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: 160-14949-2
Client Project/Site: HDP

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

Attn: Brian Miller

Authorized for release by:
12/17/2015 11:29:20 PM

Ivan Vania, Project Manager II
(314)298-8566
ivan.vania@testamericainc.com

LINKS

Review your project results through TotalAccess

Have a Question? Ask The Expert

Visit us at: www.testamericainc.com

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.

Table of Contents

Cover Page 1
Table of Contents 2
Case Narrative 3
Chain of Custody 4
Receipt Checklists 5
Definitions/Glossary 6
Method Summary 7
Sample Summary 8
Client Sample Results 9
QC Sample Results 10
QC Association Summary 12

Job ID: 160-14949-2

Laboratory: TestAmerica St. Louis

Narrative

CASE NARRATIVE

Client: Perma-Fix Environmental Services Inc.

Project: HDP

Report Number: 160-14949-2

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 11/19/2015 11:05 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 19.4º C.

RADIUM-226 BY GAMMA SPEC (21 DAY INGROWTH)

Samples L08-11-36-T-E-B-00 (160-14949-1) and L08-11-37-T-E-B-00 (160-14949-2) were analyzed for Radium-226 by gamma spec (21 day ingrowth) in accordance with EPA GA_01_R. The samples were leached on 11/20/2015, prepared on 11/25/2015 and analyzed on 12/16/2015.

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

TestAmerica St. Louis
13715 Rider Trail North

Earth City, MO 63045
phone 314.298.8566 fax

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: 11/19/2015	COC No: 111915-FSS1
Perma-Fix Environmental Services	Tel/Fax: (314) 810-3333	Lab Contact: Ivan Vania	Carrier: Courier	___1___ of ___1___ COCs
2800 Solway Road	Analysis Turnaround Time			Sampler:
Knoxville, TN 37931	☑ CALENDAR DAYS ☐ WORKING DAYS			For Lab Use Only:
(865) 690-0501 Phone	TAT if different from Below _____			Walk-in Client:
(865) 539-9868 FAX	☐ 2 weeks			Lab Sampling:
Project Name: Hematite Decommissioning Project	☑ 1 week			
Site: Westinghouse Hematite, MO	☐ 2 days			Job / SDG No.:
P O # 832953	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)	Gamma Spec Westinghouse Hematite Library	Alpha Spec	ICP/MS (Tc-99)	Gamma Spec (With post-21 day ingrowth)	Sample Specific Notes:
L08-11-36-T-E-B-00	11/15/15	1350	G	Soil	1	N		X		X	X	Matt Cushman
L08-11-37-T-E-B-00	11/15/15	1355	G	Soil	1	N		X		X	X	Matt Cushman
								A				
					N							

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

Sample Disposal (A fee may be assessed if samples are retained longer than 1 mont

☑ Return to Client ☐ Disposal by Lab ☐ Archive for_____ Months

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

Custody Seals Intact: ☑ Yes ☐ No | Custody Seal No.: | Cooler Temp. (°C): Obs'd:_____ Corr'd:_____ Therm ID No.:_____

	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by: Ellen C. Jakub	Perma-Fix	11/19/15 0930		Cross Roads	11/19/15 0930
Relinquished by: 815	Company: Cross Roads	Date/Time: 11/19/15 1105	Received by: Cross Roads	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time: 11-19-15 1105

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

160-14949 Chain of Custody

Login Sample Receipt Checklist

Client: Perma-Fix Environmental Services Inc.

Job Number: 160-14949-2

Login Number: 14949
List Number: 1
Creator: Clarke, Jill C

List Source: TestAmerica St. Louis

Question	Answer	Comment
Radioactivity wasn't checked or is </= 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 <6mm (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: 160-14949-2

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.
¤	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: 160-14949-2

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: 160-14949-2

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
160-14949-1	L08-11-36-T-E-B-00	Solid	11/15/15 13:50	11/19/15 11:05
160-14949-2	L08-11-37-T-E-B-00	Solid	11/15/15 13:55	11/19/15 11:05

Client Sample ID: L08-11-36-T-E-B-00

Lab Sample ID: 160-14949-1
Matrix: Solid
Date Collected: 11/15/15 13:50
Date Received: 11/19/15 11:05

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	**1.21**		0.149	0.193		0.127	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Bismuth 212	**1.70**		0.561	0.588		0.504	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Bismuth 214	**1.11**		0.123	0.169		0.0808	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Lead 212	**1.12**		0.0978	0.175		0.0851	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Lead 214	**1.23**		0.104	0.165		0.0878	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Potassium 40	**20.3**		1.41	2.51		0.282	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Protactinium 231	-0.315	U	0.774	0.775		1.31	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Radium 226	**1.11**		0.123	0.169	1.00	0.0808	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Thorium 232	**1.21**		0.149	0.193		0.127	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Thorium 234	**1.41**		0.368	0.397		0.959	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Uranium 235	0.252	U	0.160	0.162		0.284	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Americium 241	-0.00773	U	0.0703	0.0703		0.119	pCi/g	11/25/15 11:00	12/16/15 12:45	1
Protactinium 234m	2.25	U	4.06	4.06		6.87	pCi/g	11/25/15 11:00	12/16/15 12:45	1

Other Detected Radionuclides	*Result*	*Qualifier*	*Count Uncert. (2σ+/-)*	*Total Uncert. (2σ+/-)*	*RL*	*MDC*	*Unit*	*Prepared*	*Analyzed*	*Dil Fac*
Tl-208	*0.441*		*0.0614*	*0.0766*		*0.0439*	*pCi/g*	*11/25/15 11:00*	*12/16/15 12:45*	*1*

Client Sample ID: L08-11-37-T-E-B-00

Lab Sample ID: 160-14949-2
Matrix: Solid
Date Collected: 11/15/15 13:55
Date Received: 11/19/15 11:05

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	**0.958**		0.150	0.179		0.151	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Bismuth 212	**1.86**		0.405	0.448		0.292	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Bismuth 214	**1.26**		0.109	0.170		0.0634	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Lead 212	**1.04**		0.0957	0.166		0.0851	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Lead 214	**1.30**		0.102	0.169		0.0772	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Potassium 40	**23.1**		1.27	2.65		0.367	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Protactinium 231	0.558	U	0.264	0.271		1.36	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Radium 226	**1.26**		0.109	0.170	1.00	0.0634	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Thorium 232	**0.958**		0.150	0.179		0.151	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Thorium 234	**8.09**		0.822	1.18		1.08	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Uranium 235	**2.05**		0.267	0.339		0.270	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Americium 241	0.0143	U	0.0832	0.0832		0.140	pCi/g	11/25/15 11:00	12/16/15 12:46	1
Protactinium 234m	**15.2**		5.55	5.75		4.71	pCi/g	11/25/15 11:00	12/16/15 12:46	1

Other Detected Radionuclides	*Result*	*Qualifier*	*Count Uncert. (2σ+/-)*	*Total Uncert. (2σ+/-)*	*RL*	*MDC*	*Unit*	*Prepared*	*Analyzed*	*Dil Fac*
Tl-208	*0.345*		*0.0484*	*0.0600*		*0.0386*	*pCi/g*	*11/25/15 11:00*	*12/16/15 12:46*	*1*

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

Lab Sample ID: MB 160-224351/1-A
Matrix: Solid
Analysis Batch: 227707

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 224351

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Actinium 228	0.0008526	U	0.00855	0.00855		0.0255	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Bismuth 212	-0.03090	U	0.735	0.735		0.204	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Bismuth 214	-0.004247	U	0.0396	0.0396		0.0384	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Lead 212	-0.007558	U	0.327	0.327		0.0233	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Lead 214	-0.002508	U	0.0274	0.0274		0.0328	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Potassium 40	-0.07094	U	2.84	2.84		0.187	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Protactinium 231	0.04837	U	0.172	0.172		0.308	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Radium 226	-0.004247	U	0.0396	0.0396	1.00	0.0384	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Thorium 232	0.0008526	U	0.00855	0.00855		0.0255	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Thorium 234	0.03938	U	0.134	0.134		0.272	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Uranium 235	0.01522	U	0.0334	0.0334		0.0657	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Americium 241	0.008656	U	0.0123	0.0124		0.0206	pCi/g	11/25/15 11:00	12/16/15 10:10	1
Protactinium 234m	0.5086	U	1.02	1.02		1.80	pCi/g	11/25/15 11:00	12/16/15 10:10	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*	*11/25/15 11:00*	*12/16/15 10:10*	*1*

Lab Sample ID: LCS 160-224351/2-A
Matrix: Solid
Analysis Batch: 227701

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 224351

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits
Americium 241	101	102.3		10.7		0.576	pCi/g	102	87 - 116
Cesium 137	34.3	33.25		3.49		0.204	pCi/g	97	87 - 120
Cobalt 60	33.0	31.88		3.23		0.128	pCi/g	97	87 - 115

Lab Sample ID: 160-15023-A-1-F DU
Matrix: Solid
Analysis Batch: 227708

Client Sample ID: Duplicate
Prep Type: Total/NA
Prep Batch: 224351

Analyte	Sample Result	Sample Qual	DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	RER	RER Limit
Actinium 228	0.913		0.8947		0.139		0.102	pCi/g	0.06	1
Bismuth 212	0.959		0.9814		0.346		0.319	pCi/g	0.03	1
Bismuth 214	0.791		0.8144		0.131		0.0715	pCi/g	0.09	1
Lead 212	0.954		0.8726		0.133		0.0564	pCi/g	0.30	1
Lead 214	0.935		0.8739		0.128		0.0680	pCi/g	0.24	1
Potassium 40	17.6		16.15		1.99		0.302	pCi/g	0.37	1
Protactinium 231	0.321	U	0.6574	U	0.319		1.09	pCi/g	0.66	1
Radium 226	0.791		0.8144		0.131	1.00	0.0715	pCi/g	0.09	1
Thorium 232	0.913		0.8947		0.139		0.102	pCi/g	0.06	1
Thorium 234	2.21		1.591		0.341		0.806	pCi/g	0.69	1
Uranium 235	0.467		0.3776		0.146		0.185	pCi/g	0.33	1
Americium 241	0.00307	U	-0.01519	U	0.0577		0.0967	pCi/g	0.16	1

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

TestAmerica Job ID: 160-14949-2

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

Lab Sample ID: 160-15023-A-1-F DU
Matrix: Solid
Analysis Batch: 227708

Client Sample ID: Duplicate
Prep Type: Total/NA
Prep Batch: 224351

Analyte	Sample Result	Sample Qual		DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit			RER	RER Limit
Protactinium 234m	1.74	U		1.625	U	3.25		5.51	pCi/g			0.02	1
Other Detected Radionuclides	***Sample Result***	***Sample Qual***		***DU Result***	***DU Qual***	***Total Uncert. (2σ+/-)***	***RL***	***MDC***	***Unit***			***RER***	***RER Limit***
Tl-208	*0.286*			*0.2893*		*0.0559*		*0.0372*	*pCi/g*			*0.03*	*1*

QC Association Summary

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

TestAmerica Job ID: 160-14949-2

Rad

Leach Batch: 222892

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-14949-1	L08-11-36-T-E-B-00	Total/NA	Solid	Dry and Grind	
160-14949-2	L08-11-37-T-E-B-00	Total/NA	Solid	Dry and Grind	

Leach Batch: 223424

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-15023-A-1-F DU	Duplicate	Total/NA	Solid	Dry and Grind	

Prep Batch: 224351

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-14949-1	L08-11-36-T-E-B-00	Total/NA	Solid	Fill_Geo-21	222892
160-14949-2	L08-11-37-T-E-B-00	Total/NA	Solid	Fill_Geo-21	222892
160-15023-A-1-F DU	Duplicate	Total/NA	Solid	Fill_Geo-21	223424
LCS 160-224351/2-A	Lab Control Sample	Total/NA	Solid	Fill_Geo-21	
MB 160-224351/1-A	Method Blank	Total/NA	Solid	Fill_Geo-21	