

# 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: 160-11590-1

Client Project/Site: HDP

For:

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

Attn: Brian Miller

*Elizabeth M. Hoerchler*

Authorized for release by:

5/11/2015 2:57:56 PM

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*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: 160-11590-1

**Job ID: 160-11590-1**

**Laboratory: TestAmerica St. Louis**

## Narrative

### CASE NARRATIVE

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

**Project: HDP**

**Report Number: 160-11590-1**

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 04/30/2015; the samples arrived in good condition, properly preserved. The temperature of the coolers at receipt was 18.0° C.

### TECHNETIUM-99 (ICPMS)

Samples L10-14-10-B-E-B-00 (160-11590-1), L10-14-11-B-E-B-00 (160-11590-2), L10-14-12-B-E-B-00 (160-11590-3) and L10-03-14-B-E-I-01 (160-11590-4) were analyzed for Technetium-99 (ICPMS) in accordance with EPA SW-846 Method 6020A. The samples were prepared on 05/04/2015 and analyzed on 05/06/2015.

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

### TECHNETIUM-99 (ICPMS)

Samples L10-14-10-B-E-B-00 (160-11590-1), L10-14-11-B-E-B-00 (160-11590-2), L10-14-12-B-E-B-00 (160-11590-3) and L10-03-14-B-E-I-01 (160-11590-4) were analyzed for Technetium-99 (ICPMS) in accordance with EPA SW-846 Method 6020A. The samples were prepared on 05/04/2015 and analyzed on 05/06/2015.

## Case Narrative

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

TestAmerica Job ID: 160-11590-1

### Job ID: 160-11590-1 (Continued)

#### Laboratory: TestAmerica St. Louis (Continued)

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

#### **PERCENT SOLIDS**

Samples L10-14-10-B-E-B-00 (160-11590-1), L10-14-11-B-E-B-00 (160-11590-2), L10-14-12-B-E-B-00 (160-11590-3) and L10-03-14-B-E-I-01 (160-11590-4) were analyzed for percent solids in accordance with EPA Method 160.3 MOD. The samples were analyzed on 05/01/2015.

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

#### **CESIUM-137 & OTHER GAMMA EMITTERS (GS)**

Samples L10-14-10-B-E-B-00 (160-11590-1), L10-14-11-B-E-B-00 (160-11590-2), L10-14-12-B-E-B-00 (160-11590-3) and L10-03-14-B-E-I-01 (160-11590-4) were analyzed for Cesium-137 & Other Gamma Emitters (GS) in accordance with DOE GA-01-R. The samples were dried on 04/30/2015, and prepared and analyzed on 05/04/2015.

#### Prep Batch 189198

Radium-226 is reported in these samples at the client's request. Radium-226 is reported from the 609.31 keV line of bismuth-214. Because the samples have not had a 21-day ingrowth, the activity for radium-226 is an estimated value and may be biased low. This bias is caused by the disruption of secular equilibrium between radium-226 and bismuth-214 by the loss of radon-222 during sample preparation. L10-14-10-B-E-B-00 (160-11590-1), L10-14-11-B-E-B-00 (160-11590-2), L10-14-12-B-E-B-00 (160-11590-3), L10-03-14-B-E-I-01 (160-11590-4), (LCS 160-189198/2-A), (MB 160-189198/1-A) and (160-11590-A-1-D DU)

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

TestAmerica St. Louis  
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## Chain of Custody Record

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratories, Inc.

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☒ Other:

Client Contact		Project Manager: Brian Miller		Site Contact: Ellen Jakub		Date: 04/30/2015	
Perma-Fix Environmental Services		Tel/Fax: (314) 810-3333		Lab Contact: Ivan Vanya		Carrier: Courier	
2800 Solway Road		Analysis Turnaround Time		Perform MS / MSD (Y / N)		Gamma Spec	
Knoxville, TN 37931		<input checked="" type="checkbox"/> CALENDAR DAYS <input type="checkbox"/> WORKING DAYS		Westinghouse Hematite Library		Alpha Spec	
(865) 690-0501 Phone		TAT if different from Below		ICP/MS (Tc-99)		(With post-21 day ingrowth)	
(865) 539-9868 FAX		<input type="checkbox"/> 2 weeks		Gamma Spec			
Project Name: Hematite Decommissioning Project		<input checked="" type="checkbox"/> 1 week		Filtered Sample (Y / N)			
Site: Westinghouse Hematite, MO		<input type="checkbox"/> 2 days		# of Cont.			
P O # 832953		<input type="checkbox"/> 1 day		Sample Type (C=Comp, G=Grab)			
Sample Identification		Sample Date	Sample Time	Matrix			
L10-14-10-B-E-B-00	4/28/15	1114	G	Soil	1	N	X
L10-14-11-B-E-B-00	4/29/15	1020	G	Soil	1	N	X
L10-14-12-B-E-B-00	4/28/15	1119	G	Soil	1	N	X
Sample Specific Notes:		Matt Cushman					
		Jahmal Williams					
		Matt Cushman					

160-11590 Chain of Custody



Preservation Used: 1= Ice, 2= HCl, 3= H2SO4, 4= HNO3, 5= NaOH, 6= Other, None

Possible Hazard Identification:  
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Special Instructions/QC Requirements & Comments: Potential for Radiological Contamination

Custody Seals Intact: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Custody Seal No.:	Cooler Temp. (°C): Obs'd:	Corr'd:	Therm ID No.:
Relinquished by: <i>[Signature]</i>	Company: Permatix	Date/Time: 10:30	Received by: <i>[Signature]</i>	Company: Crossroads
Relinquished by: <i>[Signature]</i>	Company: Crossroads	Date/Time: 4/30/15	Received by: <i>[Signature]</i>	Company: Crossroads
Relinquished by: <i>[Signature]</i>	Company: Crossroads	Date/Time: 4/30/15	Received by: <i>[Signature]</i>	Company: Crossroads

Hematite Decommissioning Project | Permatix (for Westinghouse) Non-Proprietary Class 3 | Procedure: HDP-PR-QA-006, Chain of Custody | Revision: 3



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## Chain of Custody Record

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TestAmerica Laboratories, Inc.

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☒ Other:

Client Contact Perma-Fix Environmental Services 2800 Solway Road Knoxville, TN 37931 (865) 690-0501 (865) 539-9868 Project Name: Hematite Decommissioning Project Site: Westinghouse Hematite, MO P O # 832953		Project Manager: Brian Miller Tel/Fax: (314) 810-3333		Site Contact: Ellen Jakub Lab Contact: Ivan Vanya Carrier: Courier		Date: 04/16/2015 COC No: 041615-FSS1 1 of 1 COCs	
Analysis Turnaround Time <input checked="" type="checkbox"/> CALENDAR DAYS <input type="checkbox"/> WORKING DAYS TAT if different from Below <input type="checkbox"/> 2 weeks <input checked="" type="checkbox"/> 1 week <input type="checkbox"/> 2 days <input type="checkbox"/> 1 day		Sample Type (C=Comp, G=Grab)		Sample Time		# of Cont.	
Sample Identification L10-03-14-B-E-I-01 N/A		G		1634		1	
Sample Date		4/15/15		Soil		1	
Sample Matrix		G		Soil		1	
Sample Type		G		Soil		1	
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## Login Sample Receipt Checklist

Client: Perma-Fix Environmental Services Inc.

Job Number: 160-11590-1

Login Number: 11590

List Source: TestAmerica St. Louis

List Number: 1

Creator: Clarke, Jill C

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?	True	
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: 160-11590-1

### Qualifiers

#### Metals

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

#### 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: 160-11590-1

Method	Method Description	Protocol	Laboratory
6020A	Metals (ICP/MS), Tc-99	SW846	TAL SL
Moisture	Percent Moisture	EPA	TAL SL
6020A	Metals (ICP/MS), Tc-99 in Activity	SW846	TAL SL
GA-01-R	Cesium-137 & Other Gamma Emitters (GS)	DOE	TAL SL

### Protocol References:

DOE = U.S. Department of Energy

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

### 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: 160-11590-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
160-11590-1	L10-14-10-B-E-B-00	Solid	04/28/15 11:14	04/30/15 10:55
160-11590-2	L10-14-11-B-E-B-00	Solid	04/29/15 10:20	04/30/15 10:55
160-11590-3	L10-14-12-B-E-B-00	Solid	04/28/15 11:19	04/30/15 10:55
160-11590-4	L10-03-14-B-E-I-01	Solid	04/15/15 16:34	04/30/15 10:55

## Detection Summary

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

TestAmerica Job ID: 160-11590-1

**Client Sample ID: L10-14-10-B-E-B-00**

**Lab Sample ID: 160-11590-1**

No Detections.

**Client Sample ID: L10-14-11-B-E-B-00**

**Lab Sample ID: 160-11590-2**

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Technetium 99	0.000083		0.000077	0.000023	mg/Kg	1	☼	6020A	Total/NA

**Client Sample ID: L10-14-12-B-E-B-00**

**Lab Sample ID: 160-11590-3**

No Detections.

**Client Sample ID: L10-03-14-B-E-I-01**

**Lab Sample ID: 160-11590-4**

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Technetium 99	0.000039	J	0.000079	0.000024	mg/Kg	1	☼	6020A	Total/NA

This Detection Summary does not include radiochemical test results.

TestAmerica St. Louis

# Client Sample Results

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

TestAmerica Job ID: 160-11590-1

**Client Sample ID: L10-14-10-B-E-B-00**

**Lab Sample ID: 160-11590-1**

**Date Collected: 04/28/15 11:14**

**Matrix: Solid**

**Date Received: 04/30/15 10:55**

**Percent Solids: 78.5**

## Method: 6020A - Metals (ICP/MS), Tc-99

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Technetium 99	ND		0.000071	0.000021	mg/Kg	☆	05/04/15 09:16	05/06/15 17:24	1

## Method: 6020A - Metals (ICP/MS), Tc-99 in Activity

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Technetium 99	0.0114	U	0.0406	0.0406	1.42	0.243	pCi/g	05/04/15 09:16	05/06/15 17:24	1
Carrier	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Re	89		30 - 110					05/04/15 09:16	05/06/15 17:24	1

## Method: GA-01-R - Cesium-137 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.24		0.208	0.244		0.126	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Americium 241	-0.00515	U	1.80	1.80		0.118	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Bismuth 212	1.18		0.459	0.475		0.427	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Bismuth 214	0.894		0.111	0.145		0.0662	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Lead 212	0.942		0.0865	0.149		0.0889	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Lead 214	0.943		0.104	0.143		0.0810	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Potassium 40	19.7		1.44	2.47		0.434	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Protactinium 234m	-0.129	U	4.38	4.38		7.81	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Protactinium 231	0.336	U	0.205	0.208		1.36	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Radium 226	0.894		0.111	0.145		0.0662	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Thorium 234	1.06	U	0.747	0.755		1.22	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Uranium 235	1.38		0.218	0.260		0.263	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Thorium 232	1.24		0.208	0.244		0.126	pCi/g	05/04/15 12:17	05/04/15 18:00	1
Other Detected Radionuclides	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tl-208	0.331		0.0646	0.0732		0.0539	pCi/g	05/04/15 12:17	05/04/15 18:00	1

**Client Sample ID: L10-14-11-B-E-B-00**

**Lab Sample ID: 160-11590-2**

**Date Collected: 04/29/15 10:20**

**Matrix: Solid**

**Date Received: 04/30/15 10:55**

**Percent Solids: 72.8**

## Method: 6020A - Metals (ICP/MS), Tc-99

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Technetium 99	0.000083		0.000077	0.000023	mg/Kg	☆	05/04/15 09:16	05/06/15 17:27	1

## Method: 6020A - Metals (ICP/MS), Tc-99 in Activity

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Technetium 99	1.43		0.350	0.374	1.53	0.262	pCi/g	05/04/15 09:16	05/06/15 17:27	1
Carrier	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Re	89		30 - 110					05/04/15 09:16	05/06/15 17:27	1

TestAmerica St. Louis

# Client Sample Results

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

TestAmerica Job ID: 160-11590-1

Client Sample ID: L10-14-11-B-E-B-00

Lab Sample ID: 160-11590-2

Date Collected: 04/29/15 10:20

Matrix: Solid

Date Received: 04/30/15 10:55

## Method: GA-01-R - Cesium-137 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count	Total	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Actinium 228	1.28		0.163	0.208		0.109	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Americium 241	-0.0164	U	0.254	0.254		0.103	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Bismuth 212	1.37		0.428	0.450		0.381	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Bismuth 214	0.870		0.0966	0.132		0.0679	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Lead 212	1.09		0.0724	0.159		0.0679	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Lead 214	1.06		0.0904	0.143		0.0649	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Potassium 40	21.9		1.18	2.50		0.386	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Protactinium 234m	5.35		2.81	2.86		4.71	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Protactinium 231	0.341	U	0.213	0.216		1.13	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Radium 226	0.870		0.0966	0.132		0.0679	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Thorium 234	0.942		0.258	0.276		0.755	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Uranium 235	0.111	U	0.107	0.107		0.150	pCi/g	05/04/15 12:17	05/04/15 18:01	1
Thorium 232	1.28		0.163	0.208		0.109	pCi/g	05/04/15 12:17	05/04/15 18:01	1
<b>Other Detected</b>										
Radionuclides	Result	Qualifier	Count	Total	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Tl-208	0.402		0.0491	0.0641		0.0340	pCi/g	05/04/15 12:17	05/04/15 18:01	1

Client Sample ID: L10-14-12-B-E-B-00

Lab Sample ID: 160-11590-3

Date Collected: 04/28/15 11:19

Matrix: Solid

Date Received: 04/30/15 10:55

Percent Solids: 78.5

## Method: 6020A - Metals (ICP/MS), Tc-99

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Technetium 99	ND		0.000072	0.000022	mg/Kg	☼	05/04/15 09:16	05/06/15 17:31	1

## Method: 6020A - Metals (ICP/MS), Tc-99 in Activity

Analyte	Result	Qualifier	Count	Total	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Technetium 99	0.148	U	0.0392	0.0415	1.43	0.245	pCi/g	05/04/15 09:16	05/06/15 17:31	1
Carrier	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Re	89		30 - 110					05/04/15 09:16	05/06/15 17:31	1

## Method: GA-01-R - Cesium-137 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count	Total	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Actinium 228	1.20		0.128	0.177		0.113	pCi/g	05/04/15 12:17	05/04/15 18:02	1
Americium 241	-0.000872	U	0.0575	0.0575		0.0968	pCi/g	05/04/15 12:17	05/04/15 18:02	1
Bismuth 212	1.00		0.309	0.326		0.409	pCi/g	05/04/15 12:17	05/04/15 18:02	1
Bismuth 214	0.936		0.0900	0.132		0.0584	pCi/g	05/04/15 12:17	05/04/15 18:02	1
Lead 212	1.25		0.0700	0.176		0.0543	pCi/g	05/04/15 12:17	05/04/15 18:02	1
Lead 214	1.05		0.0783	0.134		0.0621	pCi/g	05/04/15 12:17	05/04/15 18:02	1
Potassium 40	17.4		1.01	2.05		0.310	pCi/g	05/04/15 12:17	05/04/15 18:02	1
Protactinium 234m	-0.377	U	15.1	15.1		4.37	pCi/g	05/04/15 12:17	05/04/15 18:02	1
Protactinium 231	-0.825	U	0.671	0.677		1.08	pCi/g	05/04/15 12:17	05/04/15 18:02	1

TestAmerica St. Louis

# Client Sample Results

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

TestAmerica Job ID: 160-11590-1

**Client Sample ID: L10-14-12-B-E-B-00**

**Lab Sample ID: 160-11590-3**

Date Collected: 04/28/15 11:19

Matrix: Solid

Date Received: 04/30/15 10:55

## Method: GA-01-R - Cesium-137 & Other Gamma Emitters (GS) (Continued)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium 226	0.936		0.0900	0.132		0.0584	pCi/g	05/04/15 12:17	05/04/15 18:02	1
Thorium 234	1.09		0.452	0.466		0.715	pCi/g	05/04/15 12:17	05/04/15 18:02	1
Uranium 235	0.173		0.114	0.115		0.158	pCi/g	05/04/15 12:17	05/04/15 18:02	1
Thorium 232	1.20		0.128	0.177		0.113	pCi/g	05/04/15 12:17	05/04/15 18:02	1
<b>Other Detected</b>										
Radionuclides	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tl-208	0.438		0.0526	0.0695		0.0374	pCi/g	05/04/15 12:17	05/04/15 18:02	1

**Client Sample ID: L10-03-14-B-E-I-01**

**Lab Sample ID: 160-11590-4**

Date Collected: 04/15/15 16:34

Matrix: Solid

Date Received: 04/30/15 10:55

Percent Solids: 72.6

## Method: 6020A - Metals (ICP/MS), Tc-99

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Technetium 99	0.000039	J	0.000079	0.000024	mg/Kg	☆	05/04/15 09:16	05/06/15 17:35	1

## Method: 6020A - Metals (ICP/MS), Tc-99 in Activity

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Technetium 99	0.675		0.0820	0.103	1.58	0.271	pCi/g	05/04/15 09:16	05/06/15 17:35	1
<b>Carrier</b>										
Re	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Re	87		30 - 110					05/04/15 09:16	05/06/15 17:35	1

## Method: GA-01-R - Cesium-137 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	1.10		0.126	0.169		0.107	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Americium 241	0.0542	U	0.0620	0.0622		0.102	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Bismuth 212	1.49		0.449	0.476		0.395	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Bismuth 214	0.892		0.115	0.147		0.0779	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Lead 212	1.09		0.0796	0.162		0.0666	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Lead 214	0.868		0.0982	0.133		0.0755	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Potassium 40	15.8		1.16	1.99		0.249	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Protactinium 234m	2.33	U	3.29	3.29		5.57	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Protactinium 231	0.466	U	0.222	0.228		1.30	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Radium 226	0.892		0.115	0.147		0.0779	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Thorium 234	1.70		0.542	0.570		0.824	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Uranium 235	0.344		0.135	0.139		0.200	pCi/g	05/04/15 12:17	05/04/15 18:34	1
Thorium 232	1.10		0.126	0.169		0.107	pCi/g	05/04/15 12:17	05/04/15 18:34	1
<b>Other Detected</b>										
Radionuclides	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tl-208	0.365		0.0499	0.0626		0.0373	pCi/g	05/04/15 12:17	05/04/15 18:34	1

TestAmerica St. Louis



# QC Sample Results

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

TestAmerica Job ID: 160-11590-1

## Method: 6020A - Metals (ICP/MS), Tc-99

Lab Sample ID: MB 160-189160/1-A

Matrix: Solid

Analysis Batch: 189950

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 189160

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Technetium 99	ND		0.000054	0.000016	mg/Kg		05/04/15 09:16	05/06/15 16:41	1

Lab Sample ID: LCS 160-189160/2-A

Matrix: Solid

Analysis Batch: 189950

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 189160

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Technetium 99	0.00123	0.00131		mg/Kg		106	80 - 120

Lab Sample ID: 160-11610-A-21-C MS

Matrix: Solid

Analysis Batch: 189950

Client Sample ID: Matrix Spike

Prep Type: Total/NA

Prep Batch: 189160

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Technetium 99	0.000040	J	0.00148	0.00158		mg/Kg	☼	103	75 - 125

Lab Sample ID: 160-11610-A-21-D MSD

Matrix: Solid

Analysis Batch: 189950

Client Sample ID: Matrix Spike Duplicate

Prep Type: Total/NA

Prep Batch: 189160

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Technetium 99	0.000040	J	0.00147	0.00163		mg/Kg	☼	108	75 - 125	3	30

## Method: 6020A - Metals (ICP/MS), Tc-99 in Activity

Lab Sample ID: MB 160-189160/1-A

Matrix: Solid

Analysis Batch: 189951

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 189160

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Technetium 99	-0.01185	U	0.0462	0.0462	1.08	0.185	pCi/g	05/04/15 09:16	05/06/15 16:41	1

Carrier	MB %Yield	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
Re	92		30 - 110	05/04/15 09:16	05/06/15 16:41	1

Lab Sample ID: LCS 160-189160/2-A

Matrix: Solid

Analysis Batch: 189951

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 189160

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits
Technetium 99	21.1	22.40		2.29	1.17	0.200	pCi/g	106	80 - 120

Carrier	LCS %Yield	LCS Qualifier	Limits
Re	86		30 - 110

TestAmerica St. Louis

# QC Sample Results

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

TestAmerica Job ID: 160-11590-1

## Method: 6020A - Metals (ICP/MS), Tc-99 in Activity (Continued)

Lab Sample ID: 160-11610-A-21-C MS

Matrix: Solid

Analysis Batch: 189951

Client Sample ID: Matrix Spike

Prep Type: Total/NA

Prep Batch: 189160

Analyte	Sample Result	Sample Qual	Spike Added	MS Result	MS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits
Technetium 99	0.692		25.4	26.97		2.81	1.31	0.224	pCi/g	103	75 - 125
Carrier	MS %Yield	MS Qualifier	Limits								
Re	92		30 - 110								

Lab Sample ID: 160-11610-A-21-D MSD

Matrix: Solid

Analysis Batch: 189951

Client Sample ID: Matrix Spike Duplicate

Prep Type: Total/NA

Prep Batch: 189160

Analyte	Sample Result	Sample Qual	Spike Added	MSD Result	MSD Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits	RER	RER Limit
Technetium 99	0.692		25.1	27.86		2.76	1.34	0.230	pCi/g	108	75 - 125	0.16	1
Carrier	MSD %Yield	MSD Qualifier	Limits										
Re	89		30 - 110										

## Method: GA-01-R - Cesium-137 & Other Gamma Emitters (GS)

Lab Sample ID: MB 160-189198/1-A

Matrix: Solid

Analysis Batch: 189168

Client Sample ID: Method Blank

Prep Type: Total/NA

Prep Batch: 189198

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	0.01539	U	0.0235	0.0236		0.0574	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Americium 241	0.0005264	U	0.0115	0.0115		0.0210	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Bismuth 212	0.005752	U	0.0791	0.0791		0.155	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Bismuth 214	-0.003242	U	0.0118	0.0118		0.0365	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Lead 212	-0.008969	U	0.0923	0.0923		0.0254	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Lead 214	-0.005565	U	0.0421	0.0421		0.0303	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Potassium 40	-0.03319	U	0.199	0.199		0.246	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Protactinium 234m	0.0000	U	0.241	0.241		0.888	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Protactinium 231	0.01448	U	0.0437	0.0438		0.316	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Radium 226	-0.003242	U	0.0118	0.0118		0.0365	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Thorium 234	-0.03303	U	0.169	0.169		0.223	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Uranium 235	0.002419	U	0.0106	0.0106		0.0573	pCi/g	05/04/15 12:17	05/04/15 17:57	1
Thorium 232	0.01539	U	0.0235	0.0236		0.0574	pCi/g	05/04/15 12:17	05/04/15 17:57	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	05/04/15 12:17	05/04/15 17:57	1

TestAmerica St. Louis

# QC Sample Results

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

TestAmerica Job ID: 160-11590-1

## Method: GA-01-R - Cesium-137 & Other Gamma Emitters (GS) (Continued)

Lab Sample ID: LCS 160-189198/2-A

Matrix: Solid

Analysis Batch: 189170

Client Sample ID: Lab Control Sample

Prep Type: Total/NA

Prep Batch: 189198

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits
Americium 241	101	102.9		10.7		0.530	pCi/g	102	87 - 116
Cesium 137	34.8	35.20		3.69	0.200	0.170	pCi/g	101	87 - 120
Cobalt 60	35.7	35.58		3.59		0.117	pCi/g	100	87 - 115

Lab Sample ID: 160-11590-1 DU

Matrix: Solid

Analysis Batch: 189173

Client Sample ID: L10-14-10-B-E-B-00

Prep Type: Total/NA

Prep Batch: 189198

Analyte	Sample Result	Sample Qual	DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	RER	RER Limit
Actinium 228	1.24		1.137		0.170		0.104	pCi/g	0.24	1
Americium 241	-0.00515	U	-0.01211	U	0.0621		0.104	pCi/g	0	1
Bismuth 212	1.18		1.376		0.447		0.385	pCi/g	0.21	1
Bismuth 214	0.894		0.8092		0.125		0.0624	pCi/g	0.31	1
Lead 212	0.942		1.083		0.158		0.0563	pCi/g	0.46	1
Lead 214	0.943		0.9114		0.127		0.0689	pCi/g	0.12	1
Potassium 40	19.7		18.67		2.22		0.294	pCi/g	0.21	1
Protactinium 234m	-0.129	U	-0.3013	U	5.64		5.17	pCi/g	0.02	1
Protactinium 231	0.336	U	0.3638	U	0.203		1.06	pCi/g	0.07	1
Radium 226	0.894		0.8092		0.125		0.0624	pCi/g	0.31	1
Thorium 234	1.06	U	0.9633		0.381		0.930	pCi/g	0.09	1
Uranium 235	1.38		1.489		0.259		0.215	pCi/g	0.20	1
Thorium 232	1.24		1.137		0.170		0.104	pCi/g	0.24	1
<b>Total</b>										
<b>Other Detected Radionuclides</b>	<b>Sample Result</b>	<b>Sample Qual</b>	<b>DU Result</b>	<b>DU Qual</b>	<b>Uncert. (2σ+/-)</b>	<b>RL</b>	<b>MDC</b>	<b>Unit</b>	<b>RER</b>	<b>RER Limit</b>
Tl-208	0.331		0.3392		0.0574		0.0341	pCi/g	0.06	1

TestAmerica St. Louis

# QC Association Summary

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

TestAmerica Job ID: 160-11590-1

## Metals

### Prep Batch: 189160

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-11590-1	L10-14-10-B-E-B-00	Total/NA	Solid	None	
160-11590-2	L10-14-11-B-E-B-00	Total/NA	Solid	None	
160-11590-3	L10-14-12-B-E-B-00	Total/NA	Solid	None	
160-11590-4	L10-03-14-B-E-I-01	Total/NA	Solid	None	
160-11610-A-21-C MS	Matrix Spike	Total/NA	Solid	None	
160-11610-A-21-D MSD	Matrix Spike Duplicate	Total/NA	Solid	None	
LCS 160-189160/2-A	Lab Control Sample	Total/NA	Solid	None	
MB 160-189160/1-A	Method Blank	Total/NA	Solid	None	

### Analysis Batch: 189950

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-11590-1	L10-14-10-B-E-B-00	Total/NA	Solid	6020A	189160
160-11590-2	L10-14-11-B-E-B-00	Total/NA	Solid	6020A	189160
160-11590-3	L10-14-12-B-E-B-00	Total/NA	Solid	6020A	189160
160-11590-4	L10-03-14-B-E-I-01	Total/NA	Solid	6020A	189160
160-11610-A-21-C MS	Matrix Spike	Total/NA	Solid	6020A	189160
160-11610-A-21-D MSD	Matrix Spike Duplicate	Total/NA	Solid	6020A	189160
LCS 160-189160/2-A	Lab Control Sample	Total/NA	Solid	6020A	189160
MB 160-189160/1-A	Method Blank	Total/NA	Solid	6020A	189160

## General Chemistry

### Analysis Batch: 188908

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-11589-A-1 DU	Duplicate	Total/NA	Solid	Moisture	
160-11590-1	L10-14-10-B-E-B-00	Total/NA	Solid	Moisture	
160-11590-2	L10-14-11-B-E-B-00	Total/NA	Solid	Moisture	
160-11590-3	L10-14-12-B-E-B-00	Total/NA	Solid	Moisture	
160-11590-4	L10-03-14-B-E-I-01	Total/NA	Solid	Moisture	

## Rad

### Leach Batch: 188779

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-11590-1	L10-14-10-B-E-B-00	Total/NA	Solid	Dry and Grind	
160-11590-1 DU	L10-14-10-B-E-B-00	Total/NA	Solid	Dry and Grind	
160-11590-2	L10-14-11-B-E-B-00	Total/NA	Solid	Dry and Grind	
160-11590-3	L10-14-12-B-E-B-00	Total/NA	Solid	Dry and Grind	
160-11590-4	L10-03-14-B-E-I-01	Total/NA	Solid	Dry and Grind	

### Prep Batch: 189160

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-11590-1	L10-14-10-B-E-B-00	Total/NA	Solid	None	
160-11590-2	L10-14-11-B-E-B-00	Total/NA	Solid	None	
160-11590-3	L10-14-12-B-E-B-00	Total/NA	Solid	None	
160-11590-4	L10-03-14-B-E-I-01	Total/NA	Solid	None	
160-11610-A-21-C MS	Matrix Spike	Total/NA	Solid	None	
160-11610-A-21-D MSD	Matrix Spike Duplicate	Total/NA	Solid	None	
LCS 160-189160/2-A	Lab Control Sample	Total/NA	Solid	None	
MB 160-189160/1-A	Method Blank	Total/NA	Solid	None	

TestAmerica St. Louis

## QC Association Summary

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

TestAmerica Job ID: 160-11590-1

### Rad (Continued)

#### Prep Batch: 189198

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-11590-1	L10-14-10-B-E-B-00	Total/NA	Solid	Fill_Geo-0	188779
160-11590-1 DU	L10-14-10-B-E-B-00	Total/NA	Solid	Fill_Geo-0	188779
160-11590-2	L10-14-11-B-E-B-00	Total/NA	Solid	Fill_Geo-0	188779
160-11590-3	L10-14-12-B-E-B-00	Total/NA	Solid	Fill_Geo-0	188779
160-11590-4	L10-03-14-B-E-I-01	Total/NA	Solid	Fill_Geo-0	188779
LCS 160-189198/2-A	Lab Control Sample	Total/NA	Solid	Fill_Geo-0	
MB 160-189198/1-A	Method Blank	Total/NA	Solid	Fill_Geo-0	

## Tracer/Carrier Summary

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

TestAmerica Job ID: 160-11590-1

### Method: 6020A - Metals (ICP/MS), Tc-99 in Activity

Matrix: Solid

Prep Type: Total/NA

		Percent Yield (Acceptance Limits)	
Lab Sample ID	Client Sample ID	Re (30-110)	
160-11590-1	L10-14-10-B-E-B-00	89	
160-11590-2	L10-14-11-B-E-B-00	89	
160-11590-3	L10-14-12-B-E-B-00	89	
160-11590-4	L10-03-14-B-E-I-01	87	
160-11610-A-21-C MS	Matrix Spike	92	
160-11610-A-21-D MSD	Matrix Spike Duplicate	89	
LCS 160-189160/2-A	Lab Control Sample	86	
MB 160-189160/1-A	Method Blank	92	
<b>Tracer/Carrier Legend</b>			
Re = Re			