



**OAK RIDGE INSTITUTE FOR  
SCIENCE AND EDUCATION**  
Managed by ORAU for DOE

October 12, 2016

Ms. Rachel Browder  
U.S. Nuclear Regulatory Commission  
Region IV  
1600 East Lamar Boulevard  
Arlington, TX 76011

**SUBJECT:       ORISE CONTRACT NO. DE-SC0014664**  
**LETTER REPORT FOR ANALYTICAL RESULTS FOR SEVEN SOIL SAMPLES**  
**ASSOCIATED WITH THE HILL AIR FORCE BASE, LITTLE MOUNTAIN**  
**TEST ANNEX WR111 SITE, UTAH**  
**[TAC NO. 030-28641/2016-001] [DOCKET NO. 30-28641](RFTA NO. 16-001)**  
**DCN: 5298-LR-01-0**

Dear Ms. Browder:

Oak Ridge Institute for Science and Education (ORISE) received seven soil samples on August 25, 2016 from the Little Mountain Test Annex WR111 site Hill AFB, Utah. ORISE is managed by Oak Ridge Associated Universities (ORAU) under DOE contract number DE-SC0014664. The samples were received in good condition. Per the NRC Form 303 that was sent with the samples, the samples were analyzed for thorium and radium by gamma spectrometry. At your request, one sample was analyzed for thorium-230 by alpha spectrometry to confirm the gamma results. The analytical data, along with the procedure references, are presented in the attached reports. A case narrative is included to provide information regarding the analytical data.

Quality Control (QC) requirements were met for these analyses. The QC files are available for your review upon request.

Please feel free to contact me at 865.576.9184 or Forrest Smith at 865.574.9802 with any questions or comments.

Sincerely,



 For Wade Ivey

Wade Ivey, Manager Laboratory  
ORAU

WPI:WFS:km:lw

Enclosures

Electronic distribution: T. Carter, NRC                      S. Roberts, ORAU                      T. Vitkus, ORAU  
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File code: 5298; Lab code: 11791

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Quality Review	
Technical Review	

# **CASE NARRATIVE FOR ANALYTICAL RESULTS FOR SEVEN SOIL SAMPLES FROM THE HILL AIR FORCE BASE, LITTLE MOUNTAIN TEST ANNEX WR111 SITE, UTAH**



**Prepared for the  
U.S. Nuclear Regulatory Commission**

**Issued October 2016**

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other requests shall be approved by the NRC.

## **CASE NARRATIVE FOR ANALYTICAL RESULTS FOR SEVEN SOIL SAMPLES FROM THE HILL AIR FORCE BASE, LITTLE MOUNTAIN TEST ANNEX WR111 SITE, UTAH**

<b>PROJECT NAME:</b>	Hill AFB
<b>PROJECT #:</b>	201211791
<b>DCN:</b>	5298-LR-01-0
<b>SDG #:</b>	201211791-1

### **1. GENERAL**

The Radiological and Environmental Analytical Laboratory (REAL) at Oak Ridge Institute for Science and Education (ORISE) received seven soil samples on August 25, 2016 from the Little Mountain Test Annex WR111 site Hill AFB, Utah. All samples were received in good condition. As requested, all samples were analyzed for thorium-232, thorium-230, and radium-226 by gamma spectrometry. In addition, one sample was analyzed for thorium-230 by alpha spectrometry.

The quality control (QC) samples were evaluated against ORISE's acceptance criteria as defined by the *ORAU Radiological and Environmental Analytical Laboratory Procedures Manual* and the *ORAU Environmental Services and Radiation Training Quality Program Manual* (ORAU 2016a and 2016b), which are at least as stringent as those set forth in the U.S. Department of Defense/U.S. Department of Energy (DoD/DOE) Quality Systems Manual (QSM). Any deviations from the approved REAL procedures are documented in the project file and described in the sections below.

### **2. SAMPLE IDENTIFICATION AND RECEIPT/CHAIN OF CUSTODY**

#### **2.1 SAMPLE IDENTIFICATION**

This data package contains analytical data for seven soil samples for gamma spectrometry and one soil sample for alpha spectrometry. The sample labels on the samples matched the sample identifications (IDs) on the chain of custody (COC). REAL sample IDs are cross-referenced with the client sample IDs below, along with the sample receipt date and requested analysis.



Client Sample ID	Lab Sample ID	LAB Receipt Date	Requested Analysis
Hill-S-01	11791S0001	08/25/2016	Gamma Spec
Hill-S-02	11791S0002	08/25/2016	Gamma Spec
Hill-S-03	11791S0003	08/25/2016	Gamma Spec
Hill-S-04	11791S0004	08/25/2016	Gamma Spec
Hill-S-05	11791S0005	08/25/2016	Gamma Spec
Hill-S-06	11791S0006	08/25/2016	Gamma Spec
Hill-S-07	11791S0007	08/25/2016	Gamma Spec and Alpha Spec

## 2.2 SAMPLE RECEIPT/CHAIN OF CUSTODY

The seven soil samples arrived on August 25, 2016 in a cooler, and all samples were received in good condition. The Form 303 supplied with the samples was complete and legible.

## 3. SAMPLE PREPARATION

The soil samples were prepared for analysis using REAL procedure SP3, revision 9. The samples were dried to constant weight, homogenized, and passed through a 0.25-inch sieve. The homogenized samples were placed in appropriately sized containers for gamma spectrometry. An aliquot of the homogenized sample (Hill-S-07) that had been counted for gamma spectroscopy was used for the alpha spectrometry analysis. There were no deviations from SP3, revision 9 for the soil samples.

## 4. GAMMA SPECTROMETRY

REAL analyzed for radium-226, thorium-230, and thorium-232, (Ra-226, Th-230, and Th-232) by gamma spectrometry using REAL procedure CP1, revision 19, which is a modified version of EPA method 901.1, DOE EMM HASL 300 Ga-010R, and Standards Methods 7120B. A summary of these standardized methods may be found in the EPA document titled "Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events, Revision 5.0" (EPA/600/R-04/126E September 29, 2009).

<http://nepis.epa.gov/Exe/ZyPDF.cgi/P1005B4P.PDF?Dockey=P1005B4P.PDF>.

REAL used the direct Th-230 gamma emission and the progeny of Ra-226 and Th-232 for quantification. The requested gamma-emitting radionuclide, the progeny radionuclide, and the approximate peak energy of the progeny used for quantification are presented below. The site-specific derived concentration guideline levels (DCGLs) were specified via the Form 303 for thorium-232, thorium-230, and radium-226 as 1.9, 4.3, and 1.6 pCi/g, respectively. Six of the seven soil samples had gamma spec values for Th-232 (by Ac-228 progeny) above the site specific DCGL of 1.9 pCi/g.

Client sample ID (Hill-S-07) showed an elevated thorium-230 value and did not meet the DCGL for thorium-230 by gamma spectroscopy. At the customer's request, this sample was analyzed by alpha spectroscopy to verify the results and to satisfy the required minimum detection concentration.

Requested Isotope	Progeny Isotope	Peak Energy, KeV
Ra-226	Pb-214	351.9
Th-230	NA	67.7
Th-232	Ac-228	911.2

The method blank (BLK) and laboratory control sample (LCS) quality control samples were all within acceptable limits.

## 5. ALPHA SPECTROMETRY

REAL analyzed the client sample ID (Hill-S-07) for thorium-230 by alpha spectrometry using REAL procedures AP11, revision 8 and CP2, revision 19, which are modified versions of DOE EML HASL 300 U-02-RC and DOE RESL CHEM-TP-A.1. The DUP, BLK, and LCS quality control samples were all within acceptable limits.

## 6. DATA ANALYSIS AND INTERPRETATION

All calculations—including the concentration, total propagated uncertainties (TPUs), and minimum detectable concentrations (MDCs)—were performed using Canberra's Gamma Apex and Canberra's Alpha Apex software. Units are picocuries per gram (pCi/g).

All QC samples were within acceptable limits for the analytical batch. The BLK was an empty Marinelli beaker for the gamma spectrometry analysis. For the alpha spectrometry analysis, the BLK was processed through the entire analytical process. The results of the BLK were all below the MDCs. The LCS was a 250 mL Marinelli with Standard Reference Material having known concentrations of Am-241, Cs-137, and Co-60 for the gamma spectrometry analysis. For the alpha spectrometry, the LCS was a sample of Mixed-Nuclide Reference Material with a known amount of Th-230 and was processed through the entire analytical process. The LCS percent recovery was between 80-120%. The sample duplicate (DUP) was performed by analyzing a separate fraction of the sample in the same way the sample was analyzed. The duplicate error ratio (DER) for the DUP was less than 3 for all analytes. A DER value of less than 3 indicates that the duplicate analysis was statistically equal to the sample at the 99% confidence interval.

The DER equation is:

$$DER = \frac{|S - D|}{\sqrt{U_D^2 + U_S^2}}$$

Where:

S = sample result

D = duplicate result

$U_S$  = sample one sigma uncertainty

$U_D$  = duplicate one sigma uncertainty

## 7. REFERENCES

ORAU 2016a. *ORAU Radiological and Environmental Analytical Laboratory Procedures Manual*. Oak Ridge, Tennessee. September 8.

ORAU 2016b. *ORAU Environmental Services and Radiation Training Quality Program Manual*. Oak Ridge, Tennessee. September 8.

# Gamma Spectrometry Summary Results By Analyte



Report Date: October 07, 2016

<b>Analyte:</b>	Ra-226 by Pb-214	SOP (Rev. #)	CP1 (19)
Project Name:	Hill AFB	Energy Signature:	351.93 (KeV)
Project # :	201211791	SDG # :	201211791-1

Client Sample ID:	Lab Sample ID:	Result	TPU (2s)	MDC	Units	Qualifier Flag	Batch #
Hill-S-01	11791S0001	0.767	0.049	0.039	pCi/g		GS0334
Hill-S-02	11791S0002	0.686	0.026	0.030	pCi/g		GS0334
Hill-S-03	11791S0003	0.787	0.048	0.035	pCi/g		GS0334
Hill-S-04	11791S0004	1.159	0.068	0.040	pCi/g		GS0334
Hill-S-05	11791S0005	0.992	0.056	0.032	pCi/g		GS0334
Hill-S-06	11791S0006	1.132	0.065	0.036	pCi/g		GS0334
Hill-S-07	11791S0007	1.398	0.082	0.052	pCi/g		GS0334

## Electronically Validated By:

John Cox- 10/3/2016 07:43

## Electronically Approved By:

William Smith 10/4/2016 12:45

## Qualifier Flags:

U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty

MDC = Minimum Detectable Concentration

# Gamma Spectrometry Summary Results By Analyte



Report Date: November 03, 2016

<b>Analyte:</b>	Th-228 by Pb-212	SOP (Rev. #)	CP1 (19)
Project Name:	Hill AFB	Energy Signature:	238.63 (KeV)
Project # :	201211791	SDG # :	201211791-1

Client Sample ID:	Lab Sample ID:	Result	TPU (2s)	MDC	Units	Qualifier Flag	Batch #
Hill-S-01	11791S0001	2.35	0.14	0.04	pCi/g		GS0334
Hill-S-02	11791S0002	2.203	0.072	0.035	pCi/g		GS0334
Hill-S-03	11791S0003	2.42	0.14	0.03	pCi/g		GS0334
Hill-S-04	11791S0004	2.01	0.12	0.04	pCi/g		GS0334
Hill-S-05	11791S0005	2.50	0.14	0.04	pCi/g		GS0334
Hill-S-06	11791S0006	1.674	0.099	0.031	pCi/g		GS0334
Hill-S-07	11791S0007	3.83	0.22	0.05	pCi/g		GS0334

## Electronically Validated By:

John Cox- 10/3/2016 07:43

## Electronically Approved By:

William Smith 10/4/2016 12:45

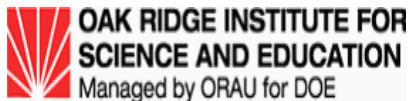
## Qualifier Flags:

U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty

MDC = Minimum Detectable Concentration

# Gamma Spectrometry Summary Results By Analyte



Report Date: October 07, 2016

<b>Analyte:</b>	Th-232 by Ac-228	SOP (Rev. #)	CP1 (19)
Project Name:	Hill AFB	Energy Signature:	911.20 (KeV)
Project # :	201211791	SDG # :	201211791-1

Client Sample ID:	Lab Sample ID:	Result	TPU (2s)	MDC	Units	Qualifier Flag	Batch #
Hill-S-01	11791S0001	2.58	0.18	0.09	pCi/g		GS0334
Hill-S-02	11791S0002	2.53	0.20	0.06	pCi/g		GS0334
Hill-S-03	11791S0003	2.69	0.19	0.06	pCi/g		GS0334
Hill-S-04	11791S0004	2.31	0.17	0.08	pCi/g		GS0334
Hill-S-05	11791S0005	2.77	0.20	0.07	pCi/g		GS0334
Hill-S-06	11791S0006	1.87	0.14	0.06	pCi/g		GS0334
Hill-S-07	11791S0007	4.34	0.29	0.10	pCi/g		GS0334

## Electronically Validated By:

John Cox- 10/3/2016 07:43

## Electronically Approved By:

William Smith 10/4/2016 12:45

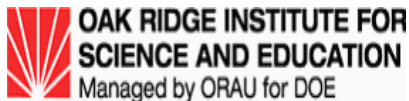
## Qualifier Flags:

U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty

MDC = Minimum Detectable Concentration

# Gamma Spectrometry Summary Results By Analyte



Report Date: October 07, 2016

<b>Analyte:</b>	Th-230	SOP (Rev. #)	CP1 (19)
Project Name:	Hill AFB	Energy Signature:	67.67 (KeV)
Project # :	201211791	SDG # :	201211791-1

Client Sample ID:	Lab Sample ID:	Result	TPU (2s)	MDC	Units	Qualifier Flag	Batch #
Hill-S-01	11791S0001	2.1	1.5	3.5	pCi/g	U	GS0334
Hill-S-02	11791S0002	1.4	1.8	4.3	pCi/g	U	GS0334
Hill-S-03	11791S0003	1.1	1.5	3.5	pCi/g	U	GS0334
Hill-S-04	11791S0004	1.8	1.5	3.4	pCi/g	U	GS0334
Hill-S-05	11791S0005	3.3	1.4	2.9	pCi/g		GS0334
Hill-S-06	11791S0006	0.5	1.4	3.3	pCi/g	U	GS0334
Hill-S-07	11791S0007	19.5	3.8	4.5	pCi/g		GS0334

## Electronically Validated By:

John Cox- 10/3/2016 07:43

## Electronically Approved By:

William Smith 10/4/2016 12:45

## Qualifier Flags:

U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty

MDC = Minimum Detectable Concentration

Report Date: October 07, 2016

**Project Name:** Hill AFB  
**Project # :** 201211791  
**COC # :** 1608-009  
**SDG #:** 201211791-1  
**Analyst:** nagler

**Batch # :** AS0349  
**Receipt Date:** 8/25/2016  
**Collection Date:** 8/24/2016  
**Count Date:** 9/29/2016  
**SOP (Rev. #):** AP11 (8)

Client								
Sample ID	Lab Sample ID	Analyte	Result	TPU (2s)	MDC	Units	Yield	Qualifier
Hill-S-07	11791S0007	TH-228	3.99	0.46	0.07	pCi/g	0.8276	
Hill-S-07	11791S0007	TH-230	13.2	1.4	0.0	pCi/g	0.8276	
Hill-S-07	11791S0007	TH-232	3.88	0.45	0.03	pCi/g	0.8276	
	11791S0007Dup	TH-228	4.63	0.54	0.07	pCi/g	0.7758	
	11791S0007Dup	TH-230	16.8	1.9	0.0	pCi/g	0.7758	
	11791S0007Dup	TH-232	4.60	0.54	0.01	pCi/g	0.7758	
	BLK0349S	TH-228	0.004	0.043	0.113	pCi/g	0.8746	U
	BLK0349S	TH-230	0.015	0.024	0.056	pCi/g	0.8746	U
	BLK0349S	TH-232	0.004	0.013	0.037	pCi/g	0.8746	U
	LCS0349S	TH-228	4.92	0.56	0.06	pCi/sample	0.8309	
	LCS0349S	TH-230	6.92	0.77	0.03	pCi/sample	0.8309	
	LCS0349S	TH-232	4.90	0.56	0.02	pCi/sample	0.8309	
		<u>Known</u>	<u>Known</u>					
<u>SampleCode</u>	<u>Isotope</u>	<u>Activity</u>	<u>Uncertainty</u>	<u>Meas./Known</u>				
		<u>(pCi)</u>	<u>(1 s)</u>	<u>Activity Ratio</u>				
LCS0349S	TH-230	6.68	0.27	1.04				
		<u>Duplicate</u>						
		<u>Error</u>						
<u>SampleCode</u>	<u>Isotope</u>	<u>Ratio</u>						
11791S0007Dup	TH-228	1.77						
11791S0007Dup	TH-230	2.99						
11791S0007Dup	TH-232	2.03						

Qualifier Flags:

U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty  
MDC = Minimum Detectable Concentration

Report Date: October 07, 2016

**AS Electronically Reviewed By:**  
Roxanne Nagle- 9/30/2016 10:05

**Electronically Validated By:**  
Wade Ivey- 9/30/2016 11:06

**Electronically Approved By:**



William Smith 10/4/2016 12:45

Qualifier Flags:

U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty

MDC = Minimum Detectable Concentration

<b>NRC FORM 303</b> (4-2004)		<b>U.S. NUCLEAR REGULATORY COMMISSION</b>		<b>LABORATORY USE ONLY</b>	
<b>REQUEST FOR ANALYSIS AND CHAIN OF CUSTODY</b>  <b>LABORATORY -- ORISE</b>				CONTROL NUMBER  RFTA-16-001	
SAMPLE LOCATION (LICENSEE) Hill AFB - Little Mountain Test Annex WR111 site				LICENSE NO. 42-23539-01AF	DOCKET NO. 30-28641
SAMPLE SUBMITTED					
# TOTAL	TYPE	VOLUME	WEIGHT	DATE SAMPLES SUBMITTED	PRIORITY
7	Soil Samples			8/24/16	<input checked="" type="checkbox"/> ROUTINE <input type="checkbox"/> URGENT
				SAMPLE COLLECTION INTERVAL	
				START	MONTH DAY YEAR TIME 8 24 16 11:00
				STOP	MONTH DAY YEAR TIME 8 24 16 11:30
INSPECTOR RESPONSIBLE Rachel Browder			TELEPHONE NUMBER 817-200-1452		
ANALYSIS TO BE PERFORMED		LIST DESIRED LLD (Optional)	OTHER TYPE OF ANALYSIS (Specify)		LIST DESIRED LLD (Optional)
<input type="checkbox"/> GROSS ALPHA (GA)			<input type="checkbox"/>		
<input type="checkbox"/> GROSS BETA (GB)			<input type="checkbox"/>		
<input checked="" type="checkbox"/> GAMMA SPEC (GS)			<input type="checkbox"/>		
<input type="checkbox"/> TRITIUM (H3)			<input type="checkbox"/>		
<input type="checkbox"/> CARBON-14 (C14)			<input type="checkbox"/>		
<input type="checkbox"/> IODINE-125 (I125)			<input type="checkbox"/>		
RELINQUISHED BY	RECEIVED BY	DATE	TIME	REASON FOR CHANGE OF CUSTODY	
Rachel Browder	Fed Ex	8-24-16		Ship to ORAU Lab Analysis	
Fed Ex	ORAU <i>Paul Smith</i>	8/25/16	1100		
FEE RECOVERABLE		<input type="checkbox"/> NO <input checked="" type="checkbox"/> YES		IF YES TAC NUMBER	
				030-28641/2016-001	
REMARKS Return samples to:    AFCEC/CZOM 7290 Weiner St., Building 383 Hill AFB, UT 84056-5003 Attn: Mark Roginske, Room 210  Radionuclides of concern: Th-232; Th-230; Ra-226 Action levels - Site Specific DCGLs: Th-232 - 1.9 pCi/g; Th-230 - 4.3 pCi/g; Ra-226 - 1.6 pCi/g NRC Inspection Report Number: 03028641/2016-001					
NOTE: SAMPLES WILL BE DISCARDED AFTER ANALYSIS UNLESS REASONS ARE NOTED IN REMARKS ABOVE.					

**SAMPLE RECORD -- (Continued)**  
**LABORATORY -- ORISE**

CONTROL NUMBER

RFTA-16-001

[illegible]

Page 1 of 1	<b>Project Name:</b> Hill AFB					<b>ORAU/ORISE Chain of Custody and Analytical Request</b>			ORAU/ORISE 1299 Bethel Valley Road, Bldg SC-200 Oak Ridge, TN 37831 Phone: (865) 576-9184 Fax: (865) 241-3248	
<b>Project #:</b>  201211791	<b>COC # :</b> 1608-009									
<b>Client Name:</b> IEAV - Lab		<b>Phone # :</b> 865-576-9184			<b>Fax # :</b>					
<b>Address:</b>					<b>Email :</b> Wade.Ivey@orau.org					
<b>Collected By:</b> Rachel Browder		<b>Send Results To:</b> IveyWade								
<b>Client Sample ID</b>	Date Collected (mm-dd-yy)	Time Collected (military)	Sample Matrix (1)	Field Filtered (2)	<b>ORAU/ORISE Lab Sample ID (Lab Use Only)</b>	<b>Total # of containers</b>	<b>Sample Analysis Requested (3)</b>		<b>Comments</b>	
Hill-S-01	08/24/16	11:00	S	No	11791S0001	1	GAMMA SPEC			
Hill-S-02	08/24/16	11:05	S	No	11791S0002	1	GAMMA SPEC			
Hill-S-03	08/24/16	11:10	S	No	11791S0003	1	GAMMA SPEC			
Hill-S-04	08/24/16	11:15	S	No	11791S0004	1	GAMMA SPEC			
Hill-S-05	08/24/16	11:20	S	No	11791S0005	1	GAMMA SPEC			
Hill-S-06	08/24/16	11:25	S	No	11791S0006	1	GAMMA SPEC			
Hill-S-07	08/24/16	11:30	S	No	11791S0007	1	GAMMA SPEC, ALPHA SPEC			
<b>Gamma Isotopes:</b> AC228, AC228, Bi212, Bi214, Bi214, K40, PA234, PB212, PB214, PB214, RA226, TH230, TH234, TH234, U235, U235, U235										
<b>Alpha Isotopes:</b> Th, <b>LSA:</b>										
<b>TAT Requested:</b> 28		<b>Rush:</b>		<u><b>Fax Results</b></u>		<b>Fax # :</b>				
<b>Chain of Custody Signatures</b>							<b>Sample Shipping and Delivery Details</b>			
<b>Relinquished By (Signed)</b>		<b>Date</b>	<b>Time</b>	<b>Received By (Signed)</b>		<b>Date</b>	<b>Time</b>	ORAU/ORISE PM: IveyWade Phone # : 865-576-9184		
Fed Ex		8/25/2016	11:00:00AM	Forrest Smith		8/25/2016	11:00:00AM	Method of Shipment: Date Shipped:		
<b>EDD Required:</b>		<b>Report Type:</b> 3		<b>Received in Good Condition:</b> Yes				Airbill # :		
<b>PEMS Project ID :</b> Hill AFB		<b>PEMS SOW ID:</b> Hill AFB						Airbill # :		

1) Matrix Codes: **S**=Soil, **W**=Water, **M**=Miscellaneous, **A**=Air Filter, **R**=Smear/Wipe  
2) Field Filtered: For liquid matrices, indicate **-Y-** for yes the sample was field filtered or **-N-** for sample was not field filtered.  
3) If the integrity of the samples and/or sample packaging are in question, provide details in the CoC comment field.

**COC Comments:**

DGCLS: Th-232 - 1.9 pCi/g  
Th-230 - 4.3 pCi/g  
Ra-226 - 1.6 pCi/g