

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
		Revision: 10	Appendix P-4 Page 1 of 1

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area:	LSA 10	Description:	Burial Pits Open Land Area
Survey Unit:	07	Description:	South Eastern Survey Unit in "Area 9"
Survey Type:	FSS	Classification:	Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L100702BES00	Uniform	S	426.6	426.1	864940.5	827742.0	Excavation 6-inch grab
L100703BSS00	Uniform	S	432.3	431.9	864926.6	827783.7	Surface 6-inch grab
L100704BRS00	Uniform	S	431.9	427.4	864926.6	827783.7	Root Zone Composite
L100705BES00	Uniform	S	423.2	422.7	864969.7	827774.9	Excavation 6-inch grab
L100706BRS00	Uniform	S	429.4	426.4	864955.8	827816.7	Root Zone Composite
L100707BES00	Uniform	S	426.4	425.9	864955.8	827816.7	Excavation 6-inch grab
L100708BES00	Uniform	S	424.6	424.1	864998.9	827807.9	Excavation 6-inch grab
L100709BRS00	Uniform	S	426.3	425.3	864985.0	827849.6	Root Zone Composite
L100710BES00	Uniform	S	425.3	424.8	864985.0	827849.6	Excavation 6-inch grab
L100711BRS00	Uniform	S	425.2	423.3	865028.1	827840.8	Root Zone Composite
L100712BES00	Uniform	S	423.3	422.8	865028.1	827840.8	Excavation 6-inch grab
L100713BRS00	Uniform	S	424.3	422.1	865014.1	827882.5	Root Zone Composite
L100714BES00	Uniform	S	422.1	421.6	865014.1	827882.5	Excavation 6-inch grab
L100704BRQ00	Uniform	Q	431.9	427.4	864926.6	827783.7	Root Zone Composite
L100701BUB00	Uniform	B	422.0	421.5	864980.1	827783.2	Biased 6-inch grab
L100715BUB00	Uniform	B	421.5	421.0	864980.1	827783.2	Biased 6-inch grab
L100716BUB00	Uniform	B	422.0	421.5	864940.0	827740.3	Biased 6-inch grab
L100701BUI01	Uniform	I	422.0	421.5	864976.6	827785.0	Investigation 6-inch grab
L100701BUI02	Uniform	I	422.0	421.5	864976.6	827788.9	Investigation 6-inch grab
L100701BUI03	Uniform	I	422.0	421.5	864972.9	827787.9	Investigation 6-inch grab
L100701BUI04	Uniform	I	422.0	421.5	864975.0	827783.9	Investigation 6-inch grab

Green shaded samples are the samples at each sample location, for use in WRS test.

*Elevations are in feet above mean sea level.

** Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area) OR

Distance in feet from lower left corner of the surface (Structures); each surface has it's own (X,Y) = (0,0); OR

For piping the distance from the beginning of the survey unit.

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Deep) or Uniform

Type: Systematic = S, Biased = B; QC = Q; Investigation = I

Quality Record

HDP-PR-FSS-721 Final Status Survey Data Evaluation
Steps 8.3 Preliminary Data Review and 8.4 Calculation of the Sum-of-Fractions (SOF)

Sample ID	Sample Depth (R)	Type (S/S/S/S/B/B/C/C)	TestAmerica Analytical Results Step 6.3.2																												
			Ra-226				Th-99				Th-232				Inferred U-234				U-235				U-238								
			Result	Uncertainty	DOC	Qualifier	Result	Uncertainty	DOC	Qualifier	Result	Uncertainty	DOC	Qualifier	Result	Uncertainty	DOC	Qualifier	Result	Uncertainty	DOC	Qualifier	Result	Uncertainty	DOC	Qualifier					
L100702BS00	5.37	S	1.15	0.175	0.083	NA	0.060	0.000	-0.0215	0.000	0.007	0.234	U	1.09	0.198	0.187	NA	0.090	0.000	3.781	NA	NA	NA	0.12	0.15	0.252	U	1.64	0.710	0.862	
L100703BS00	0.97	S	1.08	0.151	0.043	NA	0.010	0.010	-0.193	0.193	0.193	0.112	0.232	U	1.09	0.16	0.0831	NA	0.090	0.090	3.781	NA	NA	NA	0.204	0.148	0.184	U	1.56	0.852	0.833
L100704BS00	0.50	S	1.05	0.143	0.0694	NA	-0.020	0.000	-0.0098	0.000	0.0104	0.214	U	1.11	0.167	0.117	NA	0.110	0.110	3.887	NA	NA	NA	0.22	0.154	0.198	U	0.907	0.317	0.778	
L100705BS00	0.50	S	0.982	0.14	0.051	NA	-0.088	0.000	-0.0315	0.000	0.0007	0.245	U	0.975	0.18	0.13	NA	-0.025	0.000	8.888	NA	NA	NA	0.495	0.148	0.217	U	2.03	0.813	0.338	
L100706BS00	7.51	S	1.31	0.192	0.0891	NA	0.240	0.240	0.0963	0.098	0.0622	0.218	U	1.26	0.207	0.0758	NA	0.260	0.260	2.464	NA	NA	NA	0.134	0.14	0.219	U	0.917	0.367	0.96	
L100707BS00	2.02	S	1.53	0.227	0.121	NA	0.480	0.480	0.0388	0.040	0.0293	0.222	U	1.36	0.301	0.209	NA	0.360	0.360	2.679	NA	NA	NA	0.146	0.21	0.372	U	0.933	0.413	1.05	
L100708BS00	4.00	S	1.01	0.151	0.094	NA	-0.050	0.000	-0.0348	0.000	0.0582	0.232	U	1.14	0.198	0.0793	NA	0.140	0.140	2.450	NA	NA	NA	0.125	0.169	0.278	U	1.88	0.968	1.01	
L100709BS00	5.12	S	1.2	0.167	0.0603	NA	0.130	0.130	0.0168	0.000	0.0691	0.224	U	1.34	0.196	0.0817	NA	0.340	0.340	0.208	NA	NA	NA	0.004	0.032	0.295	U	0.958	0.39	0.971	
L100710BS00	4.04	S	1.28	0.185	0.069	NA	0.210	0.210	0.0149	0.000	0.0748	0.23	U	1.17	0.179	0.101	NA	0.170	0.170	1.701	NA	NA	NA	0.089	0.097	0.262	U	1.06	0.549	1.04	
L100711BS00	5.00	S	1.07	0.199	0.0682	NA	0.000	0.000	-0.0293	0.000	0.0503	0.222	U	1.07	0.193	0.111	NA	0.070	0.070	2.286	NA	NA	NA	0.125	0.132	0.212	U	0.744	0.321	0.801	
L100712BS00	3.11	S	1.13	0.156	0.0711	NA	0.050	0.050	-0.0002	0.000	0.117	0.224	U	1.16	0.197	0.128	NA	0.160	0.160	2.659	NA	NA	NA	0.144	0.155	0.268	U	1.15	0.627	0.874	
L100713BS00	5.00	S	1.19	0.191	0.069	NA	0.120	0.120	0.0074	0.000	0.0755	0.23	U	1.15	0.197	0.128	NA	0.160	0.160	2.651	NA	NA	NA	0.139	0.157	0.246	U	1.04	0.563	0.907	
L100714BS00	2.88	S	1.13	0.159	0.0595	NA	0.050	0.060	0.0213	0.021	0.0103	0.23	U	1.14	0.172	0.0954	NA	0.140	0.140	2.556	NA	NA	NA	0.137	0.147	0.261	U	1.41	0.598	0.879	
L100704MR00	5.00	Q	1.16	0.178	0.0794	NA	0.090	0.090	0.008	0.000	0.0388	0.213	U	1.08	0.195	0.169	NA	0.080	0.080	1.390	NA	NA	NA	0.073	0.166	0.234	U	0.808	0.368	1.26	
L100701BL00	5.00	B	1.38	0.195	0.089	NA	0.310	0.310	0.028	0.000	0.0381	0.221	U	1.19	0.201	0.0951	NA	0.190	0.190	833.987	NA	NA	NA	3.17	0.17	0.568	U	3.27	1.14	1.87	
L100715BL00	5.50	B	1.21	0.167	0.044	NA	0.140	0.140	0.0018	0.002	0.013	0.223	U	1.15	0.198	0.098	NA	0.150	0.150	38.339	NA	NA	NA	1.87	0.281	0.232	U	0.971	0.414	0.885	
L100716BL00	5.00	B	1.16	0.156	0.0509	NA	0.060	0.060	0.013	0.013	0.0272	0.228	U	1.14	0.17	0.132	NA	0.140	0.140	2.995	NA	NA	NA	0.164	0.139	0.201	U	0.949	0.663	0.883	
L100701BL01	5.00	I	1.26	0.176	0.069	NA	0.190	0.190	0	0.000	0	0.226	U	1.18	0.187	0.0566	NA	0.180	0.180	3.898	NA	NA	NA	0.214	0.158	0.213	U	1.13	0.36	0.895	
L100701BL02	5.00	I	1.08	0.161	0.057	NA	0.010	0.000	0.0184	0.018	0.0628	0.23	U	1	0.167	0.168	NA	0.000	0.000	2.537	NA	NA	NA	0.132	0.129	0.213	U	1.62	0.783	0.841	
L100701BL03	5.00	I	1.13	0.154	0.0649	NA	0.080	0.080	0.0317	0.032	0.0581	0.231	U	1.12	0.17	0.105	NA	0.120	0.120	1.523	NA	NA	NA	0.076	0.146	0.229	U	1.36	0.834	0.821	
L100701BL04	5.00	I	1.21	0.181	0.0784	NA	0.140	0.140	0.0088	0.009	0.0219	0.228	U	1.17	0.202	0.121	NA	0.170	0.170	1.307	NA	NA	NA	0.056	0.174	0.269	U	1.82	0.804	1	
Systematic Maximum			0.000				0.000				0.000				2.028				0.004				0.144								
Systematic Minimum			0.460				0.193				0.360				8.988				0.496				2.030								
Systematic Mean			0.105				0.027				0.160				2.683				0.160				1.295								
Systematic Median			0.080				0.000				0.140				2.598				0.130				1.150								
Systematic Standard Deviation			0.134				0.057				0.104				2.020				0.113				0.420								
Step 6.3.3																															
Step 6.4.2																															
NOTES:			With Inproth, use Ra226 flag = 1.07 Th232 flag = 1.0																												
Gross results in units of pCi/g																															
* Background with inproth, 107 pCi/g subtracted from gross result.																															
*Background, 1.0 pCi/g subtracted from gross result.																															
U Qualifier: Result is less than the sample detection limit.																															
All uncertainty values are reported at the 2-sigma confidence level.																															
Ave Conc. Ra-226, SS			0.010				0.193				0.090				3.781				0.204				1.560								
Ave Conc. Ra-226, RS			0.010				0.193				0.090				3.781				0.204				1.560								
Ave Conc. Th-99, SS			0.000				0.000				0.110				3.987				0.220				0.907								
Ave Conc. Th-99, RS			0.000				0.000				0.110				3.988				0.496				2.030								
Ave Conc. Th-232, SS			0.460				0.040				0.360				2.679				0.146				0.933								
Ave Conc. Th-232, RS			0.460				0.040				0.360				2.679				0.146				0.933								
Ave Conc. U-234, SS			0.210				0.170				1.701				0.089				1.060												
Ave Conc. U-234, RS			0.060				0.160				2.669				0.144				1.150												
Ave Conc. U-235, SS			0.060				0.021				0.140				2.596				0.137				1.410								
Ave Conc. U-235, RS			0.060				0.021				0.140				2.596				0.137				1.410								
Ave Conc. U-238, SS			0.132				0.010				0.157				3.770				0.205				1.248								
Ave Conc. Ra-226, ES			0.08				0				0.09				2.327				0.12				1.64								
Ave Conc. Th-99, ES			0.0983				0.26				2.4638				0.134				0.917												
Ave Conc. Th-232, ES			0				0.14				0.245				0.125				1.88												
Ave Conc. U-234, ES			0.13				0.34				0.208				0.0045				0.958												
Ave Conc. U-235, ES			0				0.07				2.2857				0.125				0.744												
Ave Conc. U-238, ES			0.12				0.15				2.6509				0.139				1.64												
0.095			0.016				0.175				2.064				0.108				1.297												

HDP-PR-FSS-721 Final Status Survey Data Evaluation
Steps 8.3 Preliminary Data Review and 8.4 Calculation of the Sum-of-Fractions (SOF)

Sample ID	Sample Depth (ft)	Type (B=Backfill, C=Concrete, S=Soil)	Enrichment (%)	SOF _u Step 8.4.3	Step 8.4.3	Root Stratum SOF Verification (enrichment backfill only) Step 8.4.4a.1	In Sample In Root Enrichment	In SOF _u Sample SOF _u A	Root count	enrichment count	enrichment count	
L100702BES00	5.37	S	1.2	0.11	EXCAVATION	good			1			
L100703BES00	0.07	S	2.0	0.09	SURFACE	good				1		
L100704BRS00	0.50	S	3.7	0.09	ROOT	good	1					
L100705BES00	0.50	S	3.7	0.07	ROOT	good	1					
L100706BRS00	1.51	S	2.3	0.29	EXCAVATION	good		1				
L100707BES00	2.02	S	2.4	0.45	ROOT	good	1					
L100708BES00	5.00	S	1.1	0.10	EXCAVATION	good		1				
L100709BRS00	5.12	S	0.1	0.25	EXCAVATION	good		1				
L100709BES00	4.04	S	1.3	0.21	ROOT	good	1					
L100710BRS00	5.00	S	2.6	0.80	EXCAVATION	good		1				
L100712BES00	3.11	S	2.0	0.13	ROOT	good	1					
L100713BRS00	5.00	S	1.4	0.16	EXCAVATION	good		1				
L100714BES00	2.82	S	1.5	0.13	ROOT	good	1					
L100704BRD00	5.00	D	1.4	0.10		good						
L100701BLUB00	5.00	B	59.9	5.16		good						
L100715BLUB00	5.50	B	23.1	0.99		good						
L100716BLUB00	5.00	B	2.7	0.14		good						
L100701BLU01	5.00	I	2.9	0.22		good						
L100701BLU02	5.00	I	1.3	0.03		good						
L100701BLU03	5.00	I	0.6	0.11		good						
L100701BLU04	5.00	I	0.5	0.18		good						
Σ						0.05			13	6	6	1
Average Enrichment (%)	Σ				0.05							
	Σ				0.18							
	Σ				0.13							
	Σ				0.11							

Use corrected net results for all DE calcs 721 Sec. 8.4.2

MDC SOF Step 8.4.4
0.19
0.11
0.13
0.15
0.12
0.23
0.14
0.17
0.15
0.13
0.16
0.18
0.18
0.20
0.13
0.13
0.10
0.10
0.13
0.13
0.15

Step 8.4.1 DCLG_u Measure Tc-99, Ai SEAs

U-234	U-235
195.4	51.6
168.6	25.1
2.0	1.9

Step 8.4.5a

weighted SOF _u	SS	RS	ES
0.076923077	0.461538462	0.461538	

fractions

Step 8.4.5c SOF_u Re-use Backfill Material

0

Step 8.4.5e SOF_u Groundwater

0.16

Step 8.6.7 g EMC SOF

0.01

Step 8.4.5g (<=1)

SOF_u = 0

0.31 PASS

Step 8.4.8 Calculate the dose contribution for the SU by multiplying SOF_u (including contribution from Re-use backfill and Groundwater) by 25 mrem

U-238/U-235	U-234/U-235	U-238	%
19.4	19.4	2.3	1.2
7.6	18.5	3.8	2.0
4.1	18.1	4.0	3.7
4.1	18.1	9.0	3.7
6.8	18.4	2.5	2.3
6.4	18.3	2.7	2.4
15.0	19.6	2.5	1.1
215.4	46.5	0.2	0.1
12.0	19.2	1.7	1.3
6.0	18.3	2.3	2.6
8.0	18.5	2.7	2.0
11.8	19.1	2.7	1.4
10.3	18.9	2.6	1.5
11.1	19.1	1.4	1.4
0.1	20.2	833.6	59.9
0.5	20.5	38.3	23.1
5.8	18.3	3.0	2.7
5.3	18.2	3.9	2.9
12.3	19.2	2.5	1.3
18.0	20.2	1.5	0.9
31.7	22.7	1.3	0.5

Average Enrichment (%) 5.62

Infer U-234 MDC using U-235 MDC ratio of U-234/U-235 (B) that sample's enrichment

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Step 8.6 Investigations

Elevated Measurement Comparison

Sample ID Step 8.6.4	Sample Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																								SOF									
			Ra-226						Tc-99					Th-232					U-234				U-235					U-238								
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC		Qualifier	Result	Uncertainty	MDC	Qualifier				
L100701BUB00	5.00	B	1.38	0.195	0.089	NA	0.31	0.31	-0.028	0	0.0361	0.22	U	1.19	0.201	0.095	NA	0.19	0.19	833.6	NA	NA	NA	31.8	3.17	0.568	U	3.27	1.14	1.87		5.16				
L100715BUB00	5.50	B	1.21	0.167	0.0744	NA	0.14	0.14	0.0018	0.0018	0.013	0.22	U	1.15	0.189	0.091	NA	0.15	0.15	38.34	NA	NA	NA	1.87	0.297	0.232	U	0.971	0.414	0.985	U	0.39				
L100701BUI01	5.00	I	1.26	0.176	0.069	NA	0.19	0.19	0	0	0	0.23	U	1.18	0.187	0.057	NA	0.18	0.18	3.898	NA	NA	NA	0.214	0.158	0.213	U	1.13	0.36	0.865	0	0.22				
L100701BUI02	5.00	I	1.06	0.161	0.0757	NA	-0.01	0	0.0184	0.0184	0.0628	0.23	U	1	0.167	0.169	N/A	0	0	2.537	NA	NA	NA	0.132	0.129	0.213	U	1.62	0.783	0.941	0	0.03				
L100701BUI03	5.00	I	1.13	0.154	0.0649	NA	0.06	0.06	0.0317	0.0317	0.0561	0.23	U	1.12	0.17	0.105	N/A	0.12	0.12	1.523	NA	NA	NA	0.076	0.146	0.229	0	1.36	0.634	0.821	U	0.11				
L100701BUI04	5.00	I	1.21	0.181	0.0764	NA	0.14	0.14	0.0088	0.0088	0.0219	0.23	U	1.17	0.202	0.121	N/A	0.17	0.17	1.307	NA	NA	NA	0.058	0.174	0.269	U	1.82	0.804	1	0	0.18				
			With ingrowth, use Ra226 bkg =										1.07	Th232 bkg =										1.0												

NOTES:

Gross results in units of pCi/g

* Background with ingrowth (1.07 pCi/g) subtracted from gross result

**Background (1.0 pCi/g) subtracted from gross result

U qualifier: A normal, non-detected result (result less than MDC).

All uncertainty values are reported at the 2-sigma confidence level.

Step 8.6.7.c.

DCGL_{EMC}

Ra-226 82.46
Tc-99 25778
Th-232 57.8
U-234 25949
U-235 1057.8
U-238 5334.1

Step 8.6.7.e.
"clean" systematic samples δ_i

0.105
0.027
0.160
2.983
0.160
1.295

Step 8.6.7.f.1)

τ_i

0.14
0.01
0.14
146.87
5.69
1.70

$\tau_i - \delta_i$

0.035
-0.017
-0.025
143.882
5.531
0.401

Step 8.6.7.f.2)

f_{elev}

0.000
0.000
0.000
0.006
0.005
0.000

Step 8.6.7.f.3) $f_{EMC} = 0.01$

Step 8.6.7.g. Summed elevated radioactivity fractions for the SU = 0.01 = EMC SOF

Step 8.6.7.h. Total SOF for the SU = 0.33 PASS

Step 8.6.7.i.

weighted SOF_{MEAN} 0.16
SOF_{MEAN} Re-use Backfill Material (used off-site BF) 0
SOF_{MEAN} Groundwater 0.16

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Step 8.6 Investigations

Step 8.6.6 Bounding samples:

Step 8.6.7b

Need area from GIS. 1 m²

Confirm area

Step 8.6.7.a. DCLG_W, Uniform, Measure Tc-99, All SEAs

	Uniform
U-234	195.4
U-235	51.6
U-238	168.8
Tc-99	25.1
Th-232	2.0
Ra-226	1.9

Step 8.6.7b

Uniform Stratum

Radionuclide	Elevated Measurement Area (m ²)									
	153,375	10,000	3,000	1,000	300	100	30	10	3	1
U-234	1.0	1.2	1.3	1.3	4.0	9.3	19.6	34.3	70.5	132.8
U-235	1.0	1.1	1.1	1.1	1.9	2.5	3.3	4.7	9.6	20.5
U-238	1.0	1.1	1.3	1.3	2.5	3.6	5.0	7.2	14.9	31.6
Tc-99	1.0	1.0	1.0	1.0	3.4	10.3	34.3	102.9	342.7	1,027.0
Th-232	1.0	1.0	1.0	1.0	2.1	3.0	4.2	6.1	12.9	28.9
Ra-226	1.0	1.1	1.1	1.1	2.5	4.1	6.1	9.1	19.3	43.4

Interpolated results:

1
132.8
20.5
31.6
1027.0
28.9
43.4

Step 8.6.7.e. δ_i = average concentration of systematic "clean" samples for each "elevated" nuclide

Step 8.6.7.f.1) τ_i = average concentration of elevated sample(s) for each ROC

Step 8.6.7.f.2) f_{elev} = elevated radioactivity fraction

$t_i - \delta_i$
DCLG _{EMC}

Step 8.6.7.f.3) Sum all f_{elev} (all ROCs in the elevated area) if applicable

Step 8.6.7.g. Sum all f_{EMC} (all elevated areas in the SU) if applicable

Step 8.6.7.h. Sum Step 8.6.7.g. and Step 8.4.5.g. (SOF_{MEAN,SU} use total SOF SU (including GW, BF, etc.)

(Use corrected net results.)

HDP-PR-FSS-721 Final Status Survey Data Evaluation
Step 8.6.7b. Area Factor Interpolation

The following equation is from "Decommissioning Health Physics: A Handbook for MARSSIM Users," p. 277, Abelquist, 2001, for interpolating Area Factors (AF) from the first existing AF under (smaller) than the desired area and the first existing AF over (larger) the desired area.

$$e^{\left[\frac{(\ln(\text{actual area}) - \ln(\text{under area}))(\ln(\text{over AF}) - \ln(\text{under AF}))}{\ln(\text{over area}) - \ln(\text{under area})} + \ln(\text{under AF}) \right]}$$

Ra-226 Excavation Area Factors		
	Area (m ²)	AF
Under	10	5.0
Over	30	4.0
Interpolated	13	4.74

Tc-99 Excavation Area Factors		
	Area (m ²)	AF
Under	10	20.0
Over	30	6.7
Interpolated	13	15.40

Th-232 Excavation Area Factors		
	Area (m ²)	AF
Under	10	4.0
Over	30	3.0
Interpolated	13	3.7

U-234 Excavation Area Factors		
	Area (m ²)	AF
Under	10	19.0
Over	30	6.7
Interpolated	13	14.8

U-235 Excavation Area Factors		
	Area (m ²)	AF
Under	10	2.0
Over	30	2.0
Interpolated	13	2.0

U-238 Excavation Area Factors		
	Area (m ²)	AF
Under	10	4.0
Over	30	3.0
Interpolated	13	3.7

Ra-226 Root Area Factors		
	Area (m ²)	AF
Under	100	3.9
Over	300	2.4
Interpolated	130	3.5

Tc-99 Root Area Factors		
	Area (m ²)	AF
Under	100	10
Over	300	3.4
Interpolated	153	6.7

Th-232 Root Area Factors		
	Area (m ²)	AF
Under	100	3.0
Over	300	2.1
Interpolated	130	2.8

U-234 Root Area Factors		
	Area (m ²)	AF
Under	100	9.4
Over	300	4.1
Interpolated	130	7.7

U-235 Root Area Factors		
	Area (m ²)	AF
Under	100	2.3
Over	300	1.9
Interpolated	130	2.2

U-238 Root Area Factors		
	Area (m ²)	AF
Under	100	3.6
Over	300	2.5
Interpolated	130	3.3

Enter the appropriate AF from tables in HDP-PR-FSS-721 Appendix E:

1. Choose appropriate stratum
2. Choose elevated ROC
3. Enter appropriate Elevated Measurement Areas (m², Over and Under)
4. Enter area (m²) of elevated area to be interpolated
5. Use Interpolated AF in Investigation worksheet

From HDP-PR-FSS-721, Appendix E Area Factors for Soil Contamination

Surface Stratum										
Radionuclide	153,375	10,000	3,000	1,000	300	100	30	10	3	1
U-234	1.0	1.5	2.2	2.6	7.8	19.3	41.7	67.3	96.0	119.5
U-235	1.0	1.1	1.2	1.2	1.3	1.5	1.8	2.6	5.4	12.1
U-238	1.0	1.2	1.5	1.6	2.2	2.6	3.4	4.9	10.2	22.3
Tc-99	1.0	1.0	1.0	1.0	3.4	10.3	34.2	102.2	338.5	1,009
Th-232	1.0	1.0	1.1	1.1	1.4	1.7	2.3	3.5	7.3	16.9
Ra-226	1.0	1.1	1.2	1.2	1.8	2.2	3.0	4.5	9.6	22.4

Root Stratum										
Radionuclide	153,375	10,000	3,000	1,000	300	100	30	10	3	1
U-234	1.0	1.2	1.3	1.4	4.1	9.4	19.2	33.0	67.9	130.4
U-235	1.0	1.0	1.1	1.1	1.9	2.3	2.9	4.1	8.3	17.9
U-238	1.0	1.1	1.3	1.3	2.5	3.6	5.0	7.2	14.8	31.5
Tc-99	1.0	1.0	1.0	1.0	3.4	10.3	34.3	103.0	343.3	1,029
Th-232	1.0	1.0	1.0	1.0	2.1	3.0	4.2	6.0	12.8	28.4
Ra-226	1.0	1.0	1.1	1.1	2.4	3.9	5.8	8.7	18.5	41.6

Excavation Stratum										
Radionuclide					148	100	30	10	3	1
U-234					1.0	2.0	6.7	19	35	65
U-235					1.0	1.3	2	2	4	7
U-238					1.0	1.9	3	4	7	13
Tc-99					1.0	2.0	6.7	20	67	200
Th-232					1.0	1.9	3	4	7	14
Ra-226					1.0	2.0	4	5	10	20

HDP-PR-FSS-721 Final Status Survey Data Evaluation
Step 8.6.7b. Area Factor Interpolation

Ra-226 Surface Area Factors		
	Area (m ²)	AF
Under	10	4.5
Over	30	3.0
Interpolated	13	4.08

Tc-99 Surface Area Factors		
	Area (m ²)	AF
Under	10	102.2
Over	30	34.2
Interpolated	13	78.69

Th-232 Surface Area Factors		
	Area (m ²)	AF
Under	10	3.5
Over	30	2.3
Interpolated	13	3.2

U-234 Surface Area Factors		
	Area (m ²)	AF
Under	10	67.3
Over	30	41.7
Interpolated	13	60.0

U-235 Surface Area Factors		
	Area (m ²)	AF
Under	10	2.6
Over	30	1.8
Interpolated	13	2.4

U-238 Surface Area Factors		
	Area (m ²)	AF
Under	10	4.9
Over	30	3.4
Interpolated	13	4.5

Ra-226 Uniform Area Factors		
	Area (m ²)	AF
Under	1	43.4
Over	3	19.3
Interpolated	1	43.4

Tc-99 Uniform Area Factors		
	Area (m ²)	AF
Under	1	1027
Over	3	342.7
Interpolated	1	1027.0

Th-232 Uniform Area Factors		
	Area (m ²)	AF
Under	1	28.9
Over	3	12.9
Interpolated	1	28.9

U-234 Uniform Area Factors		
	Area (m ²)	AF
Under	1	132.8
Over	3	70.5
Interpolated	1	132.8

U-235 Uniform Area Factors		
	Area (m ²)	AF
Under	1	20.5
Over	3	9.6
Interpolated	1	20.5

U-238 Uniform Area Factors		
	Area (m ²)	AF
Under	1	31.6
Over	3	14.9
Interpolated	1	31.6

Uniform Stratum

Radionuclide	Elevated Measurement Area (m ²)									
	153,375	10,000	3,000	1,000	300	100	30	10	3	1
U-234	1.0	1.2	1.3	1.3	4.0	9.3	19.6	34.3	70.5	132.8
U-235	1.0	1.1	1.1	1.1	1.9	2.5	3.3	4.7	9.6	20.5
U-238	1.0	1.1	1.3	1.3	2.5	3.6	5.0	7.2	14.9	31.6
Tc-99	1.0	1.0	1.0	1.0	3.4	10.3	34.3	102.9	342.7	1,027
Th-232	1.0	1.0	1.0	1.0	2.1	3.0	4.2	6.1	12.9	28.9
Ra-226	1.0	1.1	1.1	1.1	2.5	4.1	6.1	9.1	19.3	43.4

Change area if it is incorrect. Make sure "over" and "under" correlate for all six nuclides.

HDP-PR-FSS-721 Final Status Survey Data Evaluation
Step 8.5 Performance of Statistical Tests

WRS TEST					
SAMPLE ID	AREA (Reference, Survey Unit)	Gross SOF ($X_{i,ref}$, $Y_{i,SU,gross}$) Step 8.5.3a	ADJUSTED SOF (Z_i) Step 8.5.3b	RANKS Step 8.5.3d	REFERENCE AREA RANKS
9574-SS-140910-01-01	Reference	1.19	2.188	37	37
9574-SS-140910-01-02	Reference	0.76	1.757	15	15
9574-SS-140910-01-03	Reference	1.02	2.023	24	24
9574-SS-140910-01-04	Reference	1.02	2.018	23	23
9574-SS-140910-01-05	Reference	1.00	2.002	20	20
9574-SS-140910-01-07	Reference	0.87	1.873	17	17
9574-SS-140910-01-08	Reference	1.04	2.040	27	27
9574-SS-140910-01-09	Reference	0.96	1.959	19	19
9574-SS-140910-01-10	Reference	1.20	2.204	38	38
9574-SS-140910-01-11	Reference	1.01	2.007	22	22
9574-SS-140910-01-12	Reference	1.22	2.223	39	39
9574-SS-140910-01-13	Reference	1.03	2.035	26	26
9574-SS-140910-01-14	Reference	1.00	2.005	21	21
9574-SS-140910-01-15	Reference	0.86	1.865	16	16
9574-SS-140910-01-16	Reference	1.24	2.238	41	41
9574-SS-140910-01-17	Reference	1.19	2.185	36	36
9574-SS-140910-01-18	Reference	1.31	2.310	43	43
9574-SS-140910-01-20	Reference	1.18	2.179	34	34
9574-SS-140910-01-21	Reference	1.06	2.064	29	29
9574-SS-140910-01-22	Reference	1.10	2.101	30	30
9574-SS-140910-01-23	Reference	1.29	2.293	42	42
9574-SS-140910-01-24	Reference	1.34	2.339	44	44
9574-SS-140910-01-25	Reference	1.15	2.154	33	33
9574-SS-140910-01-26	Reference	1.18	2.182	35	35
9574-SS-140910-01-27	Reference	1.23	2.227	40	40
9574-SS-140910-01-28	Reference	1.38	2.380	45	45
9574-SS-140910-01-29	Reference	1.05	2.055	28	28
9574-SS-140910-01-30	Reference	0.94	1.941	18	18
9574-SS-140910-01-31	Reference	1.12	2.119	31	31
9574-SS-140910-01-32	Reference	1.15	2.152	32	32
9574-SS-140910-01-33	Reference	1.03	2.028	25	25
9574-SS-140910-01-34	Reference	0.44	1.443	13	13
L100702BES00	Survey Unit	1.17	1.174	6	0
L100703BSS00	Survey Unit	1.15	1.154	5	0
L100704BRS00	Survey Unit	1.14	1.138	4	0
L100705BES00	Survey Unit	1.07	1.072	1	0
L100706BRS00	Survey Unit	1.34	1.344	12	0
L100707BES00	Survey Unit	1.51	1.509	14	0
L100708BES00	Survey Unit	1.13	1.128	3	0
L100709BRS00	Survey Unit	1.31	1.308	11	0
L100710BES00	Survey Unit	1.28	1.275	10	0
L100711BRS00	Survey Unit	1.12	1.117	2	0
L100712BES00	Survey Unit	1.20	1.198	8	0
L100713BRS00	Survey Unit	1.23	1.227	9	0
L100714BES00	Survey Unit	1.19	1.190	7	0
Rank Sums				1035	943
# Reference Area Measurements				m	32
# Survey Unit Measurements				n	13
Total Number of Measurements Step 8.5.3c				N	45
α) percentile of a standard normal distribution (MARSSIM Pg. I-10)				z	1.645
WRS Critical Value (MARSSIM Pg. I-10, Eq. I.1)				CV	802

Min adjusted bkg SOF:
1.44

No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
Perform WRS test
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary
No WRS test necessary

W, Step 8.5.3e

$\alpha = 0.05$

TEST: **PASS** Step 8.5.3f

HDP-PR-FSS-701 Final Status Survey Plan Development

Appendix D.4 Step 2: Calculate the Number of Samples in the Statistical Survey Population

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	SOF (Ra/Tc/Th/Iso U)
St. Dev.	0.11
DCGL _{SOF}	1
LBGR (Mean)	0.16
Shift	0.84
Relative Shift (Δ/σ)	7.63
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	SUFFICIENT MEASUREMENTS
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

Δ/σ	P_r
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

MARSSIM Table 5.2, $\alpha = 0.05$, $\beta = 0.10$

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)
0.005	2.576
0.01	2.326
0.015	2.241
0.025	1.960
0.05	1.645
0.10	1.282
0.15	1.036
0.2	0.842
0.25	0.674
0.30	0.524

α
 β

Hematite Decommissioning Project		Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control									
										Revision: 2	Page 1 of 1

FORM HDP-PR-FSS-703-1												
FIELD DUPLICATE SAMPLE ASSESSMENT												

Survey Unit No.:		LSA 10-07			Survey Unit Description:		Burial Pits Open Land Area South Eastern Survey Unit in "Area 9"					
------------------	--	-----------	--	--	--------------------------	--	--	--	--	--	--	--

Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (pCi/g)		Field Duplicate Sample (pCi/g)		Average Activity (\bar{x}) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic ²	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity (x_i)	MDC	Activity (x_i)	MDC						
L100704BRS00	L100704BRQ00	Ra-226	1.05	0.0694	1.16	0.0784	1.105	1.9	0.11	0.269	0.403	N
L100704BRS00	L100704BRQ00	Tc-99	-0.00664	0.214	-0.00597	0.213	-0.006305	25.1	NA	3.552	5.321	NA
L100704BRS00	L100704BRQ00	Th-232	1.11	0.169	1.08	0.169	1.095	2.0	0.030	0.283	0.424	N
L100704BRS00	L100704BRQ00	U-234 ¹	3.987	N/A	1.390	N/A	2.688	195.4	2.596	27.649	41.425	N
L100704BRS00	L100704BRQ00	U-235	0.22	0.196	0.0729	0.294	0.146	51.6	NA	7.301	10.939	NA
L100704BRS00	L100704BRQ00	U-238	0.907	0.778	0.806	1.26	0.8565	168.8	NA	23.885	35.786	NA

Comments:
 1. U-234 is inferred, no MDC available.
 2. Duplicate assessment is not necessary if the result of either sample is < MDC.

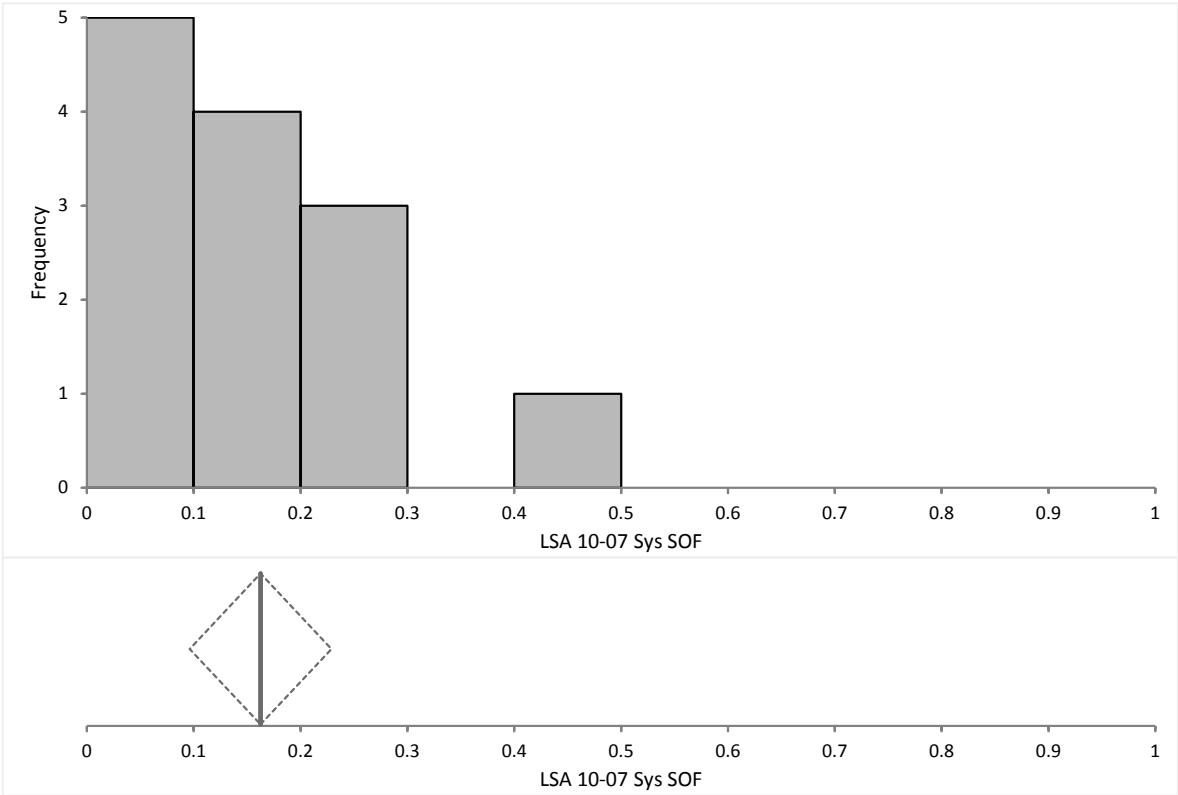
Performed by: _____ Date: _____	Reviewed by: _____ Date: _____
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Quality Record

LSA 10-07 Sys SOF

0.1
0.1
0.1
0.1
0.3
0.4
0.1
0.2
0.2
0.1
0.1
0.2
0.1

Descriptives



N		13							
		Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 10-07 Sys SOF		0.16	0.10 to 0.23		0.030	0.11	0.01	1.6	2.70
		Minimum	1st quartile	Median	97.75% CI		3rd quartile	Maximum	IQR
LSA 10-07 Sys SOF		0.1	0.09	0.13	0.09 to 0.25		0.22	0.4	0.13