Received 9/95

Analytical Data Package Prepared For

Rust Environment

D.O. NO. RW-41
FILE INDEX NO. COC#12138
FILE NAME: Initial Lab Report
DATE 10/11/95 INT. AP

Radiochemical Analysis By

Quanterra Analytical Services
Richland Laboratory

Report Nbr: 8763

SDG Nbr	ORDER Nbr	CLIENT ID NUMBER	LOT Nbr	WORK ORDER	RPT DB ID	BATCH
12966		RW-41-SB-50-0.3-#10	J9I010155-1	D20X1101	9D20X110	9252340
		RW-41-SB-50-0.3-#60	J9I010155-2	D20X4102	9D20X410	9252340
		RW-41-SB-50-0.3-#230	J9I010155-3	D20X7101	9D20X710	9252340

Comments:

Quanterra

CERTIFICATE OF ANALYSIS

Rust International Corporation
Environmental & Infrastructure
15 Brendan Way
Greenville SC 29615

September 20, 1999

Attention Jim Refermat (RUST) and Alec McBeth (EarthTeck)

SDG Number	:	12958
Date Samples Received	:	August 31, 1999
Number of Samples	:	Three (3)
Sample Type	:	Soil
P.O. Number	:	29234/55556
COC No.	:	12966

I. Introduction

On September 1, 1999, three soil samples were received for radiochemical analysis at the Quanterra Richland Laboratory (QRL). Upon receipt the samples were assigned QRL ID number to correspond with the RUST ID number, as listed on the attached pages.

II. Analytical Results/Methodology

The analytical results for this report are presented by laboratory sample ID. Each set of data includes sample identification information analytical results and the appropriate associated statistical errors.

The requested analyses were: **Gamma by HPGE**
Gamma Scan by Quanterra Method RICHRC5013 and RICHRC5017

II. Quality Control

The analytical results for each analysis performed under SDG 12966 include a minimum of one Laboratory Control Sample (LCS), and one method blank. Any exceptions have been noted in the "Comments" section.

IV. Comments

Gamma by HPGE

Gamma Scan by Quanterra Method RICHRC5013 and RICHRC5017

The sample batch was analyzed with it's own quality control samples and processed for gamma analysis by Quanterra. All samples were analyzed using approximately 350 g of sample. Uranium-239 results are reported as U-238DHP. Sample D20X1 (client id RW-41-SB-50, depth –0.3 #10) has an elevated activity resulting in a MDA above the CRDL. The LCS, batch blank and sample results are within contractual requirements. As part of Quanterra effort to help clients understand gamma analysis a technical guidance document is included in this report.

I certify that this Certificate of Analysis is in compliance with the SOW, both technically and for completeness, for other than the conditions detailed above. The Laboratory Manager or a designee, as verified by the following signature has authorized release of the data contained in this hard copy data package.

Reviewed and approved:

Toni Lynn Lauricella
Project Manager

Technical Guidance Document

Quanterra Northwest/Central Region

Recommendations for Matrix Spike and Matrix Spike Duplicate Analyses – Gamma Spectroscopy

Customers should be made aware of the limitations of ordering MS/MSDs on some matrices. Also customers should be advised that with some preparation and analysis methods it may not be technically correct to request a matrix spike. In applications and methods where the homogeneity of the spiked sample creates potential calibration differences with the standard, it is not technically advisable to spike the matrix and an alternative approach should be pursued to demonstrate precision and accuracy.

Discussion

Soil analyses by gamma spectroscopy is a situation where it is not advisable to spike the matrix for the analysis. Soil by nature of its variable and complex chemical constituency, offers the greatest challenge when MS/MSDs are requested. The primary challenge is the laboratory's ability to produce homogeneous spiked soil material since a liquid spike cannot be uniformly distributed in the soil matrix. This is inherent to the granular matrix and the absorption properties of liquid on/in porous materials. Best attempts at producing matrix spikes and matrix spike duplicates have proven to be less than adequate due to homogeneity and absorption issues.

With a destructive preparatory method, used for analysis such as strontium, the homogeneity issue may not present much of a complication. Destructive methods typically totally dissolve, leach, digest, or chemically breakdown the constituents and remove the isotope of interest from both the sample and the spike that was added. However, with nondestructive preparation methods or a method where an entire aliquot may not be used, homogeneity of the matrix spike is essential. Spatial and geometrical differences between the soil sample, the matrix spike, and the sources used to calibrate the detectors have significant impact on the percent recoveries and the relative percent differences between recoveries.

Gamma spectroscopy of soil is one such analysis where the spiked material in the soil must match or approximate the distribution of the spiked material in the standard. Additionally, the constituents of the soil can impact or mask one's ability to detect or quantify an added spike. Activity levels, as well as the energies of the isotopes in a soil, influence the spectral features such as Compton continuum and summation effects. These geometric effects can limit a laboratory's ability to detect an added spike. In addition the activity level of other isotopes and the geometry can create interfering lines which can affect the spike recovery.

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Area of Interest: Gamma Spectroscopy
Document No.: 99002-R0
Authored By: Brian Crandall
Reviewed By: Matt Lardy and Jackie Waddell
Date Reviewed: 08/19/99

Recommendations

Matrix spikes (MS) and matrix spike duplicates (MSD) may not be valid or required for all matrices and methods. Quanterra Richland has attempted matrix spike and matrix spike duplicates for soil samples analyzed by gamma spectroscopy even though this may not be technically advisable for this matrix and analysis method. It is our belief that an incorrect perception of precision and accuracy may be developed due to the limitations and interferences that are associated with the matrix. It is the recommendation of Quanterra to use the gamma lines of naturally occurring radionuclides, such as ^{40}K, ^{214}Pb (after equilibrium with ^{226}Ra is achieved), ^{232}Th(in equilibrium with ^{228}Ra and ^{228}Ac), or ^{238}U (in equilibrium with ^{234}Th) to measure precision and/or accuracy (indicators of quality control) on replicate samples for gamma spectroscopy. This will more accurately portray the quality of the laboratory and method rather than gauge Quanterra's ability to create a homogeneously spiked soil material.

Technical Guidance Document

Quanterra Northwest/Central Region

Recommendations for Reporting Naturally Occurring Radionuclides (Often called naturally occurring radioactive materials, NORM):

Discussion

Many long-lived naturally occurring radionuclides do not emit gammas with energies in the most efficient range of germanium detectors. In addition, gammas that are emitted often have abundances that are so low that their measurement is precluded on a practical basis. Examples of these radionuclides are Ra-226, Ra-228, Th-228, Th-230, and Th-232, U-234, U-235 and U-238. These radionuclides exist in what are called decay chains. For example, U-238, U-234, Th-230 and Ra-226 are in a decay chain with U-238 as the precursor. These radionuclides decay to progeny with energetic gammas, but many progeny have a very short half-life (seconds, minutes and hours). These progeny then are used to estimate the concentrations of their parent(s). Quanterra Richland's nuclide library for Gamma Spectroscopy includes many of the predominant natural naturally occurring radionuclides and their progeny.

The issue is further complicated by the fact that a radon radionuclide is also part of the decay progeny. Radon usually precedes the short-lived progeny so that in the sample treatment because of its nature the radon is usually removed. The radon and its progeny will grow back in (ingrowth) from decay of the parent, but it takes a minimum of 10 days to accomplish this. This works well for soil samples, to a lesser extent for other solid samples and not at all for water samples. An example of this is Ra-226 and its progeny Rn-222, Po-218, Pb-214 and Bi-214.

In other cases the progeny is not preceded by radon, but care must be taken that equilibrium between progeny and parent has been established before counting. Two examples of this are Ra-228 and its progeny Ac-228 and Th-232 and its progeny Ra-228.

Listed in the tables below are examples of long-lived naturally occurring radionuclides with their short-lived progeny. The short-lived radionuclides are used to determine the concentrations of their long-lived precursor.

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Area of Interest: Gamma Spectroscopy
Document No.: 99001-R0
Authored By: Matt Lardy
Reviewed By: Jackie Waddell and Brian Crandall
Date Reviewed: 08/16/99

A. Thorium-234 and Uranium-238

U-238 DA represents the U-238 concentration and is reported using the lines from Pb-214 and Bi-214 as shown in the table below.

U-238 DHP represents the U-238 concentration and is reported using Th-234 with its key line at 63.28 keV and the 92.59 keV line as the secondary line. See the table below.

Th-234 may be reported as TH-234DA. TH-234DA is determined from the 1001 and 766 keV lines of its progeny, Pa-234m. See the table below.

Isotope to be Identified	Isotope of Gamma Line used for Identification	Energy of Gamma Lines (keV)
Th-234DA	Pa-234m	766.41
	Pa-234m	1001.03*
U-238DHP	Th-234	63.28*
	Th-234	92.59**
U-238DA	Pb-214	241.98
	Pb-214	295.21
	Pb-214	351.92*
	Bi-214	609.31
		* keyline
		** The activity and abundances of the two peaks at 92.3 and 92.8 keV are summed.

Quanterra Richland's preparation methods are designed to ensure that the progeny are in near equilibrium with their respective parent nuclides For calculation purposes the half-life of U-238 is used for reporting Th-234DA. Likewise, the half-lives of Th-234, Pa-234m, Pb-214 and Bi-214 are 24.1 days, 1.17 minutes, 27 minutes and 19.9 minutes respectively. It is not reasonable to use the individual half-lives for decay correction since their production is limited by the decay of the long lived precursor parent. In these cases the half-life of the parent is used for calculation purposes.

B. Actinium-228, Radium-228 and Thorium-232

Ac-228, Ra-228 and Th-232 may be reported using the energy lines from the isotope itself or from progeny and associated energy lines as shown in the table below.

Isotope to be Identified	Isotope of Gamma Line used for Identification	Energy of Gamma Lines (keV)
Ac-228	Ac-228	209.28
	Ac-228	270.23
	Ac-228	338.32
	Ac-228	911.07*
	Ac-228	969.11
Ra-228DA	Ac-228	209.28
	Ac-228	338.32
	Ac-228	911.07*
	Ac-228	964.6
	Ac-228	969.11
Th-232DA	Pb-212	238.63
	Ac-228	338.32*
	Ac-228	583.14
	Ac-228	911.07
	Ac-228	964.60
	Ac-228	969.11
		* keyline

Note that there is very little flexibility for distinguishing between these three analytes. Quanterra Richland's preparation methods are designed to ensure near equilibrium exists and for calculation purposes the progeny are assumed to be in equilibrium with their parent. For calculation purposes Ac-228 is given a half-life of Th-232 when reported individually since the half-life of Ac-228 is 6.15 hours.

C. Bismuth-214, Lead-214 and Radium-226

Bi-214, Pb-214 and Ra-226 may be reported using the energy lines from the isotope itself or from progeny and associated energy lines as shown in the table below:

Isotope to be Identified	Isotope of Gamma Line used for Identification	Energy of Gamma Lines (keV)
Bi-214	Bi-214	609.32*
	Bi-214	768.36
	Bi-214	1120.29
	Bi-214	1764.49
Pb-214	Pb-214	241.98
	Pb-214	295.21
	Pb-214	351.92*
	Pb-214	785.91
Ra-226DA	Ra-226	186.21
	Pb-214	214.98
	Pb-214	295.22
	Pb-214	351.92
	Bi-214	609.32*
	Bi-214	1120.28
	Bi-214	1238.11
	Bi-214	1764.49
		* keyline

Quanterra Richland's preparation methods are designed to ensure that near equilibrium exists between parent and progeny. A period of ~ 10 days or more should elapse between sample preparation (drying and grinding) and counting as to allow a sufficient period for the ingrowth of Ra-226 progeny. For calculation purposes equilibrium with Ra-226 and its progeny Bi-214 and Pb-214 is assumed. The half-life of Ra-226 is used when the Ra-226 result is calculated. When Bi-214 and Pb-214 are reported separately the half-life of U-238 is used.

D. Thallium-208, Lead-212, Radium-224 and Thorium-228

Tl-208, Pb-212, Ra-224 and Th-228 may be reported using the energy lines from the isotope itself or from progeny and associated energy lines as shown in the table below.

Isotope to be Identified	Isotope of Gamma Line used for Identification	Energy of Gamma Lines (keV)
Tl-208	Tl-208	277.35
	Tl-208	510.84
	Ac-228	583.14*
	Tl-208	860.37
Pb-212	Pb-212	238.63*
	Pb-212	300.09
Ra-224	Pb-212	238.63*
	Ra-224	240.98
	Ac-228	583.14
	Tl-208	860.37
Th-228DA	Pb-212	238.63
	Ra-224	240.98
	Ac-228	583.14*
	Tl-208	860.37
		* keyline

Note that there is very little flexibility for distinguishing between these four analytes. Care must be taken to assure that equilibrium is reached between the parent and its progeny. Quanterra Richland's preparation methods are designed to ensure near equilibrium exists and for calculation purposes the progeny are assumed to be in equilibrium with their parent. For calculation purposes the half-life of Th-232 is used for Tl-208 and Pb-212 when they are reported individually since their half-lives are 3.053 minutes and 10.64 hours respectively. When reported separately the half-life of Th-228 is used when Ra-224 is reported separately.

Recommendations for Soil Samples:
The following recommendations are made for the naturally occurring radionuclides Quanterra Richland will report for soil samples provided the customer has not given other guidance.

K-40
Ra-226DA
Th-232DA
U-238DHP

Reporting progeny such as Tl-208, Pb-212, Bi-214 and Pb-214 is not recommended. Three reasons can be given: (a) the gamma lines used to calculate the results are used to produce the concentration of one or more isotopes of the same chain, (b) the progeny are too far down the decay chain to assure that equilibrium exists, and (c) use of the gamma lines from these isotopes can result in false positive or false negative detection of the long-lived precursor. The activities of these radionuclides can be reported at the customer's request, however, the assumption must be made that equilibrium exists because time has been provided for ingrowth, and therefore the progeny concentration is given by the result for the parent. The half-life of the appropriate long-lived parent is used for decay correction when the activities of these radionuclides are reported individually.

Recommendations for Water Samples:
The following recommendations are made for the naturally occurring radionuclides Quanterra Richland will report for water samples provided the customer has not given other guidance.

K-40
Th-232DA
U-238DHP

The parameters for reporting are the same as for soil with one exception: Reporting Ra-226 from its progeny is not reliable, since ingrowth and subsequent equilibrium cannot be established. Therefore the 186 keV line of Ra-226 must be utilized. However, U-235 has a primary gamma line at 186.57 keV with a 54% abundance, and if present it would interfere with the 186 keV line of Ra-226 (which is at 3.2% abundance). This interference generally creates a high false positive for Ra-226 results.

References:

Browne, E., R.B. Firestone and V.S. Shirley (Editors)
Table of Radioactive Isotopes
John Wiley and Sons, Inc., New York (1986)

Chieco, N.A, (Editor)
EML Procedures Manual, HASL 300, The Procedures Manual of the Environmental Measurements Laboratory.
Environmental Measurements Laboratory, Department of Energy, USA, 28th Edition, (1992)

Sample Results Summary

Quanterra, Richland

Date: 9/24/99

REPORT No. : 8763

SDG NBR: 12966

CLIENT ID	WORK ORDER NUMBER	PARAMETER	RESULT	UNITS	YIELD	MDA
BLANK QC	D291V101	U-235HP	7.38E-02 +- 4.83E-02 (1s)	pCi/g		1.79E-01
BLANK QC		U-238	9.03E-02 +- 2.69E-02 (1s)	pCi/g		5.76E-02
BLANK QC		U-238DHP	-9.02E-02 +- 2.18E-01 (1s)	pCi/g		7.52E-01
BLANK QC	D291V103	U-235HP	2.23E-01 +- 2.38E-01 (1s)	pCi/g		9.03E-01
BLANK QC		U-238	-4.07E-02 +- 1.26E-01 (1s)	pCi/g		4.48E-01
BLANK QC		U-238DHP	9.60E-02 +- 1.23E+00 (1s)	pCi/g		4.27E+00
LCS	D291V102	CS-137	3.77E-01 +- 5.51E-02 (1s)	pCi/g		9.23E-02
RW-41-SB-46-0.5e DU	D1XML103	U-235HP	2.21E-02 +- 4.15E-02 (1s)	pCi/g		1.51E-01
RW-41-SB-46-0.5e DU		U-238	1.35E-01 +- 2.17E-02 (1s)	pCi/g		8.43E-02
RW-41-SB-46-0.5e DU		U-238DHP	2.44E-02 +- 1.49E-01 (1s)	pCi/g		5.33E-01
RW-41-SB-50-0.3-#10	D20X1101	U-235HP	2.73E+02 +- 1.46E+01 (1s)	pCi/g		1.02E+01
RW-41-SB-50-0.3-#10		U-238	9.13E-01 +- 8.70E-01 (1s)	pCi/g		2.90E+00
RW-41-SB-50-0.3-#10		U-238DHP	1.15E+04 +- 5.77E+02 (1s)	pCi/g		3.41E+01
RW-41-SB-50-0.3-#23	D20X7101	U-235HP	5.27E+01 +- 2.84E+00 (1s)	pCi/g		2.10E+00
RW-41-SB-50-0.3-#23		U-238	8.09E-01 +- 1.89E-01 (1s)	pCi/g		4.77E-01
RW-41-SB-50-0.3-#23		U-238DHP	3.04E+03 +- 1.52E+02 (1s)	pCi/g		1.05E+01
RW-41-SB-50-0.3-#60	D20X4102	U-235HP	3.20E+01 +- 1.89E+00 (1s)	pCi/g		2.14E+00
RW-41-SB-50-0.3-#60		U-238	2.00E-01 +- 1.46E-01 (1s)	pCi/g		4.86E-01
RW-41-SB-50-0.3-#60		U-238DHP	1.72E+03 +- 8.69E+01 (1s)	pCi/g		1.61E+01

Number of Results: 19

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	SDG:	12966	COLLECTION DATE:	8/30/99 11:20:00 AM
LOT,RPT DB ID:	J9I010155-1 9D20X110	REPORT NBR:	8763	RECEIVED DATE:	9/1/99 10:30:00 AM
CLIENT ID:	RW-41-SB-50-0.3-#10	ORDER NBR:		MATRIX:	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252340	Work Order:	D20X1101											
U-235HP	2.73E+02	2.9E+01	2.9E+01	1.02E+01	pCi/g		(26.8)	(18.7)	9/13/99 06:42 p	61.0	g	GER5$1	RICHRC5017
U-238	9.13E-01	1.7E+00	1.7E+00	2.90E+00	pCi/g		0.32	(1.)	9/13/99 06:42 p	61.0	g	GER5$1	RICHRC5017
U-238DHP	1.15E+04	1.2E+03	1.2E+03	3.41E+01	pCi/g		(337.9)	(20.)	9/13/99 06:42 p	61.0	g	GER5$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	SDG:	12966	COLLECTION DATE:	8/30/99 11:25:00 AM
LOT,RPT DB ID:	J9I010155-2 9D20X410	REPORT NBR:	8763	RECEIVED DATE:	9/1/99 10:30:00 AM
CLIENT ID:	RW-41-SB-50-0.3-#60	ORDER NBR:		MATRIX:	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252340	Work Order:	D20X4102											
U-235HP	3.20E+01	3.8E+00	3.8E+00	2.14E+00	pCi/g		(14.9)	(16.9)	9/13/99 06:43 p	341.4	g	GER7$1	RICHRC5017
U-238	2.00E-01	2.9E-01	2.9E-01	4.86E-01	pCi/g		0.41	(1.4)	9/13/99 06:43 p	341.4	g	GER7$1	RICHRC5017
U-238DHP	1.72E+03	1.7E+02	1.7E+02	1.61E+01	pCi/g		(107.2)	(19.8)	9/13/99 06:43 p	341.4	g	GER7$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

SAMPLE RESULTS

Date: 9/24/99

LAB NAME: QUANTERRA, Richland

LOT,RPT DB ID: J9I010155-3 9D20X710

CLIENT ID: RW-41-SB-50-0.3-#230

SDG: 12966

REPORT NBR: 8763

ORDER NBR:

COLLECTION DATE: 8/30/99 11:30:00 AM

RECEIVED DATE: 9/1/99 10:30:00 AM

MATRIX: SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252340	Work Order:	D20X7101											
U-235HP	5.27E+01	5.7E+00	5.7E+00	2.10E+00	pCi/g		(25.)	(18.6)	9/13/99 08:21 p	352.1	g	GER8$1	RICHRC5017
U-238	8.09E-01	3.8E-01	3.8E-01	4.77E-01	pCi/g		(1.7)	(4.3)	9/13/99 08:21 p	352.1	g	GER8$1	RICHRC5017
U-238DHP	3.04E+03	3.0E+02	3.0E+02	1.05E+01	pCi/g		(290.)	(20.)	9/13/99 08:21 p	352.1	g	GER8$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

DUPLICATE RESULTS

Date: 9/24/99

LAB NAME:	QUANTERRA, Richland	SDG:	12958	COLLECTION DATE:	8/26/99 10:45:00 AM
RPT DB ID/ORIG ID:	D1XML13R / 9D1XML10	REPORT NBR:	8763	RECEIVED DATE:	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-46-0.5e DUP	ORDER NBR:		MATRIX:	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	ORIG RESULT	RPD	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252340	Work Order:	D1XML103											
U-235HP	2.21E-02	8.3E-02	8.3E-02	1.51E-01	pCi/g		4.50E-02	68.13%	9/13/99 06:32 p	338.8	g	GER8$1	RICHRC5017
U-238	1.35E-01	4.3E-02	4.3E-02	8.43E-02	pCi/g		6.79E-02	66.40%	9/13/99 06:32 p	338.8	g	GER8$1	RICHRC5017
U-238DHP	2.44E-02	3.0E-01	3.0E-01	5.33E-01	pCi/g		-3.02E-01	235.16%	9/13/99 06:32 p	338.8	g	GER8$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

Date: 9/24/99

BLANK RESULTS

LAB NAME: QUANTERRA, Richland SDG: 12966 ORDER NBR:

LOT,RPT DB ID: J9I090000-340 D291V11X REPORT NBR: 8763 MATRIX: Solid

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252340	Work Order:	D291V101											
U-235HP	7.38E-02	9.7E-02	9.7E-02	1.79E-01	pCi/g		0.41	(1.5)	9/13/99 08:22 p	348.0	g	GER6$1	RICHRC5017
U-238	9.03E-02	5.4E-02	5.4E-02	5.76E-02	pCi/g		(1.6)	(3.4)	9/13/99 08:22 p	348.0	g	GER6$1	RICHRC5017
U-238DHP	-9.02E-02	4.4E-01	4.4E-01	7.52E-01	pCi/g		-0.12	-0.41	9/13/99 08:22 p	348.0	g	GER6$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

Date: 9/24/99

BLANK RESULTS

LAB NAME: QUANTERRA, Richland SDG: 12966 ORDER NBR:

LOT,RPT DB ID: J9I090000-340 D291V13B REPORT NBR: 8763 MATRIX: Solid

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252340	Work Order: D291V103												
U-235HP	2.23E-01	4.8E-01	4.8E-01	9.03E-01	pCi/g		0.25	0.94	9/13/99 08:32 p	25.0	g	GER7$1	RICHRC5017
U-238	-4.07E-02	2.5E-01	2.5E-01	4.48E-01	pCi/g		-0.09	-0.32	9/13/99 08:32 p	25.0	g	GER7$1	RICHRC5017
U-238DHP	9.60E-02	2.5E+00	2.5E+00	4.27E+00	pCi/g		0.02	0.08	9/13/99 08:32 p	25.0	g	GER7$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

Date: 9/24/99

LABORATORY CONTROL SAMPLE

LAB NAME: QUANTERRA, Richland SDG: 12966 ORDER NBR:

LOT,RPT DB ID: J9I090000-340 D291V12M REPORT NBR: 8763 MATRIX: Solid

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	Expected	Expected Uncert	Recovery	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252340	Work Order:	D291V102												
CS-137	3.77E-01	1.1E-01	1.1E-01	9.23E-02	pCi/g		3.11E-01	1.4E-02	121.39%	9/13/99 08:31 p	200.01	GRA	GER4$1	RICHRC5017

Number of Results: 1

Comments:

SITE 1 ARWW CX-31680 J4I010155

Custody No. 12138

RUST

Rust Environment & Infrastructure

Custody Chain and Analytical Request

Due 10-1

Page 1 of

Project No. 29234

LIMS No.

Base: EGLIN AFB Base ID: EGLIN

Site Name: IRP SITE NO. RW-41 TEST AREA C 74C

Collected By: A. MACBETH, J. SOKES

Sample ID: IRPIMS LOCID	Depth	Sample Code	Date	Time (24-Hour)	SAMPLE METHOD CODE*	MATRIX CODE*	# Of Containers (1L)	SAMPLE ANALYSIS (SPECIFY PARAMETER LIST AND METHOD): 644mm SPECTROSCOPY						COMMENTS (add preservative information)	FIELD CONTROL: Ambient Condition Blank	Equipment Blank
RW-41-SB-50	D20X1 0.3-#10	N1 200g	8/30/99	1120	HA	SO	1	1	DU	FRAGS IN SAMPLE				NO HOLDER RONDINIS	0	0
RW-41-SB-50	D20X4 0.3-#60	N1 1000g	8/30/99	1125	HA	SO	1	1	DU	FRAGS IN SAMPLE				TAKEN.	0	0
RW-41-SB-50	0.3-#230	N1 400g	8/30/99	1130	HA	SO	1	1	D	2	0	X	7		0	0
														COC #s SCM 400 401		

Laboratory:
Enter entire Sample ID into LIMS, including dashes but omitting blank spaces. Truncate from the right if necessary. If only one depth is provided, assume depth is ending depth of two foot sa

Custody Transfers Prior to Receipt By Laboratory

	Relinquished by/(Signed) (Organization)	Received by/(Signed) (Organization)	Date	Time
1.	A. Macbeth / RUST		8/31/99	1630
2.				
3.				

Sample Delivery Details/Laboratory Receipt

Delivered Directly to Lab ☐ Shipped ☒

Method of Shipment: FEDEX Airbill #: 79178350984

Analytical Lab: QUANTERRA Location: RICHLAND, WA

Lab Recipient: Karen Schulz (Signature) Date: 9/1/99 Time: 10:

Additional Remarks:
(Condition Upon Lab Receipt, Etc.) PLS. HOMOGENIZE SAMPLES BY GRINDING.

Rev. 01/9

White - Laborato... Yellow - RUST; Pink - Project Files

...sample method and codes are on reverse

Limited Quantity Radioactive Material

From: ALEC MACBETH
RUST ETI

To: TONI LANICCHIA
QUANTERRA LABS
RICHLAND, WA

This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910.

Radiation surveys:

<0.1 mR/hr on contact with shipping container

Loose surface contamination:

α <20
β <100 } dpm/300 cm² on surface of shipping container

Description of Contents: Soil Samples for Depleted Uranium Analysis

Prepared by: [signature] 8/31/99
Radiation Safety Officer — Date

Approved by: [signature] 8/31/99
Project Manager — Date

CLIENT CODE ID	MATRIX	RECEIVED	DETECTOR	ACQ DATE	SAMPLE	MINUTES	CNTS A	NET CPM A	CNTS B	NET CPM B
REI RW41SB4920D1XPH		9/3/99 8:00:00 AM	QUAD22D	9/7/99 11:14:34 AM	W41SB4920D1XPH	30	60	1.925	240	6.81
D1XPH	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	60	0.075	952	1.19
Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 1.15E+02	Alp; (Dpm/ 1.37E+01	(uCi/ 8.46E-02	(pCi/ 5.36E+01	± 7.7E+00	CAT	9.3E-01	Lab	
Ppt mg: 115.2	Units: g	, mg	Bet; Alq): 1.38E+01	Sa): 8.53E-02	L|g): 5.40E+01	+ 4.3E+00	II	1.9E+00	Alq L|g	
REI RW41SB4930D1XPJ		9/3/99 8:00:00 AM	QUAD23A	9/7/99 11:14:39 AM	RW41SB4930D1XPJ	30	16	0.440833333	77	1.60291667
D1XPJ	SOIL		Bkg:	9/4/99 5:30:51 AM	BKG	800	74	0.0925	771	0.96375
Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 9.80E+01	Alp; (Dpm/ 2.87E+00	(uCi/ 2.08E-02	(pCi/ 1.32E+01	± 5.5E+00	CAT	3.8E+00	Lab	
Ppt mg: 98	Units: g	, mg	Bet; Alq): 3.21E+00	Sa): 2.33E-02	L|g): 1.47E+01	+ 2.9E+00	II	6.8E+00	Alq L|g	
REI RW41SB500310D20X1		9/3/99 8:00:00 AM	QUAD23B	9/7/99 11:14:39 AM	W41SB500310D20X1	30	17657	588.4179167	111698	3722.29917
D20X1	SOIL		Bkg:	9/4/99 5:30:51 AM	BKG	800	119	0.14875	774	0.9675
Anl Date: 9/7/99	Tot Sa, Alq: 3.47E+02	, 9.48E+01	Alp; (Dpm/ 3.71E+03	(uCi/ 6.11E+00	(pCi/ 1.76E+04	± 1.2E+02	CAT	2.8E-03	Lab	
Ppt mg: 94.8	Units: g	, mg	Bet; Alq): 7.80E+03	Sa): 1.29E+01	L|g): 3.71E+04	± 1.1E+02	III	2.7E-03	Alq L|g	
REI RW41SB5003230D20X7		9/3/99 8:00:00 AM	QUAD23C	9/7/99 11:14:39 AM	W41SB5003230D20X7	30	6426	214.055	28166	937.746667
D20X7	SOIL		Bkg:	9/4/99 5:30:51 AM	BKG	800	116	0.145	896	1.12
Anl Date: 9/7/99	Tot Sa, Alq: 6.60E+02	, 8.90E+01	Alp; (Dpm/ 1.34E+03	(uCi/ 4.47E+00	(pCi/ 6.77E+03	± 7.6E+01	CAT	7.4E-03	Lab	
Ppt mg: 89	Units: g	, mg	Bet; Alq): 1.90E+03	Sa): 6.33E+00	L|g): 9.60E+03	+ 5.9E+01	III	1.0E-02	Alq L|g	
REI RW41SB500360D20X4		9/3/99 8:00:00 AM	QUAD24A	9/7/99 11:14:35 AM	W41SB500360D20X4	30	1629	54.15125	6688	221.994583
D20X4	SOIL		Bkg:	9/4/99 5:30:32 AM	BKG	800	119	0.14875	751	0.93875
Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 1.04E+02	Alp; (Dpm/ 3.84E+02	(uCi/ 2.61E+00	(pCi/ 1.66E+03	± 3.7E+01	CAT	3.0E-02	Lab	
Ppt mg: 104.3	Units: g	, mg	Bet; Alq): 4.73E+02	Sa): 3.22E+00	L|g): 2.04E+03	± 2.6E+01	III	4.9E-02	Alq L|g	
REI RW41SB5005D1XPK		9/3/99 8:00:00 AM	QUAD24B	9/7/99 11:14:35 AM	W41SB5005D1XPK	30	1349	44.83541667	4766	157.792917
D1XPK	SOIL		Bkg:	9/4/99 5:30:32 AM	BKG	800	105	0.13125	859	1.07375
Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 1.23E+02	Alp; (Dpm/ 3.37E+02	(uCi/ 1.95E+00	(pCi/ 1.23E+03	± 3.0E+01	CAT	4.1E-02	Lab	
Ppt mg: 122.9	Units: g	, mg	Bet; Alq): 3.34E+02	Sa): 1.93E+00	L|g): 1.22E+03	+ 1.9E+01	III	8.2E-02	Alq L|g	
REI RW41SB5010D1XPL		9/3/99 8:00:00 AM	QUAD24D	9/7/99 11:14:35 AM	W41SB5010D1XPL	30	65	2.081666667	229	6.48958333
D1XPL	SOIL		Bkg:	9/4/99 5:30:32 AM	BKG	800	68	0.085	915	1.14375
Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 8.10E+01	Alp; (Dpm/ 0.00E+00	(uCi/ 0.00E+00	(pCi/ 0.00E+00	± #Num!	CAT	1.6E+03	Lab	
Ppt mg: 81	Units: g	, mg	Bet; Alq): 0.00E+00	Sa): 0.00E+00	L|g): 0.00E+00	+ #Num!	I	1.6E+03	Alq L|g	

MM 9-8-99

Analytical Data Package Prepared For

Rust Environment

D.O. NO. RW-41
FILE INDEX NO. COC # 12137
FILE NAME: Initial Lab Report
DATE 10/11/99 INIT Ap

Radiochemical Analysis By

Quanterra Analytical Services
Richland Laboratory

Report Nbr: 8765

SDG Nbr	ORDER Nbr	CLIENT ID NUMBER	LOT Nbr	WORK ORDER	RPT DB ID	BATCH
12962		RW-41-SB-49-0.5	J9H310169-1	D1XPA102	9D1XPA10	9252342
		RW-41-SB-51-0.5	J9H310169-10	D1XPR101	9D1XPR10	9252342
		RW-41-SB-51-1.0	J9H310169-11	D1XPT101	9D1XPT10	9252342
		RW-41-SB-51-3.0	J9H310169-12	D1XPV101	9D1XPV10	9252342
		RW-41-SB-16-1.0	J9H310169-13	D1XPW101	9D1XPW10	9252342
		RW-41-SB-16-1.0a	J9H310169-14	D1XPX101	9D1XPX10	9252342
		RW-41-SB-16-2.0	J9H310169-15	D1XQ1101	9D1XQ110	9252342
		RW-41-SB-16-3.0	J9H310169-16	D1XQ4101	9D1XQ410	9252342
		RW-41-BP-01	J9H310169-17	D1XQ5101	9D1XQ510	9252342
		RW-41-SB-49-0.5e	J9H310169-2	D1XPF101	9D1XPF10	9252342
		RW-41-SB-49-1.0	J9H310169-3	D1XPG101	9D1XPG10	9252342
		RW-41-SB-49-2.0	J9H310169-4	D1XPH101	9D1XPH10	9252342
		RW-41-SB-49-3.0	J9H310169-5	D1XPJ101	9D1XPJ10	9252342
		RW-41-SB-50-0.5	J9H310169-6	D1XPK101	9D1XPK10	9252342
		RW-41-SB-50-1.0	J9H310169-7	D1XPL101	9D1XPL10	9252342
		RW-41-SB-50-2.0	J9H310169-8	D1XPN101	9D1XPN10	9252342

Comments:

Report Nbr: 8765

SDG Nbr	ORDER Nbr	CLIENT ID NUMBER	LOT Nbr	WORK ORDER	RPT DB ID	BATCH
12962		RW-41-SB-50-3.0	J9H310169-9	D1XPP101	9D1XPP10	9252342

Comments:

Quanterra

CERTIFICATE OF ANALYSIS

Rust International Corporation
Environmental & Infrastructure
15 Brendan Way
Greenville SC 29615

September 20, 1999

Attention Jim Refermat (RUST) and Alec McBeth (EarthTeck)

SDG Number	:	12962
Date Samples Received	:	August 31, 1999
Number of Samples	:	Seventeen (17)
Sample Type	:	Soil
P.O. Number	:	29234/55556
COC No.	:	12137

I. Introduction

On August 31, 1999, seventeen soil samples were received for radiochemical analysis at the Quanterra Richland Laboratory (QRL). Upon receipt the samples were assigned QRL ID number to correspond with the RUST ID number, as listed on the attached pages.

II. Analytical Results/Methodology

The analytical results for this report are presented by laboratory sample ID. Each set of data includes sample identification information analytical results and the appropriate associated statistical errors.

The requested analyses were: **Gamma by HPGE**
Gamma Scan by Quanterra Method RICHRC5013 and RICHRC5017

II. Quality Control

The analytical results for each analysis performed under SDG 12962 include a minimum of one Laboratory Control Sample (LCS), one method blank and one duplicate. Any exceptions have been noted in the "Comments" section.

IV. Comments

Gamma by HPGE

Gamma Scan by Quanterra Method RICHRC5013 and RICHRC5017

The sample batch was analyzed with it's own quality control samples and processed for gamma analysis by Quanterra. All samples were analyzed using approximately 350 g of sample. Uranium-239 results are reported as U-238DHP. The LCS, batch blank, sample and sample duplicate results are within contractual requirements. As part of Quanterra effort to help clients understand gamma analysis a technical guidance document is included in this report.

I certify that this Certificate of Analysis is in compliance with the SOW, both technically and for completeness, for other than the conditions detailed above. The Laboratory Manager or a designee, as verified by the following signature has authorized release of the data contained in this hard copy data package.

Reviewed and approved:

Toni Lynn Lauricella
Project Manager

Technical Guidance Document

Quanterra Northwest/Central Region

Recommendations for Matrix Spike and Matrix Spike Duplicate Analyses – Gamma Spectroscopy

Customers should be made aware of the limitations of ordering MS/MSDs on some matrices. Also customers should be advised that with some preparation and analysis methods it may not be technically correct to request a matrix spike. In applications and methods where the homogeneity of the spiked sample creates potential calibration differences with the standard, it is not technically advisable to spike the matrix and an alternative approach should be pursued to demonstrate precision and accuracy.

Discussion

Soil analyses by gamma spectroscopy is a situation where it is not advisable to spike the matrix for the analysis. Soil by nature of its variable and complex chemical constituency, offers the greatest challenge when MS/MSDs are requested. The primary challenge is the laboratory's ability to produce homogeneous spiked soil material since a liquid spike cannot be uniformly distributed in the soil matrix. This is inherent to the granular matrix and the absorption properties of liquid on/in porous materials. Best attempts at producing matrix spikes and matrix spike duplicates have proven to be less than adequate due to homogeneity and absorption issues.

With a destructive preparatory method, used for analysis such as strontium, the homogeneity issue may not present much of a complication. Destructive methods typically totally dissolve, leach, digest, or chemically breakdown the constituents and remove the isotope of interest from both the sample and the spike that was added. However, with nondestructive preparation methods or a method where an entire aliquot may not be used, homogeneity of the matrix spike is essential. Spatial and geometrical differences between the soil sample, the matrix spike, and the sources used to calibrate the detectors have significant impact on the percent recoveries and the relative percent differences between recoveries.

Gamma spectroscopy of soil is one such analysis where the spiked material in the soil must match or approximate the distribution of the spiked material in the standard. Additionally, the constituents of the soil can impact or mask one's ability to detect or quantify an added spike. Activity levels, as well as the energies of the isotopes in a soil, influence the spectral features such as Compton continuum and summation effects. These geometric effects can limit a laboratory's ability to detect an added spike. In addition the activity level of other isotopes and the geometry can create interfering lines which can affect the spike recovery.

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Area of Interest: Gamma Spectroscopy
Document No.: 99002-R0
Authored By: Brian Crandall
Reviewed By: Matt Lardy and Jackie Waddell
Date Reviewed: 08/19/99

Recommendations

Matrix spikes (MS) and matrix spike duplicates (MSD) may not be valid or required for all matrices and methods. Quanterra Richland has attempted matrix spike and matrix spike duplicates for soil samples analyzed by gamma spectroscopy even though this may not be technically advisable for this matrix and analysis method. It is our belief that an incorrect perception of precision and accuracy may be developed due to the limitations and interferences that are associated with the matrix. It is the recommendation of Quanterra to use the gamma lines of naturally occurring radionuclides, such as ^{40}K, ^{214}Pb (after equilibrium with ^{226}Ra is achieved), ^{232}Th(in equilibrium with ^{228}Ra and ^{228}Ac), or ^{238}U (in equilibrium with ^{234}Th) to measure precision and/or accuracy (indicators of quality control) on replicate samples for gamma spectroscopy. This will more accurately portray the quality of the laboratory and method rather than gauge Quanterra's ability to create a homogeneously spiked soil material.

Technical Guidance Document

Quanterra Northwest/Central Region

Recommendations for Reporting Naturally Occurring Radionuclides (Often called naturally occurring radioactive materials, NORM):

Discussion

Many long-lived naturally occurring radionuclides do not emit gammas with energies in the most efficient range of germanium detectors. In addition, gammas that are emitted often have abundances that are so low that their measurement is precluded on a practical basis. Examples of these radionuclides are Ra-226, Ra-228, Th-228, Th-230, and Th-232, U-234, U-235 and U-238. These radionuclides exist in what are called decay chains. For example, U-238, U-234, Th-230 and Ra-226 are in a decay chain with U-238 as the precursor. These radionuclides decay to progeny with energetic gammas, but many progeny have a very short half-life (seconds, minutes and hours). These progeny then are used to estimate the concentrations of their parent(s). Quanterra Richland's nuclide library for Gamma Spectroscopy includes many of the predominant natural naturally occurring radionuclides and their progeny.

The issue is further complicated by the fact that a radon radionuclide is also part of the decay progeny. Radon usually precedes the short-lived progeny so that in the sample treatment because of its nature the radon is usually removed. The radon and its progeny will grow back in (ingrowth) from decay of the parent, but it takes a minimum of 10 days to accomplish this. This works well for soil samples, to a lesser extent for other solid samples and not at all for water samples. An example of this is Ra-226 and its progeny Rn-222, Po-218, Pb-214 and Bi-214.

In other cases the progeny is not preceded by radon, but care must be taken that equilibrium between progeny and parent has been established before counting. Two examples of this are Ra-228 and its progeny Ac-228 and Th-232 and its progeny Ra-228.

Listed in the tables below are examples of long-lived naturally occurring radionuclides with their short-lived progeny. The short-lived radionuclides are used to determine the concentrations of their long-lived precursor.

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Area of Interest: Gamma Spectroscopy
Document No.: 99001-R0
Authored By: Matt Lardy
Reviewed By: Jackie Waddell and Brian Crandall
Date Reviewed: 08/16/99

A. Thorium-234 and Uranium-238

U-238 DA represents the U-238 concentration and is reported using the lines from Pb-214 and Bi-214 as shown in the table below.

U-238 DHP represents the U-238 concentration and is reported using Th-234 with its key line at 63.28 keV and the 92.59 keV line as the secondary line. See the table below.

Th-234 may be reported as TH-234DA. TH-234DA is determined from the 1001 and 766 keV lines of its progeny, Pa-234m. See the table below.

Isotope to be Identified	Isotope of Gamma Line used for Identification	Energy of Gamma Lines (keV)
Th-234DA	Pa-234m	766.41
	Pa-234m	1001.03*
U-238DHP	Th-234	63.28*
	Th-234	92.59**
U-238DA	Pb-214	241.98
	Pb-214	295.21
	Pb-214	351.92*
	Bi-214	609.31
		* keyline
		** The activity and abundances of the two peaks at 92.3 and 92.8 keV are summed.

Quanterra Richland's preparation methods are designed to ensure that the progeny are in near equilibrium with their respective parent nuclides For calculation purposes the half-life of U-238 is used for reporting Th-234DA. Likewise, the half-lives of Th-234, Pa-234m, Pb-214 and Bi-214 are 24.1 days, 1.17 minutes, 27 minutes and 19.9 minutes respectively. It is not reasonable to use the individual half-lives for decay correction since their production is limited by the decay of the long lived precursor parent. In these cases the half-life of the parent is used for calculation purposes.

B. Actinium-228, Radium-228 and Thorium-232

Ac-228, Ra-228 and Th-232 may be reported using the energy lines from the isotope itself or from progeny and associated energy lines as shown in the table below.

Isotope to be Identified	Isotope of Gamma Line used for Identification	Energy of Gamma Lines (keV)
Ac-228	Ac-228	209.28
	Ac-228	270.23
	Ac-228	338.32
	Ac-228	911.07*
	Ac-228	969.11
Ra-228DA	Ac-228	209.28
	Ac-228	338.32
	Ac-228	911.07*
	Ac-228	964.6
	Ac-228	969.11
Th-232DA	Pb-212	238.63
	Ac-228	338.32*
	Ac-228	583.14
	Ac-228	911.07
	Ac-228	964.60
	Ac-228	969.11
		* keyline

Note that there is very little flexibility for distinguishing between these three analytes. Quanterra Richland's preparation methods are designed to ensure near equilibrium exists and for calculation purposes the progeny are assumed to be in equilibrium with their parent. For calculation purposes Ac-228 is given a half-life of Th-232 when reported individually since the half-life of Ac-228 is 6.15 hours.

C. Bismuth-214, Lead-214 and Radium-226

Bi-214, Pb-214 and Ra-226 may be reported using the energy lines from the isotope itself or from progeny and associated energy lines as shown in the table below:

Isotope to be Identified	Isotope of Gamma Line used for Identification	Energy of Gamma Lines (keV)
Bi-214	Bi-214	609.32*
	Bi-214	768.36
	Bi-214	1120.29
	Bi-214	1764.49
Pb-214	Pb-214	241.98
	Pb-214	295.21
	Pb-214	351.92*
	Pb-214	785.91
Ra-226DA	Ra-226	186.21
	Pb-214	214.98
	Pb-214	295.22
	Pb-214	351.92
	Bi-214	609.32*
	Bi-214	1120.28
	Bi-214	1238.11
	Bi-214	1764.49
		* keyline

Quanterra Richland's preparation methods are designed to ensure that near equilibrium exists between parent and progeny. A period of ~ 10 days or more should elapse between sample preparation (drying and grinding) and counting as to allow a sufficient period for the ingrowth of Ra-226 progeny. For calculation purposes equilibrium with Ra-226 and its progeny Bi-214 and Pb-214 is assumed. The half-life of Ra-226 is used when the Ra-226 result is calculated. When Bi-214 and Pb-214 are reported separately the half-life of U-238 is used.

D. Thallium-208, Lead-212, Radium-224 and Thorium-228

Tl-208, Pb-212, Ra-224 and Th-228 may be reported using the energy lines from the isotope itself or from progeny and associated energy lines as shown in the table below.

Isotope to be Identified	Isotope of Gamma Line used for Identification	Energy of Gamma Lines (keV)
Tl-208	Tl-208	277.35
	Tl-208	510.84
	Ac-228	583.14*
	Tl-208	860.37
Pb-212	Pb-212	238.63*
	Pb-212	300.09
Ra-224	Pb-212	238.63*
	Ra-224	240.98
	Ac-228	583.14
	Tl-208	860.37
Th-228DA	Pb-212	238.63
	Ra-224	240.98
	Ac-228	583.14*
	Tl-208	860.37
		* keyline

Note that there is very little flexibility for distinguishing between these four analytes. Care must be taken to assure that equilibrium is reached between the parent and its progeny. Quanterra Richland's preparation methods are designed to ensure near equilibrium exists and for calculation purposes the progeny are assumed to be in equilibrium with their parent. For calculation purposes the half-life of Th-232 is used for Tl-208 and Pb-212 when they are reported individually since their half-lives are 3.053 minutes and 10.64 hours respectively. When reported separately the half-life of Th-228 is used when Ra-224 is reported separately.

Recommendations for Soil Samples:
The following recommendations are made for the naturally occurring radionuclides Quanterra Richland will report for soil samples provided the customer has not given other guidance.

K-40
Ra-226DA
Th-232DA
U-238DHP

Reporting progeny such as Tl-208, Pb-212, Bi-214 and Pb-214 is not recommended. Three reasons can be given: (a) the gamma lines used to calculate the results are used to produce the concentration of one or more isotopes of the same chain, (b) the progeny are too far down the decay chain to assure that equilibrium exists, and (c) use of the gamma lines from these isotopes can result in false positive or false negative detection of the long-lived precursor. The activities of these radionuclides can be reported at the customer's request, however, the assumption must be made that equilibrium exists because time has been provided for ingrowth, and therefore the progeny concentration is given by the result for the parent. The half-life of the appropriate long-lived parent is used for decay correction when the activities of these radionuclides are reported individually.

Recommendations for Water Samples:
The following recommendations are made for the naturally occurring radionuclides Quanterra Richland will report for water samples provided the customer has not given other guidance.

K-40
Th-232DA
U-238DHP

The parameters for reporting are the same as for soil with one exception: Reporting Ra-226 from its progeny is not reliable, since ingrowth and subsequent equilibrium cannot be established. Therefore the 186 keV line of Ra-226 must be utilized. However, U-235 has a primary gamma line at 186.57 keV with a 54% abundance, and if present it would interfere with the 186 keV line of Ra-226 (which is at 3.2% abundance). This interference generally creates a high false positive for Ra-226 results.

References:

Browne, E., R.B. Firestone and V.S. Shirley (Editors)
Table of Radioactive Isotopes
John Wiley and Sons, Inc., New York (1986)

Chieco, N.A, (Editor)
EML Procedures Manual, HASL 300, The Procedures Manual of the Environmental Measurements Laboratory.
Environmental Measurements Laboratory, Department of Energy, USA, 28th Edition, (1992)

Sample Results Summary

Quanterra, Richland

Date: 9/24/99

REPORT No. : 8765

SDG NBR: 12962

CLIENT ID	WORK ORDER NUMBER	PARAMETER	RESULT	UNITS	YIELD	MDA
BLANK QC	D2921101	U-235HP	1.23E-02 +- 4.54E-02 (1s)	pCi/g		1.58E-01
BLANK QC		U-238	1.32E-01 +- 2.24E-02 (1s)	pCi/g		9.11E-02
BLANK QC		U-238DHP	-8.53E-02 +- 1.40E-01 (1s)	pCi/g		4.92E-01
LCS	D2921102	CS-137	2.98E-01 +- 6.22E-02 (1s)	pCi/g		9.30E-02
LCS	D2921103	CS-137	3.46E-01 +- 4.68E-02 (1s)	pCi/g		8.64E-02
RW-41-BP-01	D1XQ5101	U-235HP	2.67E+00 +- 2.97E-01 (1s)	pCi/g		5.43E-01
RW-41-BP-01		U-238	3.82E-01 +- 8.11E-02 (1s)	pCi/g		1.83E-01
RW-41-BP-01		U-238DHP	1.42E+02 +- 8.22E+00 (1s)	pCi/g		5.85E+00
RW-41-SB-16-1.0	D1XPW101	U-235HP	4.66E-01 +- 1.45E-01 (1s)	pCi/g		2.73E-01
RW-41-SB-16-1.0		U-238	3.46E-01 +- 5.20E-02 (1s)	pCi/g		9.04E-02
RW-41-SB-16-1.0		U-238DHP	3.03E+01 +- 2.09E+00 (1s)	pCi/g		2.06E+00
RW-41-SB-16-1.0a	D1XPX101	U-235HP	2.57E-01 +- 1.45E-01 (1s)	pCi/g		2.89E-01
RW-41-SB-16-1.0a		U-238	4.04E-01 +- 5.49E-02 (1s)	pCi/g		7.89E-02
RW-41-SB-16-1.0a		U-238DHP	2.80E+01 +- 1.63E+00 (1s)	pCi/g		1.37E+00
RW-41-SB-16-2.0	D1XQ1101	U-235HP	4.57E-01 +- 1.72E-01 (1s)	pCi/g		5.84E-01
RW-41-SB-16-2.0		U-238	2.69E-01 +- 6.90E-02 (1s)	pCi/g		1.36E-01
RW-41-SB-16-2.0		U-238DHP	1.71E+01 +- 2.38E+00 (1s)	pCi/g		3.74E+00
RW-41-SB-16-3.0	D1XQ4101	U-235HP	4.71E-02 +- 6.98E-02 (1s)	pCi/g		2.52E-01
RW-41-SB-16-3.0		U-238	2.31E-01 +- 5.58E-02 (1s)	pCi/g		7.81E-02
RW-41-SB-16-3.0		U-238DHP	5.72E-01 +- 8.51E-01 (1s)	pCi/g		2.96E+00
RW-41-SB-49-0.5	D1XPA102	U-235HP	1.79E+01 +- 1.07E+00 (1s)	pCi/g		1.18E+00
RW-41-SB-49-0.5		U-238	3.77E-01 +- 8.00E-02 (1s)	pCi/g		2.71E-01
RW-41-SB-49-0.5		U-238DHP	9.75E+02 +- 4.90E+01 (1s)	pCi/g		7.13E+00
RW-41-SB-49-0.5	D1XPA103	U-235HP	1.51E+01 +- 9.45E-01 (1s)	pCi/g		1.01E+00

Comments:

Sample Results Summary

Quanterra, Richland

Date: 9/24/99

REPORT No. : 8765

SDG NBR: 12962

CLIENT ID	WORK ORDER NUMBER	PARAMETER	RESULT	UNITS	YIELD	MDA
RW-41-SB-49-0.5	D1XPA103	U-238	3.51E-01 +- 8.37E-02 (1s)	pCi/g		2.37E-01
RW-41-SB-49-0.5		U-238DHP	8.82E+02 +- 4.45E+01 (1s)	pCi/g		8.57E+00
RW-41-SB-49-0.5e	D1XPF101	U-235HP	5.61E-02 +- 4.37E-02 (1s)	pCi/g		1.59E-01
RW-41-SB-49-0.5e		U-238	1.13E-01 +- 2.15E-02 (1s)	pCi/g		8.78E-02
RW-41-SB-49-0.5e		U-238DHP	-8.90E-02 +- 1.43E-01 (1s)	pCi/g		5.06E-01
RW-41-SB-49-1.0	D1XPG101	U-235HP	1.53E+00 +- 2.03E-01 (1s)	pCi/g		3.75E-01
RW-41-SB-49-1.0		U-238	3.76E-01 +- 5.08E-02 (1s)	pCi/g		1.53E-01
RW-41-SB-49-1.0		U-238DHP	9.56E+01 +- 5.38E+00 (1s)	pCi/g		3.12E+00
RW-41-SB-49-2.0	D1XPH101	U-235HP	3.24E-01 +- 8.36E-02 (1s)	pCi/g		3.00E-01
RW-41-SB-49-2.0		U-238	2.94E-01 +- 4.59E-02 (1s)	pCi/g		1.20E-01
RW-41-SB-49-2.0		U-238DHP	2.27E+01 +- 1.46E+00 (1s)	pCi/g		1.25E+00
RW-41-SB-49-3.0	D1XPJ101	U-235HP	1.42E-01 +- 6.08E-02 (1s)	pCi/g		2.23E-01
RW-41-SB-49-3.0		U-238	2.42E-01 +- 3.84E-02 (1s)	pCi/g		6.72E-02
RW-41-SB-49-3.0		U-238DHP	5.84E+00 +- 7.29E-01 (1s)	pCi/g		1.03E+00
RW-41-SB-50-0.5	D1XPK101	U-235HP	1.78E+01 +- 1.13E+00 (1s)	pCi/g		1.40E+00
RW-41-SB-50-0.5		U-238	3.68E-01 +- 9.53E-02 (1s)	pCi/g		3.21E-01
RW-41-SB-50-0.5		U-238DHP	1.03E+03 +- 5.17E+01 (1s)	pCi/g		7.82E+00
RW-41-SB-50-1.0	D1XPL101	U-235HP	3.60E-01 +- 1.08E-01 (1s)	pCi/g		2.92E-01
RW-41-SB-50-1.0		U-238	2.66E-01 +- 4.24E-02 (1s)	pCi/g		7.96E-02
RW-41-SB-50-1.0		U-238DHP	2.79E+01 +- 1.89E+00 (1s)	pCi/g		1.73E+00
RW-41-SB-50-2.0	D1XPN101	U-235HP	2.27E-02 +- 7.96E-02 (1s)	pCi/g		2.72E-01
RW-41-SB-50-2.0		U-238	2.83E-01 +- 4.07E-02 (1s)	pCi/g		1.27E-01
RW-41-SB-50-2.0		U-238DHP	6.07E+00 +- 9.22E-01 (1s)	pCi/g		1.78E+00
RW-41-SB-50-3.0	D1XPP101	U-235HP	1.68E+00 +- 2.60E-01 (1s)	pCi/g		5.63E-01
RW-41-SB-50-3.0		U-238	2.92E-01 +- 6.32E-02 (1s)	pCi/g		1.21E-01

Comments:

Sample Results Summary

Quanterra, Richland

Date: 9/24/99

REPORT No. : 8765

SDG NBR: 12962

CLIENT ID	WORK ORDER NUMBER	PARAMETER	RESULT	UNITS	YIELD	MDA
RW-41-SB-50-3.0	D1XPP101	U-238DHP	1.13E+02 +- 8.56E+00 (1s)	pCi/g		8.82E+00
RW-41-SB-51-0.5	D1XPR101	U-235HP	1.77E+00 +- 2.36E-01 (1s)	pCi/g		4.26E-01
RW-41-SB-51-0.5		U-238	2.75E-01 +- 4.93E-02 (1s)	pCi/g		1.02E-01
RW-41-SB-51-0.5		U-238DHP	1.05E+02 +- 6.18E+00 (1s)	pCi/g		4.60E+00
RW-41-SB-51-1.0	D1XPT101	U-235HP	9.80E-01 +- 1.62E-01 (1s)	pCi/g		3.69E-01
RW-41-SB-51-1.0		U-238	2.88E-01 +- 6.38E-02 (1s)	pCi/g		1.06E-01
RW-41-SB-51-1.0		U-238DHP	6.22E+01 +- 3.38E+00 (1s)	pCi/g		2.01E+00
RW-41-SB-51-3.0	D1XPV101	U-235HP	5.31E-01 +- 1.84E-01 (1s)	pCi/g		2.94E-01
RW-41-SB-51-3.0		U-238	2.63E-01 +- 5.42E-02 (1s)	pCi/g		8.06E-02
RW-41-SB-51-3.0		U-238DHP	3.95E+01 +- 2.43E+00 (1s)	pCi/g		1.99E+00

Number of Results: 59

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12962	**COLLECTION DATE:**	8/25/99 9:30:00 AM
LOT,RPT DB ID:	J9H310169-1 9D1XPA10	**REPORT NBR:**	8765	**RECEIVED DATE:**	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-49-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	**Work Order:**	D1XPA102											
U-235HP	1.79E+01	2.1E+00	2.1E+00	1.18E+00	pCi/g		(15.2)	(16.8)	9/14/99 04:01 p	352.4	g	GER8$1	RICHRC5017
U-238	3.77E-01	1.6E-01	1.6E-01	2.71E-01	pCi/g		(1.4)	(4.7)	9/14/99 04:01 p	352.4	g	GER8$1	RICHRC5017
U-238DHP	9.75E+02	9.8E+01	9.8E+01	7.13E+00	pCi/g		(136.8)	(19.9)	9/14/99 04:01 p	352.4	g	GER8$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12962	**COLLECTION DATE:**	8/25/99 9:30:00 AM
LOT,RPT DB ID:	J9H310169-2 9D1XPF10	**REPORT NBR:**	8765	**RECEIVED DATE:**	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-49-0.5e	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	**Work Order:** D1XPF101												
U-235HP	5.61E-02	8.7E-02	8.7E-02	1.59E-01	pCi/g		0.35	(1.3)	9/14/99 05:57 p	336.4	g	GER8$1	RICHRC5017
U-238	1.13E-01	4.3E-02	4.3E-02	8.78E-02	pCi/g		(1.3)	(5.2)	9/14/99 05:57 p	336.4	g	GER8$1	RICHRC5017
U-238DHP	-8.90E-02	2.9E-01	2.9E-01	5.06E-01	pCi/g		-0.18	-0.62	9/14/99 05:57 p	336.4	g	GER8$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

SAMPLE RESULTS

Date: 9/24/99

LAB NAME:	QUANTERRA, Richland	SDG:	12962	COLLECTION DATE:	8/25/99 9:35:00 AM
LOT,RPT DB ID:	J9H310169-3 9D1XPG10	REPORT NBR:	8765	RECEIVED DATE:	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-49-1.0	ORDER NBR:		MATRIX:	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	Work Order:	D1XPG101											
U-235HP	1.53E+00	4.1E-01	4.1E-01	3.75E-01	pCi/g		(4.1)	(7.5)	9/14/99 06:43 p	333.2	g	GER6$1	RICHRC5017
U-238	3.76E-01	1.0E-01	1.0E-01	1.53E-01	pCi/g		(2.5)	(7.4)	9/14/99 06:43 p	333.2	g	GER6$1	RICHRC5017
U-238DHP	9.56E+01	1.1E+01	1.1E+01	3.12E+00	pCi/g		(30.6)	(17.8)	9/14/99 06:43 p	333.2	g	GER6$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12962	**COLLECTION DATE:**	8/25/99 9:40:00 AM
LOT,RPT DB ID:	J9H310169-4 9D1XPH10	**REPORT NBR:**	8765	**RECEIVED DATE:**	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-49-2.0	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	**Work Order:** D1XPH101												
U-235HP	3.24E-01	1.7E-01	1.7E-01	3.00E-01	pCi/g		(1.1)	(3.9)	9/14/99 08:06 p	326.9	g	GER8$1	RICHRC5017
U-238	2.94E-01	9.2E-02	9.2E-02	1.20E-01	pCi/g		(2.4)	(6.4)	9/14/99 08:06 p	326.9	g	GER8$1	RICHRC5017
U-238DHP	2.27E+01	2.9E+00	2.9E+00	1.25E+00	pCi/g		(18.1)	(15.6)	9/14/99 08:06 p	326.9	g	GER8$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

SAMPLE RESULTS

Date: 9/24/99

LAB NAME: QUANTERRA, Richland

LOT,RPT DB ID: J9H310169-5 9D1XPJ10

CLIENT ID: RW-41-SB-49-3.0

SDG: 12962

REPORT NBR: 8765

ORDER NBR:

COLLECTION DATE: 8/25/99 9:45:00 AM

RECEIVED DATE: 8/31/99 10:30:00 AM

MATRIX: SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	Work Order:	D1XPJ101											
U-235HP	1.42E-01	1.2E-01	1.2E-01	2.23E-01	pCi/g		0.64	(2.3)	9/14/99 08:27 p	356.9	g	GER6$1	RICHRC5017
U-238	2.42E-01	7.7E-02	7.7E-02	6.72E-02	pCi/g		(3.6)	(6.3)	9/14/99 08:27 p	356.9	g	GER6$1	RICHRC5017
U-238DHP	5.84E+00	1.5E+00	1.5E+00	1.03E+00	pCi/g		(5.7)	(8.)	9/14/99 08:27 p	356.9	g	GER6$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12962	**COLLECTION DATE:**	8/25/99 1:00:00 PM
LOT,RPT DB ID:	J9H310169-6 9D1XPK10	**REPORT NBR:**	8765	**RECEIVED DATE:**	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-50-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	**Work Order:**	D1XPK101											
U-235HP	1.78E+01	2.3E+00	2.3E+00	1.40E+00	pCi/g		(12.7)	(15.7)	9/14/99 10:29 p	339.1	g	GER8$1	RICHRC5017
U-238	3.68E-01	1.9E-01	1.9E-01	3.21E-01	pCi/g		(1.1)	(3.9)	9/14/99 10:29 p	339.1	g	GER8$1	RICHRC5017
U-238DHP	1.03E+03	1.0E+02	1.0E+02	7.82E+00	pCi/g		(131.3)	(19.9)	9/14/99 10:29 p	339.1	g	GER8$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

SAMPLE RESULTS

Date: 9/24/99

LAB NAME:	QUANTERRA, Richland	SDG:	12962	COLLECTION DATE:	8/25/99 1:05:00 PM
LOT,RPT DB ID:	J9H310169-7 9D1XPL10	REPORT NBR:	8765	RECEIVED DATE:	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-50-1.0	ORDER NBR:		MATRIX:	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	Work Order:	D1XPL101											
U-235HP	3.60E-01	2.2E-01	2.2E-01	2.92E-01	pCi/g		(1.2)	(3.3)	9/14/99 10:30 p	332.1	g	GER6$1	RICHRC5017
U-238	2.66E-01	8.5E-02	8.5E-02	7.96E-02	pCi/g		(3.3)	(6.3)	9/14/99 10:30 p	332.1	g	GER6$1	RICHRC5017
U-238DHP	2.79E+01	3.8E+00	3.8E+00	1.73E+00	pCi/g		(16.1)	(14.8)	9/14/99 10:30 p	332.1	g	GER6$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12962	**COLLECTION DATE:**	8/25/99 1:10:00 PM
LOT,RPT DB ID:	J9H310169-8 9D1XPN10	**REPORT NBR:**	8765	**RECEIVED DATE:**	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-50-2.0	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	**Work Order:** D1XPN101												
U-235HP	2.27E-02	1.6E-01	1.6E-01	2.72E-01	pCi/g		0.08	0.29	9/15/99 07:40 a	350.6	g	GER1$1	RICHRC5017
U-238	2.83E-01	8.1E-02	8.1E-02	1.27E-01	pCi/g		(2.2)	(6.9)	9/15/99 07:40 a	350.6	g	GER1$1	RICHRC5017
U-238DHP	6.07E+00	1.8E+00	1.8E+00	1.78E+00	pCi/g		(3.4)	(6.6)	9/15/99 07:40 a	350.6	g	GER1$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12962	**COLLECTION DATE:**	8/25/99 1:15:00 PM
LOT,RPT DB ID:	J9H310169-9 9D1XPP10	**REPORT NBR:**	8765	**RECEIVED DATE:**	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-50-3.0	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	**Work Order:**	D1XPP101											
U-235HP	1.68E+00	5.2E-01	5.2E-01	5.63E-01	pCi/g		(3.)	(6.5)	9/15/99 07:37 a	352.0	g	GER3$1	RICHRC5017
U-238	2.92E-01	1.3E-01	1.3E-01	1.21E-01	pCi/g		(2.4)	(4.6)	9/15/99 07:37 a	352.0	g	GER3$1	RICHRC5017
U-238DHP	1.13E+02	1.7E+01	1.7E+01	8.82E+00	pCi/g		(12.9)	(13.2)	9/15/99 07:37 a	352.0	g	GER3$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	SDG:	12562	COLLECTION DATE:	8/25/99 2:15:00 PM
LOT,RPT DB ID:	J9H310169-10 9D1XPR10	REPORT NBR:	8765	RECEIVED DATE:	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-51-0.5	ORDER NBR:		MATRIX:	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	Work Order:	D1XPR101											
U-235HP	1.77E+00	4.7E-01	4.7E-01	4.26E-01	pCi/g		(4.1)	(7.5)	9/15/99 07:42 a	345.6	g	GER4$1	RICHRC5017
U-238	2.75E-01	9.9E-02	9.9E-02	1.02E-01	pCi/g		(2.7)	(5.6)	9/15/99 07:42 a	345.6	g	GER4$1	RICHRC5017
U-238DHP	1.05E+02	1.2E+01	1.2E+01	4.60E+00	pCi/g		(22.9)	(17.1)	9/15/99 07:42 a	345.6	g	GER4$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12962	**COLLECTION DATE:**	8/25/99 2:20:00 PM
LOT,RPT DB ID:	J9H310169-11 9D1XPT10	**REPORT NBR:**	8765	**RECEIVED DATE:**	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-51-1.0	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	**Work Order:**	D1XPT101											
U-235HP	9.80E-01	3.2E-01	3.2E-01	3.69E-01	pCi/g		(2.7)	(6.)	9/15/99 07:42 a	309.4	g	GER5$1	RICHRC5017
U-238	2.88E-01	1.3E-01	1.3E-01	1.06E-01	pCi/g		(2.7)	(4.5)	9/15/99 07:42 a	309.4	g	GER5$1	RICHRC5017
U-238DHP	6.22E+01	6.8E+00	6.8E+00	2.01E+00	pCi/g		(31.)	(18.4)	9/15/99 07:42 a	309.4	g	GER5$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12962	**COLLECTION DATE:**	8/25/99 2:30:00 PM
LOT,RPT DB ID:	J9H310169-12 9D1XPV10	**REPORT NBR:**	8765	**RECEIVED DATE:**	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-51-3.0	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	**Work Order:**	D1XPV101											
U-235HP	5.31E-01	3.7E-01	3.7E-01	2.94E-01	pCi/g		(1.8)	(2.9)	9/15/99 07:40 a	337.3	g	GER6$1	RICHRC5017
U-238	2.63E-01	1.1E-01	1.1E-01	8.06E-02	pCi/g		(3.3)	(4.9)	9/15/99 07:40 a	337.3	g	GER6$1	RICHRC5017
U-238DHP	3.95E+01	4.9E+00	4.9E+00	1.99E+00	pCi/g		(19.8)	(16.3)	9/15/99 07:40 a	337.3	g	GER6$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	**QUANTERRA, Richland**	**SDG:**	12962	**COLLECTION DATE:**	8/26/99 9:00:00 AM
LOT,RPT DB ID:	J9H310169-13 9D1XPW10	**REPORT NBR:**	8765	**RECEIVED DATE:**	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-16-1.0	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	**Work Order:**	D1XPW101											
U-235HP	4.66E-01	2.9E-01	2.9E-01	2.73E-01	pCi/g		(1.7)	(3.2)	9/15/99 07:45 a	344.0	g	GER7$1	RICHRC5017
U-238	3.46E-01	1.0E-01	1.0E-01	9.04E-02	pCi/g		(3.8)	(6.6)	9/15/99 07:45 a	344.0	g	GER7$1	RICHRC5017
U-238DHP	3.03E+01	4.2E+00	4.2E+00	2.06E+00	pCi/g		(14.7)	(14.5)	9/15/99 07:45 a	344.0	g	GER7$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	**SDG:**	12962	**COLLECTION DATE:**	8/26/99 9:00:00 AM
LOT,RPT DB ID:	J9H310169-14 9D1XPX10	**REPORT NBR:**	8765	**RECEIVED DATE:**	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-16-1.0a	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	**Work Order:**	D1XPX101											
U-235HP	2.57E-01	2.9E-01	2.9E-01	2.89E-01	pCi/g		0.89	(1.8)	9/15/99 07:42 a	336.7	g	GER8$1	RICHRC5017
U-238	4.04E-01	1.1E-01	1.1E-01	7.89E-02	pCi/g		(5.1)	(7.4)	9/15/99 07:42 a	336.7	g	GER8$1	RICHRC5017
U-238DHP	2.80E+01	3.3E+00	3.3E+00	1.37E+00	pCi/g		(20.4)	(17.2)	9/15/99 07:42 a	336.7	g	GER8$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	SDG:	12962	COLLECTION DATE:	8/26/99 9:05:00 AM
LOT,RPT DB ID:	J9H310169-15 9D1XQ110	REPORT NBR:	8765	RECEIVED DATE:	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-16-2.0	ORDER NBR:		MATRIX:	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	Work Order:	D1XQ1101											
U-235HP	4.57E-01	3.4E-01	3.4E-01	5.84E-01	pCi/g		0.78	(2.7)	9/15/99 09:34 a	341.6	g	GER1$1	RICHRC5017
U-238	2.69E-01	1.4E-01	1.4E-01	1.36E-01	pCi/g		(2.)	(3.9)	9/15/99 09:34 a	341.6	g	GER1$1	RICHRC5017
U-238DHP	1.71E+01	4.8E+00	4.8E+00	3.74E+00	pCi/g		(4.6)	(7.2)	9/15/99 09:34 a	341.6	g	GER1$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

Date: 9/24/99

SAMPLE RESULTS

LAB NAME:	QUANTERRA, Richland	SDG:	12962	COLLECTION DATE:	8/26/99 9:10:00 AM
LOT,RPT DB ID:	J9H310169-16 9D1XQ410	REPORT NBR:	8765	RECEIVED DATE:	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-16-3.0	ORDER NBR:		MATRIX:	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	Work Order:	D1XQ4101											
U-235HP	4.71E-02	1.4E-01	1.4E-01	2.52E-01	pCi/g		0.19	0.68	9/15/99 09:31 a	324.1	g	GER3$1	RICHRC5017
U-238	2.31E-01	1.1E-01	1.1E-01	7.81E-02	pCi/g		(3.)	(4.1)	9/15/99 09:31 a	324.1	g	GER3$1	RICHRC5017
U-238DHP	5.72E-01	1.7E+00	1.7E+00	2.96E+00	pCi/g		0.19	0.67	9/15/99 09:31 a	324.1	g	GER3$1	RICHRC5017

Number of Results: 3

Comments:

FORM I

SAMPLE RESULTS

Date: 9/24/99

LAB NAME:	QUANTERRA, Richland	SDG:	12962	COLLECTION DATE:	8/26/99 2:15:00 PM
LOT,RPT DB ID:	J9H310169-17 9D1XQ510	REPORT NBR:	8765	RECEIVED DATE:	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-BP-01	ORDER NBR:		MATRIX:	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	Work Order:	D1XQ5101											
U-235HP	2.67E+00	5.9E-01	5.9E-01	5.43E-01	pCi/g		(4.9)	(9.)	9/15/99 09:36 a	267.0	g	GER4$1	RICHRC5017
U-238	3.82E-01	1.6E-01	1.6E-01	1.83E-01	pCi/g		(2.1)	(4.7)	9/15/99 09:36 a	267.0	g	GER4$1	RICHRC5017
U-238DHP	1.42E+02	1.6E+01	1.6E+01	5.85E+00	pCi/g		(24.2)	(17.2)	9/15/99 09:36 a	267.0	g	GER4$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

DUPLICATE RESULTS

Date: 9/24/99

LAB NAME:	QUANTERRA, Richland	**SDG:**	12962	**COLLECTION DATE:**	8/25/99 9:30:00 AM
RPT DB ID/ORIG ID:	D1XPA13R / 9D1XPA10	**REPORT NBR:**	8765	**RECEIVED DATE:**	8/31/99 10:30:00 AM
CLIENT ID:	RW-41-SB-49-0.5	**ORDER NBR:**		**MATRIX:**	SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	ORIG RESULT	RPD	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	Work Order:	D1XPA103											
U-235HP	1.51E+01	1.9E+00	1.9E+00	1.01E+00	pCi/g		1.79E+01	16.92%	9/14/99 04:56 p	393.7	g	GER6$1	RICHRC5017
U-238	3.51E-01	1.7E-01	1.7E-01	2.37E-01	pCi/g		3.77E-01	7.26%	9/14/99 04:56 p	393.7	g	GER6$1	RICHRC5017
U-238DHP	8.82E+02	8.9E+01	8.9E+01	8.57E+00	pCi/g		9.75E+02	10.04%	9/14/99 04:56 p	393.7	g	GER6$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

BLANK RESULTS

Date: 9/24/99

LAB NAME: QUANTERRA, Richland **SDG:** 12962 **ORDER NBR:**

LOT,RPT DB ID: J9I090000-342 D292111X **REPORT NBR:** 8765 **MATRIX:** SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2s)	MDA	REPORT UNIT	YIELD	RST/MDA	RST/CNTERR	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	Work Order:	D2921101											
U-235HP	1.23E-02	9.1E-02	9.1E-02	1.58E-01	pCi/g		0.08	0.27	9/15/99 09:33 a	348.0	g	GER8$1	RICHRC5017
U-238	1.32E-01	4.5E-02	4.5E-02	9.11E-02	pCi/g		(1.5)	(5.9)	9/15/99 09:33 a	348.0	g	GER8$1	RICHRC5017
U-238DHP	-8.53E-02	2.8E-01	2.8E-01	4.92E-01	pCi/g		-0.17	-0.61	9/15/99 09:33 a	348.0	g	GER8$1	RICHRC5017

Number of Results: 3

Comments:

FORM II

Date: 9/24/99

LABORATORY CONTROL SAMPLE

LAB NAME: QUANTERRA, Richland SDG: 12962 ORDER NBR:

LOT,RPT DB ID: J9I090000-342 D292112M REPORT NBR: 8765 MATRIX: SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	Expected	Expected Uncert	Recovery	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	Work Order:	D2921102												
CS-137	2.98E-01	1.2E-01	1.2E-01	9.30E-02	pCi/g		3.11E-01	1.4E-02	95.89%	9/15/99 09:38 a	200.01	GRA	GER5$1	RICHRC5017

Number of Results: 1

Comments:

FORM II

Date: 9/24/99

LABORATORY CONTROL SAMPLE

LAB NAME: QUANTERRA, Richland **SDG:** 12962 **ORDER NBR:**

LOT,RPT DB ID: J9I090000-342 D292113M **REPORT NBR:** 8765 **MATRIX:** SOIL

ISOTOPE	RESULT	COUNTING ERROR (2 s)	TOTAL ERROR (2 s)	MDA	REPORT UNIT	YIELD	Expected	Expected Uncert	Recovery	ANALYSIS DATE	ALIQUOT SIZE	ALQ UNIT	DETECTOR ID	METHOD NUMBER
Batch: 9252342	Work Order:	D2921103												
CS-137	3.46E-01	9.4E-02	9.4E-02	8.64E-02	pCi/g		3.11E-01	1.4E-02	111.26%	9/15/99 11:29 a	200.01	GRA	GER8$1	RICHRC5017

Number of Results: 1

Comments:

W-51680 JGH310169 Due 9-30

Custody No. 12137

RUST

ust Environment & Infrastructure

Custody Chain and Analytical Request

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Project No. 24234

SDG 129962

LIMS No.

e: EGLIN AFB Base ID: EGLIN

Name: IRP SITE NO. RW-41 TEST AREA C-74L

ected By: A. MACBETH, D. TILTON

Sample ID: IRPIMS LOCID	Depth	Sample Code	Date	Time (24-Hour)	SAMPLE METHOD CODE*	MATRIX CODE*	# Of Containers (1L)	GAMMA SPECTROSCOPY							FIELD READINGS (KCT/min) COMMENTS (add preservative information)	Ambient Condition Blank	Equipment Blank	Trip Blank	Cooler Letter
W-41-SB-49	0.5	N1	8/25/99	0930	HA	SO	1	1		D	1	X	P	A	121.9	0	0	0	A
W-41-SB-49	0.5-C	N2	8/25/99	0930	HA	SO	1	1		D	1	X	P	F	NA	0	0	0	A
W-41-SB-49	1.0	N1	8/25/99	0935	HA	SO	1	1		D	1	X	P	G	74.6	0	0	0	A
W-41-SB-49	2.0	N1	8/25/99	0940	HA	SO	1	1		D	1	X	P	H	76.2	0	0	0	A
W-41-SB-49	3.0	N1	8/25/99	0945	HA	SO	1	1		D	1	X	P	J	50.6	0	0	0	A
~~W-41-SB-49~~	~~A~~														COC SEAL #5398,3995				
W-41-SB-50	0.5	N1	8/25/99	1300	HA	SO	1	1		D	1	X	P	K	NMT	0	0	0	A
W-41-SB-50	1.0	N1	8/25/99	1305	HA	SO	1	1		D	1	X	P	L		0	0	0	A
W-41-SB-50	2.0	N1	8/25/99	1310	HA	SO	1	1		D	1	X	P	N		0	0	0	A
W-41-SB-50	3.0	N1	8/25/99	1315	HA	SO	1	1		D	1	X	P	P		0	0	0	A

oratory:

ler entire Sample ID into LIMS, including dashes but omitting blank spaces. Truncate from the right if necessary. If only one depth is provided, assume depth is ending depth of two foot sample.

Custody Transfers Prior to Receipt By Laboratory

Relinquished by/(Signed) (Organization)	Received by/(Signed) (Organization)	Date	Time
A. Macbeth/R-5		8/30/99	1600

Sample Delivery Details/Laboratory Receipt

Delivered Directly to Lab ☐ Shipped ☒

Method of Shipment: FedEx Airbill #: 791783218669

Analytical Lab: Quanterra Location: RICHLAND, WA

Lab Recipient: K. Schlimbley (Signature) Date: 8-31-99 Time: 1300

Additional Remarks: (Condition Upon Lab Receipt, Etc.) PLS. GRIND SAMPLES TO MAXIMIZE HOMOGENIZATION

v. 01/97 White - Laboratory; Yellow - RUST; Pink - Project Files

* Valid sampling method and matrix codes are on reverse

Custody No. 12137

RUST

Rust Environment & Infrastructure

Custody Chain and Analytical Request

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Project No. 29234

LIMS No.

Base: EGLIN AFB Base ID: EGLIN

Site Name: IRP SITE NO. RU-41 TEST AREA C-74C

Collected By: A. MACBETH, D. TILTON

Sample ID: IRPIMS LOCID	Depth	Sample Code	Date	Time (24-Hour)	SAMPLE METHOD CODE*	MATRIX CODE*	# Of Containers (1L)	Gamma Spectroscopy							Field Readings (KCT) (min) COMMENTS (add preservative information)	Ambient Condition Blank	Equipment Blank	Trip Blank	Cooler Letter
W-41-SB-51	0.5	N1	8/25/99	1415	HA	SO	1	1		D	1	X	P	R	36.4	0	0	0	A
~~W-41-SB-51-0.5-a~~		~~N2~~	~~8/25/99~~	~~1415~~	~~HA~~	~~SO~~	~~1~~	~~1~~					~~Aa~~		~~36.4~~				
W-41-SB-51	1.0	N1	8/25/99	1420	HA	SO	1	1		D	1	X	P	T	48.8	0	0	0	A
~~W-41-SB-51~~	~~2.0~~	~~N1~~	~~8/25/99~~	~~1425~~	~~HA~~	~~SO~~	~~1~~	~~1~~				~~Aam~~			~~43.5~~				
W-41-SB-51	3.0	N1	8/25/99	1430	HA	SO	1	1		D	1	X	P	V	53.0	0	0	0	A
W-41-SB-16	1.0	N1	8/26/99	0900	HA	SO	1	1		D	1	X	P	W	46.6	0	0	0	A
W-41-SB-16	1.0-a	N2	8/26/99	0900	HA	SO	1	1		D	1	X	P	X	46.6	0	0	0	A
W-41-SB-16	2.0	N1	8/26/99	0905	HA	SO	1	1		D	1	X	Q	1	36.7	0	0	0	A
W-41-SB-16	3.0	N1	8/26/99	0910	HA	SO	1	1		D	1	X	Q	4	43.5	0	0	0	A
~~W-41-SB-46~~	~~0.5~~	~~N1~~	~~8/26/99~~	~~1030~~	~~HA~~	~~SO~~	~~1~~	~~1~~			~~Aam~~				~~27.6~~				

Laboratory:

Enter entire Sample ID into LIMS, including dashes but omitting blank spaces. Truncate from the right if necessary. If only one depth is provided, assume depth is ending depth of two foot sample.

Custody Transfers Prior to Receipt By Laboratory

Relinquished by/(Signed) (Organization)	Received by/(Signed) (Organization)	Date	Time
A. Michel / Rust		8/30/99	1600

Sample Delivery Details/Laboratory Receipt

Delivered Directly to Lab ☐ Shipped ☒

Method of Shipment: FedEx Airbill #: 7917832186 65

Analytical Lab: Quanterra Location: RICHLAND, WA

Lab Recipient: Karen Dellbuck (Signature) Date: 8-31-99 Time: 1030

Additional Remarks: (Condition Upon Lab Receipt, Etc.) PLS SEE NOTE P. 1

Rev. 01/97

White - Laboratory; Yellow - RUST; Pink - Project Files

* Valid sample method and matrix codes are on reverse

Custody No. 12137

RUST

Rust Environment & Infrastructure

Custody Chain and Analytical Request

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Project No. 29231

LIMS No.

Base: Eglin AFB Base ID: Eglin

Site Name: IRP SITE No. RW-41 Test Area C74C

Collected By: A. McBeth, D. Tillon

IRPIMS LOCID	Depth	Sample Code	Date	Time (24-Hour)	SAMPLE METHOD CODE*	MATRIX CODE*	# Of Containers	Gamma Spectroscopy	Gamma Spec. All Isotopes						FIDLER READING Kct/min COMMENTS (add preservative information)	Ambient Condition Blank	Equipment Blank	Trip Blank	Cooler Letter
~~W41-SB-46~~	~~0.5~~		~~8/26/99~~	~~1030~~	~~HA~~	~~SO~~	~~1~~	~~1~~							~~N/A~~				
~~W41-SB-46~~	~~1.0~~	~~N1~~	~~8/26/99~~	~~1035~~	~~HA~~	~~SO~~	~~1~~	~~1~~	~~1~~						~~91.7~~				
~~W41-SB-46~~	~~2.0~~	~~N1~~	~~8/26/99~~	~~1040~~	~~HA~~	~~SO~~	~~1~~	~~1~~							~~19.70~~				
~~W41-SB-46~~	~~3.0~~	~~N1~~	~~8/26/99~~	~~1045~~	~~HA~~	~~SO~~	~~1~~	~~1~~							~~15.32~~				
~~W41~~ det																			
W-41-BP-01		N1	8/26/99	1415	G	SO	1	1	1	D	1	X	Q	5	~14 Kct/min	0	0	0	4
															COC Seal #s 398, 399				

Laboratory:
Enter entire Sample ID into LIMS, including dashes but omitting blank spaces. Truncate from the right if necessary. If only one depth is provided, assume depth is ending depth of two foot sample.

Custody Transfers Prior to Receipt By Laboratory

Relinquished by/(Signed) (Organization)	Received by/(Signed) (Organization)	Date	Time
1. A. McBeth / Rust		8/30/99	1600
2.			
3.			

Sample Delivery Details/Laboratory Receipt

Delivered Directly to Lab ☐ Shipped ☒

Method of Shipment: Fedex Airbill #: 791783218669

Analytical Lab: Quanterra Location: Richland, WA

Lab Recipient: [signature] (Signature) Date: 8-31-99 Time: 1030

Additional Remarks: (Condition Upon Lab Receipt, Etc.) * PLS. ANALYZE THIS SAMPLE FOR ALL AVAILABLE ISOTOPES. PLS. SEE NOTES P.

Rev. 01/97

White - Laboratory; Yellow - RUST; Pink - Project Files

* Valid sample method and matrix codes are on reverse

Client Sample Screening Results

07-Sep-99

9/8/99

CLIENT CODE ID	MATRIX	RECEIVED	DETECTOR	ACQ DATE	SAMPLE	MINUTES	CNTS A	NET CPM A	CNTS B	NET CPM B
REI RW41BP01D1XQ5		9/3/99 8:00:00 AM	QUAD21A	9/7/99 10:28:29 AM	RW41BP01D1XQ5	30	138	4.50625	811	26.0570833
D1XQ5	SOIL		Bkg:	9/4/99 5:30:34 AM	BKG	800	75	0.09375	781	0.97625
Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 1.20E+02	Alp; (Dpm/ 3.25E+01	(uCi/ 1.92E-01	(pCi/ 1.22E+02	± 1.0E+01	CAT III	4.1E-01 Lab		
Ppt mg: 120.3	Units: g	, mg	Bet; Alq): 5.83E+01	Sa): 3.45E-01	L|g): 2.18E+02	± 8.1E+00		4.6E-01 Alq L|g		
REI RW41SB1610AD1XPX		9/3/99 8:00:00 AM	QUAD22C	9/7/99 10:28:33 AM	W41SB1610AD1XPX	30	45	1.37875	189	5.295
D1XPX	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	97	0.12125	804	1.005
Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 9.06E+01	Alp; (Dpm/ 8.56E+00	(uCi/ 6.72E-02	(pCi/ 4.26E+01	± 7.7E+00	CAT II	1.2E+00 Lab		
Ppt mg: 90.6	Units: g	, mg	Bet; Alq): 1.06E+01	Sa): 8.34E-02	L|g): 5.28E+01	± 4.8E+00		1.9E+00 Alq L|g		
REI RW41SB1610D1XPW		9/3/99 8:00:00 AM	QUAD22B	9/7/99 10:28:33 AM	W41SB1610D1XPW	30	30	0.8775	179	4.68291667
D1XPW	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	98	0.1225	1027	1.28375
Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 8.88E+01	Alp; (Dpm/ 5.33E+00	(uCi/ 4.27E-02	(pCi/ 2.71E+01	± 7.3E+00	CAT II	1.8E+00 Lab		
Ppt mg: 88.8	Units: g	, mg	Bet; Alq): 9.59E+00	Sa): 7.68E-02	L|g): 4.86E+01	± 4.8E+00		2.1E+00 Alq L|g		
REI RW41SB1620D1XQ1		9/3/99 8:00:00 AM	QUAD22D	9/7/99 10:28:33 AM	W41SB1620D1XQ1	30	10	0.258333333	77	1.37666667
D1XQ1	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	60	0.075	952	1.19
Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 1.07E+02	Alp; (Dpm/ 1.74E+00	(uCi/ 1.15E-02	(pCi/ 7.28E+00	± 5.3E+00	CAT II	6.9E+00 Lab		
Ppt mg: 107.4	Units: g	, mg	Bet; Alq): 2.88E+00	Sa): 1.91E-02	L|g): 1.21E+01	± 2.7E+00		8.3E+00 Alq L|g		
REI RW41SB1630D1XQ4		9/3/99 8:00:00 AM	QUAD23A	9/7/99 10:28:30 AM	W41SB1630D1XQ4	30	12	0.3075	49	0.66958333
D1XQ4	SOIL		Bkg:	9/4/99 5:30:51 AM	BKG	800	74	0.0925	771	0.96375
Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 1.22E+02	Alp; (Dpm/ 2.24E+00	(uCi/ 1.30E-02	(pCi/ 8.25E+00	± 4.6E+00	CAT II	6.1E+00 Lab		
Ppt mg: 122.3	Units: g	, mg	Bet; Alq): 1.25E+00	Sa): 7.27E-03	L|g): 4.61E+00	± 1.9E+00		2.2E+01 Alq L|g		
REI RW41SB4605D1XM6		9/3/99 8:00:00 AM	QUAD23B	9/7/99 10:28:30 AM	W41SB4605D1XM6	30	90	2.85125	660	21.0325
D1XM6	SOIL		Bkg:	9/4/99 5:30:51 AM	BKG	800	119	0.14875	774	0.9675
Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 1.24E+02	Alp; (Dpm/ 2.02E+01	(uCi/ 1.17E-01	(pCi/ 7.38E+01	± 8.1E+00	CAT III	6.8E-01 Lab		
Ppt mg: 123.5	Units: g	, mg	Bet; Alq): 4.46E+01	Sa): 2.57E-01	L|g): 1.63E+02	± 6.8E+00		6.1E-01 Alq L|g		

(KJ) 9/8/99

CLIENT CODE ID	MATRIX	RECEIVED	DETECTOR	ACQ DATE	SAMPLE	MINUTES	CNTS A	NET CPM A	CNTS B	NET CPM B
REI RW41SB4605ED1XML		9/3/99 8:00:00 AM	QUAD23C	9/7/99 10:28:30 AM	W41SB4605ED1XML	30	2	-0.07833333	47	0.44666667
D1XML	SOIL		Bkg:	9/4/99 5:30:51 AM	BKG	800	116	0.145	896	1.12

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 1.19E+02 Alp; (Dpm/ -6.15E-01 (uCi/ -3.67E-03 (pCi/ -2.32E+00 ± 4.6E+00 CAT I 1.6E+03 Lab Alq L|g
Ppt mg: 119.2 Units: g , mg Bet; Alq): 1.05E+00 Sa): 6.29E-03 L|g): 3.98E+00 ± 2.0E+00 2.5E+01

REI RW41SB4610D1XME		9/3/99 8:00:00 AM	QUAD24A	9/7/99 10:28:32 AM	W41SB4610D1XME	30	828	27.45125	3414	112.86125
D1XME	SOIL		Bkg:	9/4/99 5:30:32 AM	BKG	800	119	0.14875	751	0.93875

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 9.63E+01 Alp; (Dpm/ 1.86E+02 (uCi/ 1.38E+00 (pCi/ 8.72E+02 ± 2.8E+01 CAT III 5.7E-02 Lab Alq L|g
Ppt mg: 96.3 Units: g , mg Bet; Alq): 2.39E+02 Sa): 1.76E+00 L|g): 1.12E+03 + 2.0E+01 9.0E-02

REI RW41SB4620D1XMC		9/3/99 8:00:00 AM	QUAD24B	9/7/99 10:28:32 AM	W41SB4620D1XMC	30	149	4.835416667	588	18.52625
D1XMC	SOIL		Bkg:	9/4/99 5:30:32 AM	BKG	800	105	0.13125	859	1.07375

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 1.18E+02 Alp; (Dpm/ 3.55E+01 (uCi/ 2.14E-01 (pCi/ 1.35E+02 + 1.1E+01 CAT III 3.7E-01 Lab Alq L|g
Ppt mg: 118.3 Units: g , mg Bet; Alq): 3.93E+01 Sa): 2.36E-01 L|g): 1.50E+02 ± 6.8E+00 6.7E-01

REI RW41SB4630D1XMH		9/3/99 8:00:00 AM	QUAD24D	9/7/99 10:28:32 AM	W41SB4630D1XMH	30	36	1.115	140	3.52291667
D1XMH	SOIL		Bkg:	9/4/99 5:30:32 AM	BKG	800	68	0.085	915	1.14375

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 8.35E+01 Alp; (Dpm/ 6.71E+00 (uCi/ 5.71E-02 (pCi/ 3.62E+01 ± 7.9E+00 CAT II 1.4E+00 Lab Alq L|g
Ppt mg: 83.5 Units: g , mg Bet; Alq): 7.11E+00 Sa): 6.06E-02 L|g): 3.84E+01 ± 4.5E+00 2.6E+00

REI RW41SB4905CD1XPF		9/3/99 8:00:00 AM	QUAD22B	9/7/99 11:14:34 AM	W41SB4905CD1XPF	30	12	0.2775	58	0.64958333
D1XPF	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	98	0.1225	1027	1.28375

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 9.56E+01 Alp; (Dpm/ 1.80E+00 (uCi/ 1.34E-02 (pCi/ 8.47E+00 ± 5.9E+00 CAT II 5.9E+00 Lab Alq L|g
Ppt mg: 95.6 Units: g , mg Bet; Alq): 1.24E+00 Sa): 9.24E-03 L|g): 5.85E+00 ± 2.7E+00 1.7E+01

REI RW41SB4905D1XPA		9/3/99 8:00:00 AM	QUAD22A	9/7/99 11:14:34 AM	W41SB4905D1XPA	30	1799	59.87916667	7139	236.851667
D1XPA	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	70	0.0875	892	1.115

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 8.55E+01 Alp; (Dpm/ 3.61E+02 (uCi/ 3.01E+00 (pCi/ 1.90E+03 ± 4.1E+01 CAT III 2.6E-02 Lab Alq L|g
Ppt mg: 85.5 Units: g , mg Bet; Alq): 4.68E+02 Sa): 3.89E+00 L|g): 2.46E+03 ± 3.0E+01 4.1E-02

REI RW41SB4910D1XPG		9/3/99 8:00:00 AM	QUAD22C	9/7/99 11:14:34 AM	W41SB4910D1XPG	30	239	7.845416667	940	30.3283333
D1XPG	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	97	0.12125	804	1.005

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 9.65E+01 Alp; (Dpm/ 5.02E+01 (uCi/ 3.70E-01 (pCi/ 2.34E+02 ± 1.4E+01 CAT III 2.1E-01 Lab Alq L|g
Ppt mg: 96.5 Units: g , mg Bet; Alq): 6.10E+01 Sa): 4.49E-01 L|g): 2.85E+02 ± 1.0E+01 3.5E-01

MWf 9-8-99

CLIENT CODE ID	MATRIX	RECEIVED	DETECTOR	ACQ DATE	SAMPLE	MINUTES	CNTS A	NET CPM A	CNTS B	NET CPM B
REI RW41SB4920D1XPH		9/3/99 8:00:00 AM	QUAD22D	9/7/99 11:14:34 AM	W41SB4920D1XPH	30	60	1.925	240	6.81
D1XPH	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	60	0.075	952	1.19

Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 1.15E+02	Alp;	(Dpm/ 1.37E+01	(uCi/ 8.46E-02	(pCi/ 5.36E+01	± 7.7E+00	CAT	9.3E-01	Lab
Ppt mg: 115.2	Units: g	, mg	Bet;	Alq): 1.38E+01	Sa): 8.53E-02	L|g): 5.40E+01	± 4.3E+00	II	1.9E+00	Alq L|g

CLIENT CODE ID	MATRIX	RECEIVED	DETECTOR	ACQ DATE	SAMPLE	MINUTES	CNTS A	NET CPM A	CNTS B	NET CPM B
REI RW41SB4930D1XPJ		9/3/99 8:00:00 AM	QUAD23A	9/7/99 11:14:39 AM	RW41SB4930D1XPJ	30	16	0.440833333	77	1.60291667
D1XPJ	SOIL		Bkg:	9/4/99 5:30:51 AM	BKG	800	74	0.0925	771	0.96375

Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 9.80E+01	Alp;	(Dpm/ 2.87E+00	(uCi/ 2.08E-02	(pCi/ 1.32E+01	± 5.5E+00	CAT	3.8E+00	Lab
Ppt mg: 98	Units: g	, mg	Bet;	Alq): 3.21E+00	Sa): 2.33E-02	L|g): 1.47E+01	± 2.9E+00	II	6.8E+00	Alq L|g

CLIENT CODE ID	MATRIX	RECEIVED	DETECTOR	ACQ DATE	SAMPLE	MINUTES	CNTS A	NET CPM A	CNTS B	NET CPM B
REI RW41SB500310D20X1		9/3/99 8:00:00 AM	QUAD23B	9/7/99 11:14:39 AM	W41SB500310D20X1	30	17657	588.4179167	111698	3722.29917
D20X1	SOIL		Bkg:	9/4/99 5:30:51 AM	BKG	800	119	0.14875	774	0.9675

Anl Date: 9/7/99	Tot Sa, Alq: 3.47E+02	, 9.48E+01	Alp;	(Dpm/ 3.71E+03	(uCi/ 6.11E+00	(pCi/ 1.76E+04	± 1.2E+02	CAT	2.8E-03	Lab
Ppt mg: 94.8	Units: g	, mg	Bet;	Alq): 7.80E+03	Sa): 1.29E+01	L|g): 3.71E+04	± 1.1E+02	III	2.7E-03	Alq L|g

CLIENT CODE ID	MATRIX	RECEIVED	DETECTOR	ACQ DATE	SAMPLE	MINUTES	CNTS A	NET CPM A	CNTS B	NET CPM B
REI RW41SB5003230D20X7		9/3/99 8:00:00 AM	QUAD23C	9/7/99 11:14:39 AM	W41SB5003230D20X7	30	6426	214.055	28166	937.746667
D20X7	SOIL		Bkg:	9/4/99 5:30:51 AM	BKG	800	116	0.145	896	1.12

Anl Date: 9/7/99	Tot Sa, Alq: 6.60E+02	, 8.90E+01	Alp;	(Dpm/ 1.34E+03	(uCi/ 4.47E+00	(pCi/ 6.77E+03	± 7.6E+01	CAT	7.4E-03	Lab
Ppt mg: 89	Units: g	, mg	Bet;	Alq): 1.90E+03	Sa): 6.33E+00	L|g): 9.60E+03	± 5.9E+01	III	1.0E-02	Alq L|g

CLIENT CODE ID	MATRIX	RECEIVED	DETECTOR	ACQ DATE	SAMPLE	MINUTES	CNTS A	NET CPM A	CNTS B	NET CPM B
REI RW41SB500360D20X4		9/3/99 8:00:00 AM	QUAD24A	9/7/99 11:14:35 AM	W41SB500360D20X4	30	1629	54.15125	6688	221.994583
D20X4	SOIL		Bkg:	9/4/99 5:30:32 AM	BKG	800	119	0.14875	751	0.93875

Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 1.04E+02	Alp;	(Dpm/ 3.84E+02	(uCi/ 2.61E+00	(pCi/ 1.66E+03	± 3.7E+01	CAT	3.0E-02	Lab
Ppt mg: 104.3	Units: g	, mg	Bet;	Alq): 4.73E+02	Sa): 3.22E+00	L|g): 2.04E+03	± 2.6E+01	III	4.9E-02	Alq L|g

CLIENT CODE ID	MATRIX	RECEIVED	DETECTOR	ACQ DATE	SAMPLE	MINUTES	CNTS A	NET CPM A	CNTS B	NET CPM B
REI RW41SB5005D1XPK		9/3/99 8:00:00 AM	QUAD24B	9/7/99 11:14:35 AM	W41SB5005D1XPK	30	1349	44.83541667	4766	157.792917
D1XPK	SOIL		Bkg:	9/4/99 5:30:32 AM	BKG	800	105	0.13125	859	1.07375

Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 1.23E+02	Alp;	(Dpm/ 3.37E+02	(uCi/ 1.95E+00	(pCi/ 1.23E+03	± 3.0E+01	CAT	4.1E-02	Lab
Ppt mg: 122.9	Units: g	, mg	Bet;	Alq): 3.34E+02	Sa): 1.93E+00	L|g): 1.22E+03	± 1.9E+01	III	8.2E-02	Alq L|g

CLIENT CODE ID	MATRIX	RECEIVED	DETECTOR	ACQ DATE	SAMPLE	MINUTES	CNTS A	NET CPM A	CNTS B	NET CPM B
REI RW41SB5010D1XPL		9/3/99 8:00:00 AM	QUAD24D	9/7/99 11:14:35 AM	W41SB5010D1XPL	30	65	2.081666667	229	6.48958333
D1XPL	SOIL		Bkg:	9/4/99 5:30:32 AM	BKG	800	68	0.085	915	1.14375

Anl Date: 9/7/99	Tot Sa, Alq: 1.58E+03	, 8.10E+01	Alp;	(Dpm/ 0.00E+00	(uCi/ 0.00E+00	(pCi/ 0.00E+00	± #Num!	CAT	1.6E+03	Lab
Ppt mg: 81	Units: g	, mg	Bet;	Alq): 0.00E+00	Sa): 0.00E+00	L|g): 0.00E+00	± #Num!	I	1.6E+03	Alq L|g

(B) 9/8/99

CLIENT CODE ID	MATRIX	RECEIVED	DETECTOR	ACQ DATE	SAMPLE	MINUTES	CNTS A	NET CPM A	CNTS B	NET CPM B
REI RW41SB5020D1XPN		9/3/99 8:00:00 AM	QUAD21A	9/7/99 11:48:52 AM	W41SB5020D1XPN	30	9	0.20625	64	1.15708333
D1XPN	SOIL		Bkg:	9/4/99 5:30:34 AM	BKG	800	75	0.09375	781	0.97625

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 9.11E+01 Alp; (Dpm/ 1.30E+00 (uCi/ 1.02E-02 (pCi/ 6.45E+00 ± 5.7E+00 CAT II 7.7E+00 Lab
Ppt mg: 91.1 Units: g , mg Bet; Alq): 2.54E+00 Sa): 1.98E-02 L|g): 1.26E+01 ± 3.1E+00 8.0E+00 Alq L|g

REI RW41SB5030D1XPP		9/3/99 8:00:00 AM	QUAD21B	9/7/99 11:48:52 AM	W41SB5030D1XPP	30	12	0.31125	69	1.39
D1XPP	SOIL		Bkg:	9/4/99 5:30:34 AM	BKG	800	71	0.08875	728	0.91

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 9.78E+01 Alp; (Dpm/ 2.09E+00 (uCi/ 1.52E-02 (pCi/ 9.61E+00 ± 5.5E+00 CAT II 5.2E+00 Lab
Ppt mg: 97.8 Units: g , mg Bet; Alq): 2.93E+00 Sa): 2.13E-02 L|g): 1.35E+01 ± 2.9E+00 7.4E+00 Alq L|g

REI RW41SB5105AD1XMG		9/3/99 8:00:00 AM	QUAD22A	9/7/99 11:48:55 AM	W41SB5105AD1XMG	30	128	4.179166667	703	22.3183333
D1XMG	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	70	0.0875	892	1.115

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 1.23E+02 Alp; (Dpm/ 2.90E+01 (uCi/ 1.68E-01 (pCi/ 1.07E+02 ± 9.4E+00 CAT III 4.7E-01 Lab
Ppt mg: 122.5 Units: g , mg Bet; Alq): 4.62E+01 Sa): 2.68E-01 L|g): 1.70E+02 ± 6.9E+00 5.9E-01 Alq L|g

REI RW41SB5105D1XPR		9/3/99 8:00:00 AM	QUAD21C	9/7/99 11:48:52 AM	W41SB5105D1XPR	30	173	5.639166667	748	23.9083333
D1XPR	SOIL		Bkg:	9/4/99 5:30:34 AM	BKG	800	102	0.1275	820	1.025

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 9.51E+01 Alp; (Dpm/ 3.71E+01 (uCi/ 2.77E-01 (pCi/ 1.76E+02 ± 1.3E+01 CAT III 2.8E-01 Lab
Ppt mg: 95.1 Units: g , mg Bet; Alq): 4.99E+01 Sa): 3.73E-01 L|g): 2.36E+02 ± 9.3E+00 4.2E-01 Alq L|g

REI RW41SB5110D1XPT		9/3/99 8:00:00 AM	QUAD22B	9/7/99 11:48:55 AM	W41SB5110D1XPT	30	100	3.210833333	444	13.51625
D1XPT	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	98	0.1225	1027	1.28375

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 1.11E+02 Alp; (Dpm/ 0.00E+00 (uCi/ 0.00E+00 (pCi/ 0.00E+00 ± #Num! CAT I 1.6E+03 Lab
Ppt mg: 110.7 Units: g , mg Bet; Alq): 0.00E+00 Sa): 0.00E+00 L|g): 0.00E+00 ± #Num! 1.6E+03 Alq L|g

REI RW41SB5120D1XM8		9/3/99 8:00:00 AM	QUAD22C	9/7/99 11:48:55 AM	W41SB5120D1XM8	30	102	3.27875	417	12.895
D1XM8	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	97	0.12125	804	1.005

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 1.20E+02 Alp; (Dpm/ 2.33E+01 (uCi/ 1.38E-01 (pCi/ 8.76E+01 ± 8.8E+00 CAT III 5.7E-01 Lab
Ppt mg: 119.7 Units: g , mg Bet; Alq): 2.59E+01 Sa): 1.54E-01 L|g): 9.75E+01 ± 5.4E+00 1.0E+00 Alq L|g

REI RW41SB5130D1XPV		9/3/99 8:00:00 AM	QUAD22D	9/7/99 11:48:55 AM	W41SB5130D1XPV	30	82	2.658333333	368	11.0766667
D1XPV	SOIL		Bkg:	9/4/99 5:30:39 AM	BKG	800	60	0.075	952	1.19

Anl Date: 9/7/99 Tot Sa, Alq: 1.58E+03 , 1.09E+02 Alp; (Dpm/ 0.00E+00 (uCi/ 0.00E+00 (pCi/ 0.00E+00 ± #Num! CAT I 1.6E+03 Lab
Ppt mg: 109 Units: g , mg Bet; Alq): 0.00E+00 Sa): 0.00E+00 L|g): 0.00E+00 ± #Num! 1.6E+03 Alq L|g