consisting only of the two trenched areas. Since an FSS is still pending for the second survey unit containing surficial contamination, the soil sample results for this area are for informational purposes only.

5. CONCLUSIONS AND RECOMMENDATIONS:

a. Based on the results of the laboratory analysis, none of the areas surveyed exceeded the cleanup goal of 2.0 pCi/g. Laboratory analysis is the primary indicator of site conditions for regulatory decisions.

b. USAFSAM/OEC detected no areas of elevated radiological activity requiring additional investigative actions using the gamma walkover technique.

c. USAFSAM/OEC recommends the survey unit consisting of the two trenched areas be considered for unrestricted free release of radiological controls, with the approval of the RICS.

d. Following the completion of the FSS for the second surface contamination survey unit of CS 022, a second independent radiation verification survey should be performed to assess this area. The contractor needs to complete remediation actions.

e. If you have any questions regarding this report, please contact the ESOH Service Center at (888) 232-3764 (DSN 798-3764) or ESOH.Service.Center@us.af.mil.

MATTHEW W. UELEN
USAFSAM Health Physicist

5 Attachments:
1. Laboratory Soil Analysis
2. Map of Gamma Walkover with Soil Sample Locations
3. Instrument Calibration Sheets
4. Radiation Meter Quality Control (QC) Log
5. Statistical Summary of Instrument Data

Attachment 1
Laboratory Soil Analysis

MEMORANDUM FOR: SSgt Michael Ames
USAFSAM/OEC
2510 Fifth St. Bldg. 840
WRIGHT-PATTERSON AFB, OH 45433

9/10/2014 10:30:43 AM

FROM: USAFSAM OE Industrial Hygiene
2510 Fifth Street, Bldg 20840, Room W327
Wright Patterson Air Force Base, OH 45433-7913

REF: Order No.: S1408005

Dear SSgt Michael Ames:

Enclosed are the sample reports from 14 samples received on 8/5/2014.

Samples, not consumed in analysis, will be held according to the appropriate regulatory authority unless you specifically request otherwise. Should you choose to reproduce this report, we recommend you do so in its entirety so that the integrity of the data package is kept intact.

If you have questions, or if we may be of further assistance to you, please do not hesitate to contact us.

Sincerely,

ERIC L WEATHERHOLT, Capt, USAF
Analytical Services Program Manager
Tel: (937) 938-2523 (DSN Prefix: 798)
https://hpws.afrl.af.mil/dhp/OE/ESOHSC/pages/index.cfm?id=742

Note: Sample analysis performed by: USAFSAM/OE Radioanalytical Division

CLIENT: USAFSAM/OEC
Project:
Lab Work Order: S1408005

CASE NARRATIVE

There were no problems associated with the samples or analysis except where noted below. Unless otherwise noted, sample results are not blank corrected, and all quality control associated with the samples were within acceptable limits.

These results relate only to the items tested.

Customer requested Ra226 analysis via gamma spectrometry. Analysis report will show results for Ra_D_214. This result is equivalent to Ra226 plus the ingrowth of Bi214/Pb214 daughters using all higher energy, high yield energy lines. Ra_D_214 = Ra226 via gamma spec analysis with ingrowth.

Sample Preparation Comments:

SampID	*TestCode*	*Comments*
S1408005-01A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-02A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-03A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-04A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-05A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-06A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15
S1408005-07A	RAD_GAMMA_SOLID_	Ingrowth Time: 6-Aug-14 16:15

Radioanalytical Services Laboratory

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Certificate of Analysis

Company:	USAFSAM/OEC		
Address:	2510 Fifth St. Bldg. 840	Report Date:	9/10/2014 10:30:43 AM
	WRIGHT-PATTERSON AFB OH, 45433		
Contact:	SSgt Michael Ames		
Client Sample ID:	GS140001		
Lab Sample ID:	S1408005-01A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/29/2014		
Receive Date:	8/5/2014		
Collector:	Client		

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
Gamma Spec Full									
U-235	G,N	9.07E-02	2.82E-02	2.20E-02	4.48E-02	pCi/g	JRO	09/05/14 1241	7630
TL-208	G,N	3.88E-01	3.46E-02	2.13E-02	4.38E-02	pCi/g	JRO	09/05/14 1241	7630
TH-234	G,N	1.15E+00	8.12E-01	9.62E-01	1.95E+00	pCi/g	JRO	09/05/14 1241	7630
TH-228	G,N	1.68E+00	8.11E-01	1.21E+00	2.47E+00	pCi/g	JRO	09/05/14 1241	7630
PB-212	G,N	1.46E+00	5.98E-02	2.67E-02	5.46E-02	pCi/g	JRO	09/05/14 1241	7630
BI-212	G,N	1.35E+00	3.09E-01	2.20E-01	4.59E-01	pCi/g	JRO	09/05/14 1241	7630
AC-228	G,N	1.26E+00	7.51E-02	7.17E-02	1.49E-01	pCi/g	JRO	09/05/14 1241	7630
RA-224		9.58E-01	2.91E-01	2.67E-01	5.46E-01	pCi/g	JRO	09/05/14 1241	7630
Ra_D_214		8.64E-01	4.41E-02	3.68E-02	7.58E-02	pCi/g	JRO	09/05/14 1241	7630
K-40		1.38E+01	9.03E-01	2.57E-01	5.35E-01	pCi/g	JRO	09/05/14 1241	7630

BRIAN J STROH, Capt, USAF
Chief, Radioanalytical Laboratory

AURELIE M SOREFAN, DR-II, PhD, DAF
Technical Director, Radioanalytical Laboratory

Radioanalytical Services Laboratory

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Lab Sample ID:	S1408005-02A		
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Collection Date:	7/29/2014		
Receive Date:	8/5/2014		
Collector:	Client		

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Gamma Spec Full									
TL-208	G,N	2.32E-01	2.89E-02	1.93E-02	3.97E-02	pCi/g	JRO	09/05/14 1842	7630
TH-234	G,N	1.94E+00	7.29E-01	9.86E-01	2.00E+00	pCi/g	JRO	09/05/14 1842	7630
PB-212	G,N	8.80E-01	4.41E-02	2.80E-02	5.71E-02	pCi/g	JRO	09/05/14 1842	7630
BI-212	G,N	8.89E-01	2.82E-01	2.23E-01	4.63E-01	pCi/g	JRO	09/05/14 1842	7630
AC-228	G,N	7.29E-01	7.34E-02	6.90E-02	1.43E-01	pCi/g	JRO	09/05/14 1842	7630
RA-224		7.66E-01	2.55E-01	2.90E-01	5.92E-01	pCi/g	JRO	09/05/14 1842	7630
Ra_D_214		6.24E-01	3.47E-02	3.33E-02	6.87E-02	pCi/g	JRO	09/05/14 1842	7630
K-40		2.08E+01	1.17E+00	2.15E-01	4.49E-01	pCi/g	JRO	09/05/14 1842	7630

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Lab Sample ID:	S1408005-03A		
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Receive Date:	8/5/2014		
Collector:	Client		

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Gamma Spec Full									
U-235	G,N	4.38E-02	2.77E-02	2.26E-02	4.59E-02	pCi/g	JRO	09/06/14 044	7630
TL-208	G,N	2.35E-01	2.75E-02	1.68E-02	3.48E-02	pCi/g	JRO	09/06/14 044	7630
TH-234	G,N	8.92E-01	7.02E-01	8.91E-01	1.81E+00	pCi/g	JRO	09/06/14 044	7630
PB-212	G,N	8.10E-01	4.21E-02	2.82E-02	5.76E-02	pCi/g	JRO	09/06/14 044	7630
BI-212	G,N	7.30E-01	2.86E-01	2.17E-01	4.52E-01	pCi/g	JRO	09/06/14 044	7630
AC-228	G,N	7.01E-01	6.74E-02	6.85E-02	1.43E-01	pCi/g	JRO	09/06/14 044	7630
RA-224		5.10E-01	2.38E-01	2.81E-01	5.75E-01	pCi/g	JRO	09/06/14 044	7630
Ra_D_214		5.02E-01	3.32E-02	3.71E-02	7.61E-02	pCi/g	JRO	09/06/14 044	7630
K-40		1.94E+01	1.12E+00	2.04E-01	4.29E-01	pCi/g	JRO	09/06/14 044	7630

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Client Sample ID:	GS140004		
Lab Sample ID:	S1408005-04A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/30/2014		
Receive Date:	8/5/2014		
Collector:	Client		

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Gamma Spec Full									
U-235	G,N	7.08E-02	3.02E-02	2.43E-02	4.94E-02	pCi/g	JRO	09/06/14 645	7630
TL-208	G,N	2.85E-01	3.02E-02	1.87E-02	3.86E-02	pCi/g	JRO	09/06/14 645	7630
TH-234	G,N	1.20E+00	7.38E-01	8.78E-01	1.79E+00	pCi/g	JRO	09/06/14 645	7630
TH-228	G,N	2.91E+00	7.97E-01	1.09E+00	2.21E+00	pCi/g	JRO	09/06/14 645	7630
PB-212	G,N	9.93E-01	4.96E-02	2.76E-02	5.64E-02	pCi/g	JRO	09/06/14 645	7630
PA-234M	G,N	5.92E+00	4.23E+00	4.31E+00	9.15E+00	pCi/g	JRO	09/06/14 645	7630
BI-212	G,N	8.43E-01	4.66E-01	3.70E-01	7.59E-01	pCi/g	JRO	09/06/14 645	7630
AC-228	G,N	8.85E-01	6.84E-02	6.86E-02	1.43E-01	pCi/g	JRO	09/06/14 645	7630
EU-154	E,N	1.12E-01	8.77E-02	1.11E-01	2.36E-01	pCi/g	JRO	09/06/14 645	7630
CD-109	D,F,N	5.78E-01	2.94E-01	3.70E-01	7.53E-01	pCi/g	JRO	09/06/14 645	7630
RA-224		6.38E-01	2.61E-01	2.68E-01	5.49E-01	pCi/g	JRO	09/06/14 645	7630
Ra_D_214		6.98E-01	3.62E-02	3.10E-02	6.42E-02	pCi/g	JRO	09/06/14 645	7630
K-40		1.39E+01	9.00E-01	2.51E-01	5.21E-01	pCi/g	JRO	09/06/14 645	7630

BRIAN J STROH, Capt, USAF
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Contact:	SSgt Michael Ames		
Client Sample ID:	GS140005		
Lab Sample ID:	S1408005-05A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/30/2014		
Receive Date:	8/5/2014		
Collector:	Client		

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
Gamma Spec Full									
U-235	G,N	1.01E-01	3.45E-02	2.74E-02	5.56E-02	pCi/g	JRO	09/06/14 1247	7630
TL-208	G,N	3.34E-01	4.62E-02	3.83E-02	7.78E-02	pCi/g	JRO	09/06/14 1247	7630
TH-234	G,N	2.36E+00	8.38E-01	9.97E-01	2.03E+00	pCi/g	JRO	09/06/14 1247	7630
TH-228	G,N	2.87E+00	8.53E-01	1.03E+00	2.10E+00	pCi/g	JRO	09/06/14 1247	7630
PB-212	G,N	1.17E+00	5.80E-02	2.84E-02	5.80E-02	pCi/g	JRO	09/06/14 1247	7630
BI-212	G,N	1.18E+00	3.40E-01	2.40E-01	4.99E-01	pCi/g	JRO	09/06/14 1247	7630
AC-228	G,N	1.05E+00	7.18E-02	7.10E-02	1.48E-01	pCi/g	JRO	09/06/14 1247	7630
CD-109	F,N	4.71E-01	5.24E-01	4.20E-01	8.55E-01	pCi/g	JRO	09/06/14 1247	7630
RA-224		6.38E-01	2.83E-01	2.99E-01	6.13E-01	pCi/g	JRO	09/06/14 1247	7630
Ra_D_214		7.71E-01	3.88E-02	3.78E-02	7.76E-02	pCi/g	JRO	09/06/14 1247	7630
K-40		1.48E+01	9.48E-01	2.29E-01	4.79E-01	pCi/g	JRO	09/06/14 1247	7630

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2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

Certificate of Analysis

Company:	USAFSAM/OEC		
Address:	2510 Fifth St. Bldg. 840	Report Date:	9/10/2014 10:30:43 AM
	WRIGHT-PATTERSON AFB OH, 45433		
Contact:	SSgt Michael Ames		
Client Sample ID:	GS140006		
Lab Sample ID:	S1408005-06A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/30/2014		
Receive Date:	8/5/2014		
Collector:	Client		

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
Gamma Spec Full									
U-235	G,N	6.42E-02	3.09E-02	2.49E-02	5.06E-02	pCi/g	JRO	09/06/14 1848	7630
TL-208	G,N	3.40E-01	3.44E-02	2.07E-02	4.28E-02	pCi/g	JRO	09/06/14 1848	7630
TH-234	G,N	2.53E+00	2.89E+00	1.10E+00	2.24E+00	pCi/g	JRO	09/06/14 1848	7630
TH-228	G,N	2.06E+00	1.33E+00	1.16E+00	2.37E+00	pCi/g	JRO	09/06/14 1848	7630
PB-212	G,N	1.17E+00	5.86E-02	3.15E-02	6.44E-02	pCi/g	JRO	09/06/14 1848	7630
BI-212	G,N	1.21E+00	3.33E-01	2.28E-01	4.76E-01	pCi/g	JRO	09/06/14 1848	7630
AC-228	G,N	1.01E+00	7.83E-02	8.26E-02	1.72E-01	pCi/g	JRO	09/06/14 1848	7630
RA-224		1.06E+00	2.99E-01	3.01E-01	6.17E-01	pCi/g	JRO	09/06/14 1848	7630
Ra_D_214		8.24E-01	4.12E-02	4.12E-02	8.49E-02	pCi/g	JRO	09/06/14 1848	7630
K-40		1.69E+01	1.05E+00	2.14E-01	4.50E-01	pCi/g	JRO	09/06/14 1848	7630

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Certificate of Analysis

Company:	USAFSAM/OEC		
Address:	2510 Fifth St. Bldg. 840	Report Date:	9/10/2014 10:30:43 AM
	WRIGHT-PATTERSON AFB OH, 45433		
Contact:	SSgt Michael Ames		
Client Sample ID:	GS140007		
Lab Sample ID:	S1408005-07A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/30/2014		
Receive Date:	8/5/2014		
Collector:	Client		

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
Gamma Spec Full									
TL-208	G,N	1.79E-01	2.60E-02	1.93E-02	3.97E-02	pCi/g	JRO	09/07/14 049	7630
TH-232	G,N	1.96E+01	1.11E+01	8.86E+00	1.80E+01	pCi/g	JRO	09/07/14 049	7630
TH-228	G,N	1.07E+00	6.86E-01	9.63E-01	1.96E+00	pCi/g	JRO	09/07/14 049	7630
PB-212	G,N	7.70E-01	4.41E-02	2.32E-02	4.77E-02	pCi/g	JRO	09/07/14 049	7630
BI-212	G,N	8.38E-01	2.68E-01	2.03E-01	4.24E-01	pCi/g	JRO	09/07/14 049	7630
AC-228	G,N	7.05E-01	7.12E-02	6.72E-02	1.40E-01	pCi/g	JRO	09/07/14 049	7630
RA-224		6.25E-01	2.50E-01	2.39E-01	4.90E-01	pCi/g	JRO	09/07/14 049	7630
Ra_D_214		6.76E-01	3.68E-02	3.22E-02	6.65E-02	pCi/g	JRO	09/07/14 049	7630
K-40		1.49E+01	9.20E-01	2.02E-01	4.23E-01	pCi/g	JRO	09/07/14 049	7630

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2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

Certificate of Analysis

Company:	USAFSAM/OEC		
Address:	2510 Fifth St. Bldg. 840	Report Date:	9/10/2014 10:30:43 AM
	WRIGHT-PATTERSON AFB OH, 45433		
Contact:	SSgt Michael Ames		
Client Sample ID:	GS140008		
Lab Sample ID:	S1408005-08A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/30/2014		
Receive Date:	8/5/2014		
Collector:	Client		

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
Gamma Spec Full									
U-235	G,N	1.09E-01	3.85E-02	3.08E-02	6.25E-02	pCi/g	TDR	09/05/14 1453	7631
TL-208	G,N	2.63E-01	3.18E-02	2.00E-02	4.13E-02	pCi/g	TDR	09/05/14 1453	7631
TH-234	G,N	2.89E+00	1.98E+00	1.05E+00	2.13E+00	pCi/g	TDR	09/05/14 1453	7631
TH-228	G,N	9.80E-01	9.82E-01	1.25E+00	2.55E+00	pCi/g	TDR	09/05/14 1453	7631
PB-212	G,N	1.03E+00	5.83E-02	3.25E-02	6.64E-02	pCi/g	TDR	09/05/14 1453	7631
PA-234M	G,N	5.77E+00	6.11E+00	4.77E+00	1.01E+01	pCi/g	TDR	09/05/14 1453	7631
BI-212	G,N	9.69E-01	3.45E-01	2.61E-01	5.42E-01	pCi/g	TDR	09/05/14 1453	7631
AC-228	G,N	9.59E-01	9.62E-02	7.40E-02	1.54E-01	pCi/g	TDR	09/05/14 1453	7631
RA-224		1.03E+00	3.01E-01	3.12E-01	6.39E-01	pCi/g	TDR	09/05/14 1453	7631
Ra_D_214		7.12E-01	4.40E-02	3.13E-02	6.52E-02	pCi/g	TDR	09/05/14 1453	7631
K-40		1.41E+01	9.48E-01	2.46E-01	5.15E-01	pCi/g	TDR	09/05/14 1453	7631

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Certificate of Analysis

Company:	USAFSAM/OEC		
Address:	2510 Fifth St. Bldg. 840	Report Date:	9/10/2014 10:30:43 AM
	WRIGHT-PATTERSON AFB OH, 45433		
Contact:	SSgt Michael Ames		
Client Sample ID:	GS140009		
Lab Sample ID:	S1408005-09A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/30/2014		
Receive Date:	8/5/2014		
Collector:	Client		

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
Gamma Spec Full									
U-235	G,N	7.29E-02	3.05E-02	2.47E-02	5.01E-02	pCi/g	TDR	09/05/14 2055	7631
TL-208	G,N	2.44E-01	2.65E-02	1.64E-02	3.39E-02	pCi/g	TDR	09/05/14 2055	7631
TH-234	G,N	9.71E-01	7.32E-01	9.27E-01	1.88E+00	pCi/g	TDR	09/05/14 2055	7631
TH-228	G,N	8.23E-01	6.86E-01	1.03E+00	2.10E+00	pCi/g	TDR	09/05/14 2055	7631
PB-212	G,N	8.76E-01	4.84E-02	2.83E-02	5.77E-02	pCi/g	TDR	09/05/14 2055	7631
BI-212	G,N	9.65E-01	2.40E-01	1.67E-01	3.50E-01	pCi/g	TDR	09/05/14 2055	7631
AC-228	G,N	7.64E-01	7.29E-02	6.59E-02	1.37E-01	pCi/g	TDR	09/05/14 2055	7631
RA-224		7.52E-01	2.54E-01	2.58E-01	5.28E-01	pCi/g	TDR	09/05/14 2055	7631
Ra_D_214		7.18E-01	3.50E-02	3.43E-02	7.06E-02	pCi/g	TDR	09/05/14 2055	7631
K-40		1.43E+01	8.81E-01	1.72E-01	3.63E-01	pCi/g	TDR	09/05/14 2055	7631

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Certificate of Analysis

Company:	USAFSAM/OEC		
Address:	2510 Fifth St. Bldg. 840	Report Date:	9/10/2014 10:30:43 AM
	WRIGHT-PATTERSON AFB OH, 45433		
Contact:	SSgt Michael Ames		
Client Sample ID:	GS140010		
Lab Sample ID:	S1408005-10A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/30/2014		
Receive Date:	8/5/2014		
Collector:	Client		

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
Gamma Spec Full									
TL-208	G,N	2.34E-01	2.81E-02	1.84E-02	3.79E-02	pCi/g	TDR	09/06/14 256	7631
TH-234	G,N	1.69E+00	7.12E-01	8.87E-01	1.80E+00	pCi/g	TDR	09/06/14 256	7631
TH-228	G,N	9.46E-01	6.89E-01	1.04E+00	2.11E+00	pCi/g	TDR	09/06/14 256	7631
PB-212	G,N	8.22E-01	4.73E-02	2.88E-02	5.87E-02	pCi/g	TDR	09/06/14 256	7631
PA-234M	G,N	4.37E+00	4.83E+00	3.77E+00	8.05E+00	pCi/g	TDR	09/06/14 256	7631
BI-212	G,N	9.22E-01	2.89E-01	2.16E-01	4.48E-01	pCi/g	TDR	09/06/14 256	7631
AC-228	G,N	8.28E-01	6.85E-02	6.15E-02	1.28E-01	pCi/g	TDR	09/06/14 256	7631
CD-109	F,N	5.21E-01	3.22E-01	3.64E-01	7.40E-01	pCi/g	TDR	09/06/14 256	7631
RA-224		5.60E-01	2.42E-01	2.61E-01	5.35E-01	pCi/g	TDR	09/06/14 256	7631
Ra_D_214		5.78E-01	3.60E-02	4.26E-02	8.70E-02	pCi/g	TDR	09/06/14 256	7631
K-40		1.69E+01	1.00E+00	2.00E-01	4.18E-01	pCi/g	TDR	09/06/14 256	7631

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2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

Certificate of Analysis

Company:	USAFSAM/OEC		
Address:	2510 Fifth St. Bldg. 840	Report Date:	9/10/2014 10:30:43 AM
	WRIGHT-PATTERSON AFB OH, 45433		
Contact:	SSgt Michael Ames		
Client Sample ID:	GS140011		
Lab Sample ID:	S1408005-11A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/30/2014		
Receive Date:	8/5/2014		
Collector:	Client		

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
Gamma Spec Full									
U-235	G,N	1.59E-01	7.71E-02	6.58E-02	1.32E-01	pCi/g	TDR	09/06/14 858	7631
TL-208	G,N	3.51E-01	3.37E-02	1.93E-02	3.99E-02	pCi/g	TDR	09/06/14 858	7631
TH-234	G,N	2.01E+00	1.13E+00	1.09E+00	2.22E+00	pCi/g	TDR	09/06/14 858	7631
TH-228	G,N	3.78E+00	1.01E+00	1.30E+00	2.64E+00	pCi/g	TDR	09/06/14 858	7631
PB-212	G,N	1.19E+00	6.23E-02	3.45E-02	7.02E-02	pCi/g	TDR	09/06/14 858	7631
PB-210	G,N	4.54E+00	2.51E+00	2.01E+00	4.10E+00	pCi/g	TDR	09/06/14 858	7631
BI-212	G,N	1.14E+00	3.60E-01	2.70E-01	5.60E-01	pCi/g	TDR	09/06/14 858	7631
AC-228	G,N	1.11E+00	8.97E-02	7.51E-02	1.56E-01	pCi/g	TDR	09/06/14 858	7631
CO-60	E,N	1.27E-02	1.44E-02	1.09E-02	2.40E-02	pCi/g	TDR	09/06/14 858	7631
BA-133	E,N	7.03E-02	2.81E-02	4.68E-02	9.51E-02	pCi/g	TDR	09/06/14 858	7631
RA-224		8.41E-01	3.25E-01	3.23E-01	6.61E-01	pCi/g	TDR	09/06/14 858	7631
Ra_D_214		1.07E+00	5.17E-02	3.76E-02	7.77E-02	pCi/g	TDR	09/06/14 858	7631
K-40		1.81E+01	1.10E+00	2.24E-01	4.70E-01	pCi/g	TDR	09/06/14 858	7631

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2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

Certificate of Analysis

Company:	USAFSAM/OEC		
Address:	2510 Fifth St. Bldg. 840	Report Date:	9/10/2014 10:30:43 AM
	WRIGHT-PATTERSON AFB OH, 45433		
Contact:	SSgt Michael Ames		
Client Sample ID:	GS140012		
Lab Sample ID:	S1408005-12A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/30/2014		
Receive Date:	8/5/2014		
Collector:	Client		

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
Gamma Spec Full									
TL-208	G,N	3.06E-01	3.17E-02	1.86E-02	3.84E-02	pCi/g	TDR	09/06/14 1459	7631
TH-234	G,N	2.56E+00	8.59E-01	1.07E+00	2.18E+00	pCi/g	TDR	09/06/14 1459	7631
TH-228	G,N	2.30E+00	8.43E-01	1.08E+00	2.20E+00	pCi/g	TDR	09/06/14 1459	7631
PB-212	G,N	1.20E+00	8.51E-02	3.21E-02	6.55E-02	pCi/g	TDR	09/06/14 1459	7631
BI-212	G,N	8.84E-01	2.62E-01	2.00E-01	4.20E-01	pCi/g	TDR	09/06/14 1459	7631
AC-228	G,N	1.09E+00	8.22E-02	6.10E-02	1.28E-01	pCi/g	TDR	09/06/14 1459	7631
I-131	E,N	2.71E-01	3.12E-01	2.49E-01	5.23E-01	pCi/g	TDR	09/06/14 1459	7631
CD-109	E,N	4.62E-01	3.52E-01	4.37E-01	8.87E-01	pCi/g	TDR	09/06/14 1459	7631
RA-224		7.30E-01	3.55E-01	3.03E-01	6.20E-01	pCi/g	TDR	09/06/14 1459	7631
Ra_D_214		7.64E-01	4.30E-02	3.48E-02	7.20E-02	pCi/g	TDR	09/06/14 1459	7631
K-40		1.63E+01	1.02E+00	2.43E-01	5.08E-01	pCi/g	TDR	09/06/14 1459	7631

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Radioanalytical Services Laboratory

2510 Fifth St, Area B Bldg 0840 WPAFB, OH 45433 - (937) 938-2523

Certificate of Analysis

Company:	USAFSAM/OEC		
Address:	2510 Fifth St. Bldg. 840	Report Date:	9/10/2014 10:30:43 AM
	WRIGHT-PATTERSON AFB OH, 45433		
Contact:	SSgt Michael Ames		
Client Sample ID:	GS140013		
Lab Sample ID:	S1408005-13A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/30/2014		
Receive Date:	8/5/2014		
Collector:	Client		

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
Gamma Spec Full									
U-235	G,N	7.21E-02	2.86E-02	2.31E-02	4.70E-02	pCi/g	TDR	09/06/14 2100	7631
TL-208	G,N	2.69E-01	2.77E-02	1.73E-02	3.57E-02	pCi/g	TDR	09/06/14 2100	7631
TH-228	G,N	1.48E+00	7.01E-01	1.17E+00	2.37E+00	pCi/g	TDR	09/06/14 2100	7631
PB-212	G,N	9.75E-01	1.01E-01	2.92E-02	5.95E-02	pCi/g	TDR	09/06/14 2100	7631
BI-212	G,N	1.19E+00	2.99E-01	2.05E-01	4.27E-01	pCi/g	TDR	09/06/14 2100	7631
AC-228	G,N	8.15E-01	7.26E-02	5.62E-02	1.17E-01	pCi/g	TDR	09/06/14 2100	7631
RA-224		8.24E-01	3.23E-01	2.59E-01	5.30E-01	pCi/g	TDR	09/06/14 2100	7631
Ra_D_214		7.49E-01	3.53E-02	3.02E-02	6.23E-02	pCi/g	TDR	09/06/14 2100	7631
K-40		1.79E+01	1.03E+00	1.93E-01	4.05E-01	pCi/g	TDR	09/06/14 2100	7631

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Certificate of Analysis

Company:	USAFSAM/OEC		
Address:	2510 Fifth St. Bldg. 840	Report Date:	9/10/2014 10:30:43 AM
	WRIGHT-PATTERSON AFB OH, 45433		
Contact:	SSgt Michael Ames		
Client Sample ID:	GS140014		
Lab Sample ID:	S1408005-14A		
Matrix:	Soil	Client ID:	0206OC
Collection Date:	7/30/2014		
Receive Date:	8/5/2014		
Collector:	Client		

Parameter	Qualifier	Activity	Uncertainty	Lc	MDA	Units	Analyst	Date/Time	Batch
Gamma Spec Full									
U-235	G,N	6.63E-02	3.10E-02	2.50E-02	5.07E-02	pCi/g	TDR	09/07/14 302	7631
TL-208	G,N	2.58E-01	3.01E-02	1.87E-02	3.87E-02	pCi/g	TDR	09/07/14 302	7631
TH-234	G,N	9.72E-01	8.00E-01	1.02E+00	2.08E+00	pCi/g	TDR	09/07/14 302	7631
PB-212	G,N	9.66E-01	8.97E-02	3.10E-02	6.33E-02	pCi/g	TDR	09/07/14 302	7631
BI-212	G,N	8.84E-01	2.40E-01	1.74E-01	3.66E-01	pCi/g	TDR	09/07/14 302	7631
AC-228	G,N	8.28E-01	7.97E-02	6.93E-02	1.44E-01	pCi/g	TDR	09/07/14 302	7631
CS-137	D,F,N	3.69E-02	2.00E-02	1.53E-02	3.19E-02	pCi/g	TDR	09/07/14 302	7631
RA-224		6.22E-01	3.48E-01	2.82E-01	5.78E-01	pCi/g	TDR	09/07/14 302	7631
Ra_D_214		7.59E-01	4.34E-02	3.59E-02	7.40E-02	pCi/g	TDR	09/07/14 302	7631
K-40		1.46E+01	9.24E-01	2.07E-01	4.36E-01	pCi/g	TDR	09/07/14 302	7631

BRIAN J STROH, Capt, USAF
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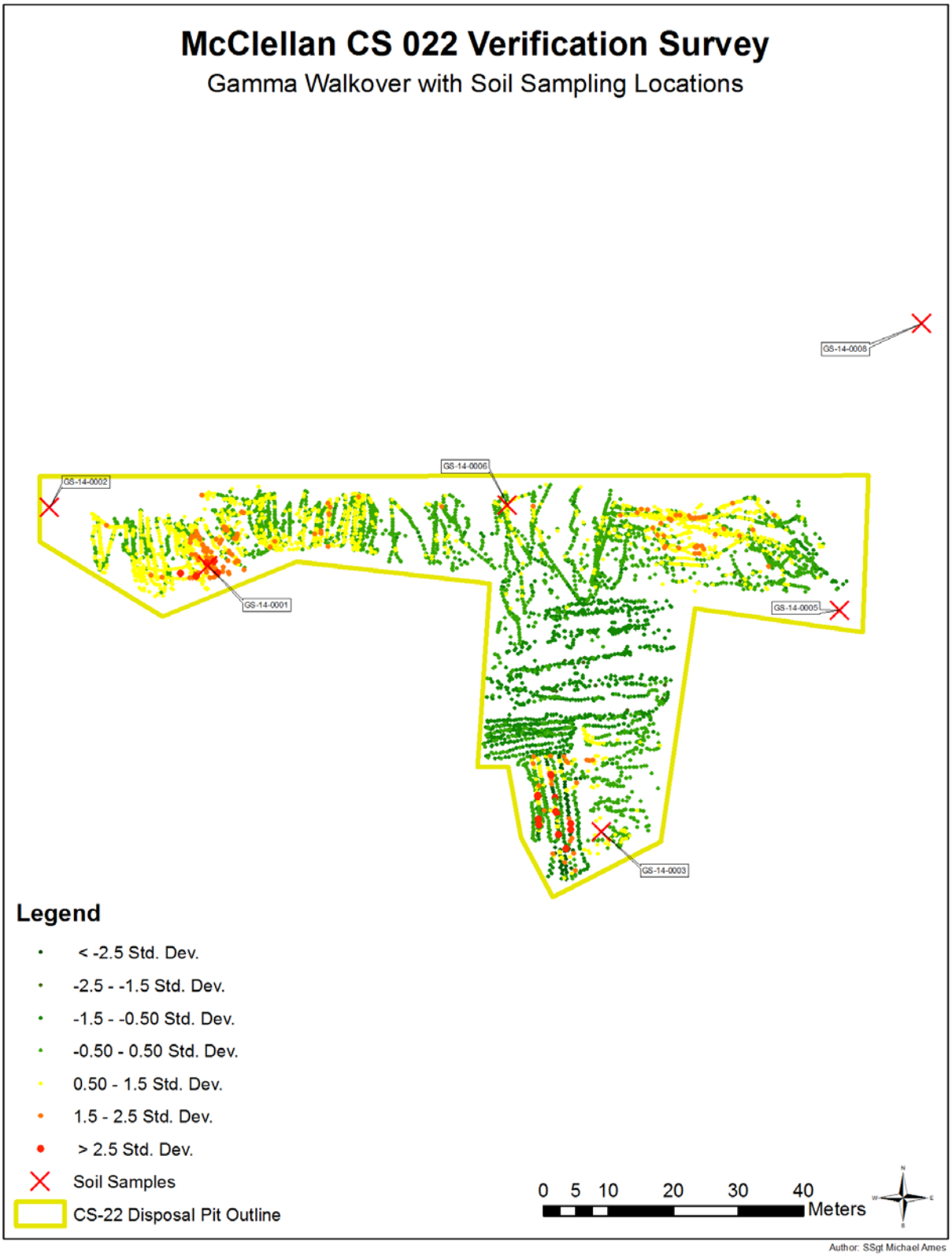
Radiation Qualifier List

Qualifier	Qualifier Description
A	Identification Rejected
B	(ELAP) Blank Contaimination
C	Inconclusive
D	Misidentification
E	False Positve
F	Consistent with False Positive
G	Qualitatively consistent with detector background
H	Quantitatively consistent with detector background
I	Inconsistent energy shift
J	(ELAP) The reported results is an esimated value
N	(ELAP) Non-target analyte
Q	(ELAP) One or more quality control criteria failed
U	(ELAP) Analyte was not detected and is reported as less than the LOD
K	Inconsistent Full Width Half Max (FWHM)
L	Hold time exceeded
M	Results invalid

Attachment 2
Map of Gamma Walkover with Soil Sample Locations



Attachment 3
Instrument Calibration Sheets

DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
OCCUPATIONAL ENVIRONMENTAL HEALTH
WRIGHT-PATTERSON AFB OHIO

CERTIFICATE OF CALIBRATION

Mfg. Ludlum Model 2221 Serial # 287511 Index # 102209 Date: 16-Jun-14
Mfg. Scionix Model 76BR76/3M-E1-X Serial # SAG 420 Index # N/A Cal. Due Date: 16-Jun-15

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources

Isotope	*Serial #*	*Cert. Date*	*DPM*
Cs 137	MU851	01-Nov-04	1974084

Reference Instruments

Mfg.	*Model*	*Serial #*	*Cal. Due Date*
Ludlum	**500-1**	102952	4 DEC 2014

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

☑ Battery Ck. ☑ Mechanical Ck. ☑ Meter Zeroed ☑ Reset Ck. NA Alarm Ck.
☑ Audio Ck. ☑ Geotropism Ck. ☑ F/S Resp. Ck. ☑ Window Op.

As Found HV 494 VDC Temperature 70.1 °F Relative Humidity 62.4 %

Final Volt. Set 700 VDC Threshold (LLD) 9 mV Window (ULD) 20 mV Window width 11 mV

HV Readout (2 points) Reference: 500 V Reference: 1000 V
Inst. Readout: 497 V ± 2% Inst. Readout: 1,012 V ± 2%

RANGE MULTIPLIER	REFERENCE CAL. POINT	"AS FOUND" READING	CORRECTED READING
x 1000	400 CPM	380,000 CPM	400,000 CPM
x 1000	100 CPM	110,000 CPM	110,000 CPM
x 100	400 CPM	40,000 CPM	40,000 CPM
x 100	100 CPM	11,000 CPM	11,000 CPM
x 10	400 CPM	4,000 CPM	4,000 CPM
x 10	100 CPM	1,100 CPM	1,100 CPM
x 1	400 CPM	400 CPM	400 CPM
x 1	100 CPM	110 CPM	110 CPM
Log Scale	200 CPM	200 CPM	200 CPM

DIGITAL SCALER READOUT

CAL. REF. POINT	AS FOUND READING	CORRECTED READING
40,000 CPM	40,000 CPM	40,000 CPM

*UNCERTAINTY WITHIN ± 10% CORRECTION FACTOR WITHIN ± 20%

COMMENTS: Calibration Interval = 1 year Use "Window OUT

Detector Parameters: Page2- 3 **Procedural Authority - ICP#22210000**

Calibrated By: Kurt Shotts Date: 16-Jun-2014

Reviewed By: Maurice Patterson Date: 17 June 2014

Page 1

Jun 16 2014 03 13 PM Kurt Shorts

HotSpot FIDLER Calibration Information

Report Date	:	Jun 16 2014 03:13 PM
Calibration Date	:	16 June 2014
Target Mix	:	Other Nuclide Check Source
Radionuclide	:	Cs-137
Detector Barcode Number	:	N/A
Meter Barcode Number	:	102209
Detector Manufacturer	:	Scionix
Detector Model Number	:	76BRS76/3M-E1-X
Detector Serial Number	:	SAG420
Meter Manufacturer	:	Ludlum
Meter Model Number	:	2221
Meter Serial Number	:	287511
Check Source I.D.	:	RP 3067
Calibration Date	:	16 June 2014
Calibrated by	:	Kurt Shorts
Check Source Activity (uCi):		8.890E-01
Sample Counting Time (minutes)	:	1.000E+00
Detector Height (cm)	:	3.000E+01

Cs-137 Window Information:

Background (cpm)	:	9,928
Areal Limit of Sensitivity (uCi/m2)	:	6.9E-02
Point Limit of Sensitivity (uCi)	:	6.4E-02
K-factor (m2)	:	0.92

Counting Data (counts):

0-cm:	16455
20-cm:	14967
40-cm:	12820
60-cm:	11625
80-cm:	11051
100-cm:	10321

Instrument Type :Other
Window Option:Only 60 keV
Units:Classic
This is an actual 3x3 calibration, and the values are typical of most 3x3 configurations.

Detector Calibration Results

Cs-137 Window Information:

Cs-137 Detector Efficiency (cpm/(uCi/m2)):		6.8E+03
Cs-137 Detector Areal LOS (uCi/m2)	:	6.9E-02
Cs-137 Detector Point LOS (uCi)	:	6.4E-02
Cs-137 Detector Background Rate (cpm)	:	9,928
Cs-137 Detector Check Source Rate (cpm)	:	6,527
Cs-137 Detector K-Factor (m2)	:	0.92
Cs-137 Detector K-Factor sdev (%)	:	5.3

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WRIGHT-PATTERSON AFB OHIO

CERTIFICATE OF CALIBRATION

Mfg. Ludlum Model 2221 Serial # 287537 Index # 102210 Date: 24-Jun-14
Mfg. Scionix Model 76BRS76/2ME1-X Serial # SAG 423 Index # 08335 Cal. Due Date: 24-Jun-15

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources

Isotope	*Serial #*	*Cert. Date*	*DPM*
Cs 137	RP3067	01-Nov-04	1972997

Reference Instruments

Mfg.	*Model*	*Serial #*	*Cal. Due Date*
Ludlum	**500-1**	102951	06 MAR 2015

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

☑ Battery Ck. ☑ Mechanical Ck. ☑ Meter Zeroed ☑ Reset Ck. NA Alarm Ck.
☑ Audio Ck. ☑ Geotropism Ck. ☑ F/S Resp. Ck. ☑ Window Op.

As Found HV 647 VDC Temperature 68.0 °F Relative Humidity 63.8 %

Final Volt. Set 675 VDC Threshold (LLD) 10 mV Window (ULD) 19 mV Window width 9 mV

HV Readout (2 points) Reference: 500 V Reference: 1000 V
Inst. Readout: 500 V ± 2% Inst. Readout: 1,006 V ± 2%

RANGE MULTIPLIER	REFERENCE CAL. POINT	"AS FOUND" READING	CORRECTED READING
x 1000	400 CPM	400,000 CPM	400,000 CPM
x 1000	100 CPM	100,000 CPM	100,000 CPM
x 100	400 CPM	40,000 CPM	40,000 CPM
x 100	100 CPM	10,000 CPM	10,000 CPM
x 10	400 CPM	4,000 CPM	4,000 CPM
x 10	100 CPM	1,000 CPM	1,000 CPM
x 1	400 CPM	400 CPM	400 CPM
x 1	100 CPM	100 CPM	100 CPM
Log Scale	200 CPM	200 CPM	200 CPM

DIGITAL SCALER READOUT

CAL. REF. POINT	AS FOUND READING	CORRECTED READING
40,000 CPM	40,067 CPM	40,067 CPM

*UNCERTAINTY WITHIN ± 10% CORRECTION FACTOR WITHIN ± 20%

COMMENTS: Calibration Interval = 1 year Use "Window OUT

Detector Parameters: Page2- 3 **Procedural Authority - ICP#22210000**

Calibrated By: _____ Date : 24-Jun-2014

Reviewed By: _____ Date: 25-Jun-2014

DEPARTMENT OF THE AIR FORCE
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OCCUPATIONAL ENVIRONMENTAL HEALTH
WRIGHT-PATTERSON AFB OHIO

CERTIFICATE OF CALIBRATION

Mfg. Ludlum	Model 2221	Serial # 287537	Index # 102210	Date: 24-Jun-14
Mfg. Scionix	Model 76BRS76/2ME1-X	Serial # SAG 423	Index # 08335	Cal. Due Date: 24-Jun-15

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources

Isotope	*Serial #*	*Cert. Date*	*DPM*
Cs 137	RP3067	01-Nov-04	1972997

Reference Instruments

Mfg.	*Model*	*Serial #*	*Cal. Due Date*
Ludlum	**500-1**	102951	06 MAR 2015

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

NaI DETECTOR HIGH VOLTAGE OPTIMIZATION

Probe #1
Mfg. Scionix
Model 76BRS76/2ME1-X
Serial # SAG 423
Index # 08335
Isotope: Cs-137 @ 6"

High Voltage	CPM
500	25427
550	27564
600	27676
650	28510
*675	28290
700	29123
750	28905
800	29710
850	33455
-----	-----
-----	-----
-----	-----
-----	-----
Bkgd@ 675v	9,258

Final Volt. Set 675 VDC
Efficiency 40000 CPM/μci/m² @12"

Probe #2
Mfg. N/A
Model
Serial #
index #
Isotope:

High Voltage	CPM

Final Volt. Set ___ VDC
Efficiency ___ CPM/μci/m² @12"

Probe #3
Mfg. N/A
Model
Serial #
Index #
Isotope:

High Voltage	CPM

Final Volt. Set ___ VDC
Efficiency ___ CPM/μci/m² @12"

COMMENTS: Calibration Interval = 1 year Use "Window OUT

Procedural Authority - ICP#22210000

Calibrated By: [signature] Date: 24-Jun-2014

Reviewed By: [signature] Date: 25-Jun-2014

Jun 24 2014 01 40 PM Willis Hosley
HotSpot FIDLER Calibration Information

Report Date	:	Jun 24 2014 01:40 PM
Calibration Date	:	June 24 2014
Target Mix	:	Other Nuclide Check Source
Radionuclide	:	Cs-137
Detector Barcode Number	:	08335
Meter Barcode Number	:	102210
Detector Manufacturer	:	Scionix
Detector Model Number	:	76BRS76/3M-E1-X
Detector Serial Number	:	SAG423
Meter Manufacturer	:	Ludlum
Meter Model Number	:	2221
Meter Serial Number	:	287537
Check Source I.D.	:	RP 3067
Calibration Date	:	June 24 2014
Calibrated by	:	Willis Hosley
Check Source Activity (uCi):		8.890E-01

Sample Counting Time (minutes) : 1.000E+00
Detector Height (cm) : 3.000E+01

Cs-137 Window Information:

Background (cpm)	:	9,258
Areal Limit of Sensitivity (uCi/m2)	:	1.1E-02
Point Limit of Sensitivity (uCi)	:	5.5E-02
K-factor (m2)	:	4.83

Counting Data (counts):

0-cm:	16549
20-cm:	14818
40-cm:	12314
60-cm:	11101
80-cm:	10529
100-cm:	10378

Instrument Type :Other
Window Option:Only 60 keV
Units:Classic
This is an actual 3x3 calibration, and the values are typical of most 3x3 configurations.

Detector Calibration Results

Cs-137 Window Information:

Cs-137 Detector Efficiency (cpm/(uCi/m2)):		4.0E+04
Cs-137 Detector Areal LOS (uCi/m2)	:	1.1E-02
Cs-137 Detector Point LOS (uCi)	:	5.5E-02
Cs-137 Detector Background Rate (cpm)	:	9,258
Cs-137 Detector Check Source Rate (cpm)	:	7,291
Cs-137 Detector K-Factor (m2)	:	4.83
Cs-137 Detector K-Factor sdev (%)	:	5.2

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CERTIFICATE OF CALIBRATION

Mfg. Ludlum Model 2221 Serial # 290803 Index # 102204 Date: 03-Jun-14
Mfg. Scionix Model 76B76/76M-E1-X Serial # SAG 427 Index # N/A Cal. Due Date: 03-Jun-15

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources

Isotope	*Serial #*	*Cert. Date*	*DPM*
Cs 137	MU851	01-Nov-04	1975850

Reference Instruments

Mfg.	*Model*	*Serial #*	*Cal. Due Date*
Ludlum	**500-1**	102952	4 DEC 2014

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

☑ Battery Ck. ☑ Mechanical Ck. ☑ Meter Zeroed ☑ Reset Ck. ☒ NA Alarm Ck.
☑ Audio Ck. ☑ Geotropism Ck. ☑ F/S Resp. Ck. ☑ Window Op.

As Found HV 694 VDC Temperature 64.8 °F Relative Humidity 69.7 %

Final Volt. Set 675 VDC Threshold (LLD) 10 mV Window (ULD) 20 mV Window width 10 mV

HV Readout (2 points) Reference: 500 V Reference: 1000 V
Inst. Readout: 497 V ± 2% Inst. Readout: 1,010 V ± 2%

RANGE MULTIPLIER	REFERENCE CAL. POINT	"AS FOUND" READING	CORRECTED READING
x 1000	400 CPM	420,000 CPM	400,000 CPM
x 1000	100 CPM	100,000 CPM	100,000 CPM
x 100	400 CPM	40,000 CPM	40,000 CPM
x 100	100 CPM	10,000 CPM	10,000 CPM
x 10	400 CPM	4,000 CPM	4,000 CPM
x 10	100 CPM	1,000 CPM	1,000 CPM
x 1	400 CPM	400 CPM	400 CPM
x 1	100 CPM	100 CPM	100 CPM
Log Scale	200 CPM	200 CPM	200 CPM

DIGITAL SCALER READOUT

CAL. REF. POINT	AS FOUND READING	CORRECTED READING
40,000 CPM	40,304 CPM	40,304 CPM

*UNCERTAINTY WITHIN ± 10% CORRECTION FACTOR WITHIN ± 20%

COMMENTS: Calibration Interval = 1 year Use "Window OUT

Detector Parameters: Page2- 3 **Procedural Authority - ICP#22210000**

Calibrated By: Kurt Shorts Date : 03-Jun-2014

Reviewed By: Matthew Patrick Date: 3 Jun '14

Page 1

DEPARTMENT OF THE AIR FORCE
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CERTIFICATE OF CALIBRATION

Mfg. Ludlum Model 2221 Serial # 290803 Index # 102204 Date: 03-Jun-14
Mfg. Scionix Model 76BRS76/3M-E1-X Serial # SAG 427 Index # N/A Cal. Due Date: 03-Jun-15

TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources

Isotope	*Serial #*	*Cert. Date*	*DPM*
Cs 137	MU851	01-Nov-04	1975850

Reference Instruments

Mfg.	*Model*	*Serial #*	*Cal. Due Date*
Ludlum	**500-1**	102952	4 DEC 2014

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

NaI DETECTOR HIGH VOLTAGE OPTIMIZATION

Probe #1
Mfg. Scionix
Model 76BRS76/3M-E1-X
Serial # SAG 427
Index # N/A
Isotope: Cs-137 @ 6"

High Voltage	CPM
500	26601
550	27564
600	27895
650	27826
*675	27780
700	28274
750	28287
800	28173
850	30217
900	41729
-----	-----
-----	-----
-----	-----
Bkgd@ 675v	8,781

Final Volt. Set 675 VDC
Efficiency 9900 CPM/μci/m² @12"

Probe #2
Mfg. N/A
Model
Serial #
Index #
Isotope:

High Voltage	CPM

Final Volt. Set ___ VDC
Efficiency ___ CPM/μci/m² @12"

Probe #3
Mfg. N/A
Model
Serial #
Index #
Isotope:

High Voltage	CPM

Final Volt. Set ___ VDC
Efficiency ___ CPM/μci/m² @12"

COMMENTS: Calibration Interval = 1 year Use "Window OUT

Procedural Authority - ICP#22210000

Calibrated By: Kurt Sloats Date: 03-Jun-2014
Reviewed By: Matthew Catinella Date: 3 Jun '14

2

Jun 03 2014 11 07 AM Kurt Shorts
HotSpot FIDLER Calibration Information

Report Date	:	Jun 03 2014 11:07 AM
Calibration Date	:	03 June 2014
Target Mix	:	Other Nuclide Check Source
Radionuclide	:	Cs-137
Detector Barcode Number	:	N/A
Meter Barcode Number	:	102204
Detector Manufacturer	:	Scionix
Detector Model Number	:	76BRS76/3M-E1-X
Detector Serial Number	:	SAG427
Meter Manufacturer	:	Ludlum
Meter Model Number	:	2221
Meter Serial Number	:	290803
Check Source I.D.	:	RP 3067
Calibration Date	:	03 June 2014
Calibrated by	:	Kurt Shorts
Check Source Activity (uCi):		8.900E-01
Sample Counting Time (minutes)	:	1.000E+00
Detector Height (cm)	:	3.000E+01

Cs-137 Window Information:

Background (cpm)	:	8,781
Areal Limit of Sensitivity (uCi/m2)	:	4.4E-02
Point Limit of Sensitivity (uCi)	:	5.5E-02
K-factor (m2)	:	1.24

Counting Data (counts):

0-cm:	15887
20-cm:	13996
40-cm:	12147
60-cm:	10389
80-cm:	10225
100-cm:	9606

Instrument Type :Other
Window Option:Only 60 kev
Units:Classic
This is an actual 3x3 calibration, and the values are typical of most 3x3 configurations.

Detector Calibration Results

Cs-137 Window Information:

Cs-137 Detector Efficiency (cpm/(uCi/m2)):		9.9E+03
Cs-137 Detector Areal LOS (uCi/m2)	:	4.4E-02
Cs-137 Detector Point LOS (uCi)	:	5.5E-02
Cs-137 Detector Background Rate (cpm)	:	8,781
Cs-137 Detector Check Source Rate (cpm)	:	7,106
Cs-137 Detector K-Factor (m2)	:	1.24
Cs-137 Detector K-Factor sdev (%)	:	5.3

Attachment 4
Radiation Meter Quality Control (QC) Log

Radiation Meter QC Log

Model	S/N	Date/Time	HV/cables/Bat check	Source Check Reading	Acceptable Range ±10%
Ludlum 2221 76BRS76/3M-E1-X	287511 SAG420	29 July/ 0846	6.1 V / 700V	21963 cpm	19713 - 24093
Ludlum 2221 TYP76BRS76	287537 SAG423	29 July/ 8[illegible]	6.0V/ 673 V	21845 cpm	19660 - 24030
Ludlum 2221 76BRS76/3M-E1-X	287511 SAG420	30 July/ 0730	6.0V / 699V	21084 cpm	19713 - 24093
Ludlum 2221 240803	287511 SAG427	30 July/ 1318	6.1V/ 674V	18416 cpm	16574 - 20258
ludlum 2221	287511 SAG420	30 July/ 16[illegible]	6.1/ 693V	20438 cpm	19713 - 24093
Ludlum 2221	287511 SAG427	30 July/ 1620	6.0/ 669V	19592 cpm	16574 - 20258

Attachment 5
Statistical Summary of Instrument Data

Instrument Model Number: Ludlum 2221 / Scionix 76BRS76 3x3 NaI
Instrument Serial Number: 287511 / SAG420
Surface Type: Dirt/Soil