

# TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

## ANALYTICAL REPORT

TestAmerica Laboratories, Inc.

TestAmerica St. Louis  
13715 Rider Trail North  
Earth City, MO 63045  
Tel: (314)298-8566

TestAmerica Job ID: 160-11391-2

Client Project/Site: HDP

For:

Perma-Fix Environmental Services Inc.  
2800 Solway Road  
Knoxville, Tennessee 37931

Attn: Brian Miller



Authorized for release by:  
5/14/2015 4:01:03 PM

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*This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.*

*Results relate only to the items tested and the sample(s) as received by the laboratory.*



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## Case Narrative

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

**Job ID: 160-11391-2**

**Laboratory: TestAmerica St. Louis**

### Narrative

## CASE NARRATIVE

**Client: Perma-Fix Environmental Services Inc.**

**Project: HDP**

**Report Number: 160-11391-2**

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

TestAmerica St. Louis attests to the validity of the laboratory data generated by TestAmerica facilities reported herein. All analyses performed by TestAmerica facilities were done using established laboratory SOPs that incorporate QA/QC procedures described in the application methods. TestAmerica's operations groups have reviewed the data for compliance with the laboratory QA/QC plan, and data have been found to be compliant with laboratory protocols unless otherwise noted below.

The test results in this report meet all NELAP requirements for parameters for which accreditation is required or available. Any exceptions to NELAP requirements are noted in this report. Pursuant to NELAP, this report may not be reproduced, except in full, without the written approval of the laboratory.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

All solid sample results for Chemistry analyses are reported on an "as received" basis unless otherwise indicated by the presence of a % solids value in the method header. All soil/sediment sample results for radiochemistry analyses are based upon sample as dried and disaggregated with the exception of tritium, carbon-14, and iodine-129 by gamma spectroscopy unless requested as wet weight by the client."

This laboratory report is confidential and is intended for the sole use of TestAmerica and its client.

### RECEIPT

The samples were received on 04/17/2015; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the coolers at receipt was 20.0 C.

### RADIUM-226 BY GAMMA SPEC (21 DAY INGROWTH)

Samples L10-14-01-B-E-S-00 (160-11391-1), L10-14-02-B-E-S-00 (160-11391-2), L10-14-03-B-E-S-00 (160-11391-3), L10-14-04-B-E-S-00 (160-11391-4), L10-14-05-B-E-S-00 (160-11391-5), L10-14-06-B-E-S-00 (160-11391-6), L10-14-07-B-E-S-00 (160-11391-7), L10-14-08-B-R-S-00 (160-11391-8), L10-14-09-B-E-S-00 (160-11391-9) and L10-14-06-B-E-Q-00 (160-11391-10) were analyzed for Radium-226 by gamma spec (21 day ingrowth) in accordance with EPA GA\_01\_R. The samples were leached on 04/17/2015, prepared on 04/21/2015 and analyzed on 05/12/2015.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.



## Login Sample Receipt Checklist

Client: Perma-Fix Environmental Services Inc.

Job Number: 160-11391-2

**Login Number: 11391**

**List Number: 1**

**Creator: Clarke, Jill C**

**List Source: TestAmerica St. Louis**

Question	Answer	Comment
Radioactivity wasn't checked or is $\leq$ background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is $<6\text{mm}$ (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

## Definitions/Glossary

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

### Qualifiers

#### Rad

Qualifier	Qualifier Description
U	Result is less than the sample detection limit.

### Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
α	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

# Method Summary

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

Method	Method Description	Protocol	Laboratory
GA-01-R	Radium-226 & Other Gamma Emitters (GS)	DOE	TAL SL

**Protocol References:**  
DOE = U.S. Department of Energy

**Laboratory References:**  
TAL SL = TestAmerica St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566



# Sample Summary

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
160-11391-1	L10-14-01-B-E-S-00	Solid	04/14/15 16:15	04/17/15 10:20
160-11391-2	L10-14-02-B-E-S-00	Solid	04/14/15 16:20	04/17/15 10:20
160-11391-3	L10-14-03-B-E-S-00	Solid	04/14/15 16:30	04/17/15 10:20
160-11391-4	L10-14-04-B-E-S-00	Solid	04/14/15 16:35	04/17/15 10:20
160-11391-5	L10-14-05-B-E-S-00	Solid	04/14/15 16:45	04/17/15 10:20
160-11391-6	L10-14-06-B-E-S-00	Solid	04/14/15 16:50	04/17/15 10:20
160-11391-7	L10-14-07-B-E-S-00	Solid	04/14/15 17:00	04/17/15 10:20
160-11391-8	L10-14-08-B-R-S-00	Solid	04/15/15 11:25	04/17/15 10:20
160-11391-9	L10-14-09-B-E-S-00	Solid	04/15/15 11:30	04/17/15 10:20
160-11391-10	L10-14-06-B-E-Q-00	Solid	04/14/15 16:50	04/17/15 10:20



# Client Sample Results

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

Client Sample ID: L10-14-01-B-E-S-00

Date Collected: 04/14/15 16:15

Date Received: 04/17/15 10:20

Lab Sample ID: 160-11391-1

Matrix: Solid

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.13		0.154	0.192		0.0871	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Bismuth 212	1.35		0.461	0.482		0.426	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Bismuth 214	0.841		0.103	0.135		0.0738	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Lead 212	1.16		0.0787	0.170		0.0636	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Lead 214	1.08		0.0916	0.145		0.0777	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Potassium 40	19.5		1.24	2.35		0.239	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Protactinium 231	-0.575	U	0.708	0.711		1.17	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Radium 226	0.841		0.103	0.135	1.00	0.0738	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Thorium 232	1.13		0.154	0.192		0.0871	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Thorium 234	0.924		0.276	0.293		0.774	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Uranium 235	0.111	U	0.149	0.150		0.228	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Americium 241	-0.00138	U	0.0608	0.0608		0.103	pCi/g	04/21/15 10:38	05/12/15 16:02	1
Protactinium 234m	2.27	U	3.15	3.15		5.22	pCi/g	04/21/15 10:38	05/12/15 16:02	1
<b>Other Detected</b>			<b>Count</b>	<b>Total</b>						
<b>Radionuclides</b>			<b>Uncert.</b>	<b>Uncert.</b>						
	<b>Result</b>	<b>Qualifier</b>	<b>(2σ+/-)</b>	<b>(2σ+/-)</b>	<b>RL</b>	<b>MDC</b>	<b>Unit</b>	<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>
Tl-208	0.365		0.0545	0.0664		0.0408	pCi/g	04/21/15 10:38	05/12/15 16:02	1

Client Sample ID: L10-14-02-B-E-S-00

Date Collected: 04/14/15 16:20

Date Received: 04/17/15 10:20

Lab Sample ID: 160-11391-2

Matrix: Solid

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.19		0.156	0.198		0.127	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Bismuth 212	1.47		0.456	0.481		0.419	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Bismuth 214	1.23		0.119	0.175		0.0720	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Lead 212	1.18		0.0856	0.175		0.0846	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Lead 214	1.35		0.114	0.181		0.0793	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Potassium 40	16.0		1.15	2.00		0.262	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Protactinium 231	0.444	U	0.274	0.279		1.43	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Radium 226	1.23		0.119	0.175	1.00	0.0720	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Thorium 232	1.19		0.156	0.198		0.127	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Thorium 234	1.23		0.553	0.568		0.878	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Uranium 235	0.0839	U	0.163	0.163		0.272	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Americium 241	0.000801	U	0.0506	0.0506		0.0858	pCi/g	04/21/15 10:38	05/12/15 16:03	1
Protactinium 234m	2.26	U	3.42	3.43		5.80	pCi/g	04/21/15 10:38	05/12/15 16:03	1
<b>Other Detected</b>			<b>Count</b>	<b>Total</b>						
<b>Radionuclides</b>			<b>Uncert.</b>	<b>Uncert.</b>						
	<b>Result</b>	<b>Qualifier</b>	<b>(2σ+/-)</b>	<b>(2σ+/-)</b>	<b>RL</b>	<b>MDC</b>	<b>Unit</b>	<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>
Tl-208	0.419		0.0569	0.0716		0.0390	pCi/g	04/21/15 10:38	05/12/15 16:03	1

TestAmerica St. Louis

# Client Sample Results

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

Client Sample ID: L10-14-03-B-E-S-00

Lab Sample ID: 160-11391-3

Date Collected: 04/14/15 16:30

Matrix: Solid

Date Received: 04/17/15 10:20

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.27		0.122	0.176		0.115	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Bismuth 212	1.53		0.504	0.527		0.438	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Bismuth 214	1.17		0.0955	0.154		0.0842	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Lead 212	1.19		0.0737	0.172		0.0722	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Lead 214	1.41		0.0943	0.174		0.0781	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Potassium 40	19.8		1.03	2.25		0.215	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Protactinium 231	0.247	U	0.423	0.424		0.708	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Radium 226	1.17		0.0955	0.154	1.00	0.0842	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Thorium 232	1.27		0.122	0.176		0.115	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Thorium 234	0.975		0.270	0.289		0.790	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Uranium 235	0.0140	U	0.0605	0.0605		0.254	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Americium 241	-0.00949	U	7.54	7.54		0.0690	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Protactinium 234m	-0.666	U	2.87	2.87		4.97	pCi/g	04/21/15 10:38	05/12/15 16:05	1
Other Detected Radionuclides			Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tl-208	0.445		0.0513	0.0687		0.0353	pCi/g	04/21/15 10:38	05/12/15 16:05	1

Client Sample ID: L10-14-04-B-E-S-00

Lab Sample ID: 160-11391-4

Date Collected: 04/14/15 16:35

Matrix: Solid

Date Received: 04/17/15 10:20

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.04		0.128	0.166		0.106	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Bismuth 212	1.66		0.558	0.584		0.482	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Bismuth 214	0.865		0.0999	0.134		0.0688	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Lead 212	1.06		0.0738	0.155		0.0618	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Lead 214	0.919		0.0917	0.132		0.0664	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Potassium 40	18.8		1.21	2.28		0.321	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Protactinium 231	0.394	U	0.211	0.216		1.19	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Radium 226	0.865		0.0999	0.134	1.00	0.0688	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Thorium 232	1.04		0.128	0.166		0.106	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Thorium 234	1.35		0.515	0.534		0.803	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Uranium 235	0.109	U	0.128	0.128		0.248	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Americium 241	0.00809	U	0.0575	0.0575		0.0968	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Protactinium 234m	7.80		2.76	2.87		2.04	pCi/g	04/21/15 10:38	05/12/15 16:38	1
Other Detected Radionuclides			Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tl-208	0.411		0.0483	0.0644		0.0293	pCi/g	04/21/15 10:38	05/12/15 16:38	1

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# Client Sample Results

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

Client Sample ID: L10-14-05-B-E-S-00

Lab Sample ID: 160-11391-5

Date Collected: 04/14/15 16:45

Matrix: Solid

Date Received: 04/17/15 10:20

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.15		0.176	0.212		0.157	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Bismuth 212	1.04		0.440	0.453		0.417	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Bismuth 214	0.889		0.133	0.162		0.0988	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Lead 212	0.954		0.0903	0.153		0.0917	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Lead 214	0.909		0.106	0.142		0.0866	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Potassium 40	19.4		1.50	2.49		0.472	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Protactinium 231	0.348	U	0.211	0.214		1.34	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Radium 226	0.889		0.133	0.162	1.00	0.0988	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Thorium 232	1.15		0.176	0.212		0.157	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Thorium 234	0.891	U	0.337	0.349		0.954	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Uranium 235	0.141	U	0.187	0.187		0.289	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Americium 241	-0.0000512	U	0.0719	0.0719		0.122	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Protactinium 234m	2.59	U	2.83	2.84		7.57	pCi/g	04/21/15 10:38	05/12/15 16:40	1
Other Detected Radionuclides			Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tl-208	0.387		0.0616	0.0736		0.0450	pCi/g	04/21/15 10:38	05/12/15 16:40	1

Client Sample ID: L10-14-06-B-E-S-00

Lab Sample ID: 160-11391-6

Date Collected: 04/14/15 16:50

Matrix: Solid

Date Received: 04/17/15 10:20

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.23		0.134	0.182		0.132	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Bismuth 212	1.15		0.339	0.358		0.438	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Bismuth 214	1.08		0.110	0.157		0.0762	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Lead 212	1.12		0.0758	0.164		0.0745	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Lead 214	1.15		0.102	0.157		0.0769	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Potassium 40	23.6		1.20	2.66		0.243	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Protactinium 231	0.402	U	0.230	0.234		1.28	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Radium 226	1.08		0.110	0.157	1.00	0.0762	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Thorium 232	1.23		0.134	0.182		0.132	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Thorium 234	1.22		0.495	0.512		0.783	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Uranium 235	0.102	U	0.152	0.153		0.253	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Americium 241	0.0110	U	0.0657	0.0657		0.111	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Protactinium 234m	3.45	U	2.78	2.80		5.13	pCi/g	04/21/15 10:38	05/12/15 16:41	1
Other Detected Radionuclides			Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tl-208	0.421		0.0520	0.0676		0.0386	pCi/g	04/21/15 10:38	05/12/15 16:41	1

TestAmerica St. Louis

# Client Sample Results

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

Client Sample ID: L10-14-07-B-E-S-00

Lab Sample ID: 160-11391-7

Date Collected: 04/14/15 17:00

Matrix: Solid

Date Received: 04/17/15 10:20

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.32		0.139	0.192		0.0946	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Bismuth 212	1.74		0.429	0.465		0.362	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Bismuth 214	1.02		0.104	0.147		0.0734	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Lead 212	1.15		0.0697	0.164		0.0644	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Lead 214	1.04		0.0853	0.138		0.0702	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Potassium 40	21.9		1.10	2.46		0.274	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Protactinium 231	-0.724	U	0.713	0.718		1.17	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Radium 226	1.02		0.104	0.147	1.00	0.0734	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Thorium 232	1.32		0.139	0.192		0.0946	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Thorium 234	1.16		0.284	0.309		0.799	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Uranium 235	0.241		0.118	0.120		0.191	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Americium 241	0.0247	U	0.0438	0.0439		0.0661	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Protactinium 234m	0.673	U	2.68	2.68		4.64	pCi/g	04/21/15 10:38	05/12/15 20:40	1
<b>Other Detected Radionuclides</b>										
Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Pb-210	1.38		0.527	0.551		0.684	pCi/g	04/21/15 10:38	05/12/15 20:40	1
Tl-208	0.352		0.0469	0.0592		0.0363	pCi/g	04/21/15 10:38	05/12/15 20:40	1

Client Sample ID: L10-14-08-B-R-S-00

Lab Sample ID: 160-11391-8

Date Collected: 04/15/15 11:25

Matrix: Solid

Date Received: 04/17/15 10:20

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.05		0.132	0.170		0.141	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Bismuth 212	0.989		0.365	0.379		0.467	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Bismuth 214	1.16		0.138	0.184		0.0944	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Lead 212	1.14		0.0816	0.168		0.0601	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Lead 214	1.19		0.102	0.161		0.0868	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Potassium 40	18.6		1.34	2.33		0.401	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Protactinium 231	0.351	U	0.255	0.258		1.20	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Radium 226	1.16		0.138	0.184	1.00	0.0944	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Thorium 232	1.05		0.132	0.170		0.141	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Thorium 234	0.809	U	0.295	0.307		0.841	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Uranium 235	0.101	U	0.155	0.156		0.254	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Americium 241	-0.00124	U	0.0632	0.0632		0.107	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Protactinium 234m	2.49	U	3.34	3.35		5.52	pCi/g	04/21/15 10:38	05/12/15 21:20	1
<b>Other Detected Radionuclides</b>										
Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Pb-210	1.62		0.638	0.666		0.795	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Tl-208	0.335		0.0501	0.0610		0.0372	pCi/g	04/21/15 10:38	05/12/15 21:20	1

TestAmerica St. Louis

# Client Sample Results

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

Client Sample ID: L10-14-09-B-E-S-00

Lab Sample ID: 160-11391-9

Date Collected: 04/15/15 11:30

Matrix: Solid

Date Received: 04/17/15 10:20

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.12		0.189	0.221		0.134	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Bismuth 212	1.35		0.436	0.458		0.534	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Bismuth 214	1.02		0.131	0.168		0.0929	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Lead 212	0.932		0.104	0.159		0.100	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Lead 214	1.10		0.113	0.161		0.0837	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Potassium 40	16.4		1.30	2.12		0.329	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Protactinium 231	0.219	U	0.229	0.230		1.38	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Radium 226	1.02		0.131	0.168	1.00	0.0929	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Thorium 232	1.12		0.189	0.221		0.134	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Thorium 234	1.57		0.911	0.925		1.08	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Uranium 235	0.111	U	0.157	0.157		0.302	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Americium 241	0.0228	U	0.0708	0.0708		0.119	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Protactinium 234m	0.700	U	3.70	3.70		6.68	pCi/g	04/21/15 10:38	05/12/15 21:20	1
Other Detected			Count	Total						
Radionuclides			Uncert.	Uncert.						
TI-208	0.388		(2σ+/-)	(2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
						0.0396	pCi/g	04/21/15 10:38	05/12/15 21:20	1

Client Sample ID: L10-14-06-B-E-Q-00

Lab Sample ID: 160-11391-10

Date Collected: 04/14/15 16:50

Matrix: Solid

Date Received: 04/17/15 10:20

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.15		0.142	0.183		0.107	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Bismuth 212	1.57		0.456	0.484		0.402	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Bismuth 214	1.10		0.0999	0.151		0.0670	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Lead 212	1.10		0.0754	0.162		0.0751	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Lead 214	1.19		0.0951	0.156		0.0825	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Potassium 40	22.1		1.17	2.51		0.310	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Protactinium 231	0.530	U	0.250	0.256		1.23	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Radium 226	1.10		0.0999	0.151	1.00	0.0670	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Thorium 232	1.15		0.142	0.183		0.107	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Thorium 234	0.937		0.290	0.306		0.868	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Uranium 235	0.150	U	0.142	0.143		0.251	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Americium 241	0.0122	U	0.0616	0.0616		0.104	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Protactinium 234m	5.08		3.32	3.36		4.84	pCi/g	04/21/15 10:38	05/12/15 21:21	1
Other Detected			Count	Total						
Radionuclides			Uncert.	Uncert.						
TI-208	0.426		(2σ+/-)	(2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
						0.0369	pCi/g	04/21/15 10:38	05/12/15 21:21	1

TestAmerica St. Louis

# QC Sample Results

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Lab Sample ID: MB 160-187165/1-A

Matrix: Solid

Analysis Batch: 190513

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 187165

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	0.0008778	U	0.0120	0.0120		0.0379	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Bismuth 212	-0.07467	U	0.180	0.180		0.317	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Bismuth 214	-0.009559	U	0.112	0.112		0.0479	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Lead 212	-0.01437	U	0.102	0.102		0.0350	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Lead 214	0.01620	U	0.0200	0.0200		0.0325	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Potassium 40	-0.1016	U	4.06	4.06		0.276	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Protactinium 231	0.05235	U	0.163	0.163		0.377	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Radium 226	-0.009559	U	0.112	0.112	1.00	0.0479	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Thorium 232	0.0008778	U	0.0120	0.0120		0.0379	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Thorium 234	-0.006531	U	0.178	0.178		0.322	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Uranium 235	0.008410	U	0.0405	0.0405		0.0729	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Americium 241	0.003455	U	0.0138	0.0138		0.0246	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Protactinium 234m	0.2022	U	1.43	1.43		2.98	pCi/g	04/21/15 10:38	05/12/15 14:40	1
Other Detected Radionuclides	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Other Detected Radionuclide	None						pCi/g	04/21/15 10:38	05/12/15 14:40	1

Lab Sample ID: LCS 160-187165/2-A

Matrix: Solid

Analysis Batch: 190511

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 187165

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits
Americium 241	101	101.0		10.5		0.519	pCi/g	100	87 - 116
Cesium 137	34.8	34.59		3.62		0.184	pCi/g	99	87 - 120
Cobalt 60	35.6	35.00		3.53		0.0976	pCi/g	98	87 - 115

Lab Sample ID: 160-11391-1 DU

Matrix: Solid

Analysis Batch: 190513

Client Sample ID: L10-14-01-B-E-S-00

Prep Type: Total/NA

Prep Batch: 187165

Analyte	Sample Result	Sample Qual	DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	RER	RER Limit
Actinium 228	1.13		1.296		0.246		0.123	pCi/g	0.37	1
Bismuth 212	1.35		1.435		0.407		0.305	pCi/g	0.1	1
Bismuth 214	0.841		0.9278		0.153		0.0809	pCi/g	0.30	1
Lead 212	1.16		0.9905		0.153		0.0842	pCi/g	0.54	1
Lead 214	1.08		1.070		0.152		0.0837	pCi/g	0.03	1
Potassium 40	19.5		19.23		2.38		0.299	pCi/g	0.05	1
Protactinium 231	-0.575	U	0.4055	U	0.508		0.833	pCi/g	0.80	1
Radium 226	0.841		0.9278		0.153	1.00	0.0809	pCi/g	0.30	1
Thorium 232	1.13		1.296		0.246		0.123	pCi/g	0.37	1
Thorium 234	0.924		0.9103	U	0.343		0.961	pCi/g	0.02	1
Uranium 235	0.111	U	0.07142	U	0.153		0.277	pCi/g	0.13	1
Americium 241	-0.00138	U	0.01120	U	0.0718		0.121	pCi/g	0.09	1

TestAmerica St. Louis

# QC Sample Results

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

## Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS) (Continued)

Lab Sample ID: 160-11391-1 DU  
Matrix: Solid  
Analysis Batch: 190513

Client Sample ID: L10-14-01-B-E-S-00  
Prep Type: Total/NA  
Prep Batch: 187165

Analyte	Sample Result	Sample Qual	DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	RER	RER Limit
Protactinium 234m	2.27	U	4.056	U	4.05		6.63	pCi/g	0.25	1
<hr/>										
Other Detected Radionuclides	Sample Result	Sample Qual	DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	RER	RER Limit
Tl-208	0.365		0.3643		0.0696		0.0430	pCi/g	0.01	1



## QC Association Summary

Client: Perma-Fix Environmental Services Inc.  
Project/Site: HDP

TestAmerica Job ID: 160-11391-2

### Rad

#### Leach Batch: 186422

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-11391-1	L10-14-01-B-E-S-00	Total/NA	Solid	Dry and Grind	
160-11391-1 DU	L10-14-01-B-E-S-00	Total/NA	Solid	Dry and Grind	
160-11391-2	L10-14-02-B-E-S-00	Total/NA	Solid	Dry and Grind	
160-11391-3	L10-14-03-B-E-S-00	Total/NA	Solid	Dry and Grind	
160-11391-4	L10-14-04-B-E-S-00	Total/NA	Solid	Dry and Grind	
160-11391-5	L10-14-05-B-E-S-00	Total/NA	Solid	Dry and Grind	
160-11391-6	L10-14-06-B-E-S-00	Total/NA	Solid	Dry and Grind	
160-11391-7	L10-14-07-B-E-S-00	Total/NA	Solid	Dry and Grind	
160-11391-8	L10-14-08-B-R-S-00	Total/NA	Solid	Dry and Grind	
160-11391-9	L10-14-09-B-E-S-00	Total/NA	Solid	Dry and Grind	
160-11391-10	L10-14-06-B-E-Q-00	Total/NA	Solid	Dry and Grind	

#### Prep Batch: 187165

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-11391-1	L10-14-01-B-E-S-00	Total/NA	Solid	Fill_Geo-21	186422
160-11391-1 DU	L10-14-01-B-E-S-00	Total/NA	Solid	Fill_Geo-21	186422
160-11391-2	L10-14-02-B-E-S-00	Total/NA	Solid	Fill_Geo-21	186422
160-11391-3	L10-14-03-B-E-S-00	Total/NA	Solid	Fill_Geo-21	186422
160-11391-4	L10-14-04-B-E-S-00	Total/NA	Solid	Fill_Geo-21	186422
160-11391-5	L10-14-05-B-E-S-00	Total/NA	Solid	Fill_Geo-21	186422
160-11391-6	L10-14-06-B-E-S-00	Total/NA	Solid	Fill_Geo-21	186422
160-11391-7	L10-14-07-B-E-S-00	Total/NA	Solid	Fill_Geo-21	186422
160-11391-8	L10-14-08-B-R-S-00	Total/NA	Solid	Fill_Geo-21	186422
160-11391-9	L10-14-09-B-E-S-00	Total/NA	Solid	Fill_Geo-21	186422
160-11391-10	L10-14-06-B-E-Q-00	Total/NA	Solid	Fill_Geo-21	186422
LCS 160-187165/2-A	Lab Control Sample	Total/NA	Solid	Fill_Geo-21	
MB 160-187165/1-A	Method Blank	Total/NA	Solid	Fill_Geo-21	