

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:	06	Description:	South Eastern Survey Unit in "Area 9"
Survey Type:	FSS	Classification:	Class I

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L100601BES00	Uniform	S	423.339	422.8	865078.8	827674.7	Excavation 6-inch grab
L100602BES00	Uniform	S	422.534	422.0	865068.7	827712.4	Excavation 6-inch grab
L100603BES00	Uniform	S	421.09	420.6	865058.6	827750.1	Excavation 6-inch grab
L100604BES00	Uniform	S	420.315	419.8	865048.5	827787.7	Excavation 6-inch grab
L100605BRQ00	Uniform	Q	424.134	423.6	865038.4	827825.4	Root 6-inch grab
L100605BRS00	Uniform	S	424.134	423.5	865038.4	827825.4	Root 6-inch grab
L100606BES00	Uniform	S	423.5	423.0	865038.4	827825.4	Excavation 6-inch grab
L100607BES00	Uniform	S	422.343	421.8	865031.0	827722.5	Excavation 6-inch grab
L100608BES00	Uniform	S	420.05	419.6	865020.9	827760.2	Excavation 6-inch grab
L100609BES00	Uniform	S	422.373	421.9	864993.3	827732.6	Excavation 6-inch grab
L100610BUB00	Uniform	B	418.0	417.5	865069.0	827698.2	Biased 6-inch grab
L100611BUB00	Uniform	B	422.0	421.5	865011.1	827715.5	Biased 6-inch grab
L100612BUB00	Uniform	B	418.0	417.5	865027.1	827789.4	Biased 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]
 Surface: Floor = F; Wall = W; Ceiling = C; Roof = R
 CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used
 Type: Systematic = S, Biased = B; QC = Q; Investigation = I

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)

Evaluate Final Status Survey Data: LSA-10-06

Sample ID	Sample Depth (ft)	Type (Systematic Bias, QC)	TestAmerica Analytical Results Step 8.3.2																												
			Ra-226						Tc-99				Th-232					Inferred U-234				U-235				U-238					
			Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result
L100601BE500	5.51	S	1.260	0.185	0.086	N/A	0.190	0.190	0.047	0.047	0.075	0.220	U	1.040	0.189	0.184	N/A	0.040	0.040	2.754	NA	NA	NA	0.142	0.160	0.278	U	1.840	0.861	1.010	N/A
L100602BE500	5.56	S	1.030	0.147	0.070	N/A	-0.040	0.000	0.013	0.013	0.128	0.227	U	1.060	0.153	0.113	N/A	0.060	0.060	3.028	NA	NA	NA	0.165	0.130	0.171	U	1.060	0.342	0.813	N/A
L100603BE500	6.17	US	1.220	0.197	0.088	N/A	0.150	0.150	0.011	0.011	0.081	0.225	U	1.040	0.236	0.145	N/A	0.040	0.040	6.977	NA	NA	NA	0.385	0.183	0.227	N/A	1.580	0.432	1.010	N/A
L100604BE500	7.45	S	1.170	0.178	0.076	N/A	0.100	0.100	-0.003	0.000	0.076	0.248	U	1.090	0.176	0.134	N/A	0.090	0.090	2.084	NA	NA	NA	0.108	0.147	0.249	U	1.480	0.740	0.936	N/A
L100605BE500	4.38	S	1.070	0.162	0.093	N/A	0.000	0.000	0.083	0.083	0.095	0.224	U	1.070	0.186	0.187	N/A	0.070	0.070	2.849	NA	NA	NA	0.152	0.150	0.196	U	1.430	0.859	1.040	N/A
L100606BE500	5.00	S	1.120	0.156	0.065	N/A	0.050	0.050	0.057	0.057	0.042	0.222	U	1.090	0.154	0.082	N/A	0.090	0.090	1.705	NA	NA	NA	0.088	0.116	0.186	U	1.220	0.680	0.874	N/A
L100607BE500	7.24	S	1.170	0.184	0.092	N/A	0.100	0.100	0.024	0.024	0.052	0.224	U	1.200	0.193	0.137	N/A	0.200	0.200	2.184	NA	NA	NA	0.118	0.191	0.301	U	1.000	0.410	1.090	U
L100608BE500	9.01	S	1.060	0.151	0.064	N/A	0.070	0.070	-0.004	0.000	0.044	0.238	U	1.110	0.187	0.113	N/A	0.110	0.110	2.292	NA	NA	NA	0.121	0.154	0.260	U	0.940	0.353	0.948	N/A
L100609BE500	8.38	S	1.110	0.164	0.085	N/A	0.040	0.040	-0.041	0.000	0.099	0.270	U	1.070	0.187	0.116	N/A	0.070	0.070	2.562	NA	NA	NA	0.130	0.157	0.257	U	0.981	0.395	0.985	U
L100610BE500	4.38	C	1.150	0.164	0.061	N/A	0.080	0.080	-0.018	0.000	0.096	0.231	U	1.140	0.180	0.135	N/A	0.140	0.140	0.675	NA	NA	NA	0.030	0.150	0.254	U	0.960	0.328	0.807	N/A
L100610BUB00	7.50	B	1.050	0.155	0.068	N/A	-0.000	0.000	-0.006	0.000	0.091	0.229	U	1.260	0.188	0.139	N/A	0.260	0.260	2.273	NA	NA	NA	0.123	0.161	0.244	U	0.920	0.325	0.897	N/A
L100611BUB00	5.50	B	1.130	0.165	0.065	N/A	0.060	0.060	0.013	0.013	0.018	0.221	U	1.030	0.205	0.137	N/A	0.030	0.030	16.094	NA	NA	NA	0.889	0.271	0.265	N/A	3.010	0.940	1.060	N/A
L100612BUB00	1.50	B	0.897	0.143	0.066	N/A	-0.073	0.000	0.009	0.009	0.062	0.224	U	1.080	0.174	0.119	N/A	0.080	0.080	2.681	NA	NA	NA	0.143	0.136	0.221	U	1.340	0.700	0.858	N/A
Systematic Minimum			0.000				0.000		0.000				0.000				0.000		1.705				0.088				0.940				
Systematic Maximum			0.190				0.083		0.290				0.290				0.290		16.094				0.385				3.010				
Systematic Mean			0.071				0.020		0.086				0.086				0.086		2.694				0.158				1.289				
Systematic Median			0.050				0.013		0.070				0.070				0.070		2.562				0.130				1.220				
Systematic Standard Deviation			0.068				0.026		0.049				0.049				0.049		1.972				0.222				0.315				
Site 8-1-1																															
Step 8-4-2			With ingrowth, use Ra226 bkg =				1.07						Th232 bkg =																		
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: Result is less than the sample selection limit.																															
All uncertainty values are reported at the 2-sigma confidence level.																															

Ave Conc. Ra-226, SS	Ave Conc. Tc-99, SS	Ave Conc. Th-232, SS	Ave Conc. U-234, SS	Ave Conc. U-235, SS	Ave Conc. U-238, SS
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0.000	0.000	0.000	0.000	0.000	0.000
Ave Conc. Ra-226, RS	Ave Conc. Tc-99, RS	Ave Conc. Th-232, RS	Ave Conc. U-234, RS	Ave Conc. U-235, RS	Ave Conc. U-238, RS
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0.000	0.083	0.070	2.849	0.152	1.430
Ave Conc. Ra-226, ES	Ave Conc. Tc-99, ES	Ave Conc. Th-232, ES	Ave Conc. U-234, ES	Ave Conc. U-235, ES	Ave Conc. U-238, ES
0.19	0.0474	0.04	2.754	0.142	1.84
0	0.0129	0.06	3.028	0.165	1.98
0.15	0.0112	0.04	6.975	0.385	1.58
-	-	0.09	2.0943	0.108	1.48
-	-	-	-	-	-
-	-	-	-	-	-
0.05	0.0568	0.09	1.705	0.0879	1.22
0.1	0.0235	0.2	2.1942	0.118	1
0.01	0	0.11	2.2624	0.121	0.949
0.04	0	0.07	2.5617	0.139	0.981
-	-	-	-	-	-
0.080	0.019	0.088	2.944	0.158	1.264

HDP-PR-FSS-T21 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 (Resonance B, BS, OC)	Enrichment (%)	SOF Step 8.4.3	Root Status (unexcavated not backfilled only) Step 8.4.4.1	In Sample (Strength)	In Root Material (SU)	root count	enrichment count	backfill count	Average enrichment wt (%)
L100601BE500	5.51	S	1.2	0.15	EXCAVATION	good			1		
L100602BE500	5.56	S	2.4	0.06	EXCAVATION	good			1		
L100603BE500	5.17	S	5.7	0.15	EXCAVATION	good			1		
L100604BE500	7.45	S	1.2	0.12	EXCAVATION	good			1		
L100605BR500	4.38	S	1.7	0.06	ROOT	good	1				
L100606BE500	5.00	S	1.2	0.09	EXCAVATION	good			1		
L100607BE500	7.24	S	1.9	0.17	EXCAVATION	good			1		
L100608BE500	9.01	S	6.0	0.04	EXCAVATION	good			1		
L100609BE500	8.38	S	2.2	0.08	EXCAVATION	good			1		
L100605BR200	4.38	D	0.5	0.12		good					
L100610BLB00	7.50	B	2.1	0.15		good					
L100611BLB00	5.50	B	4.4	0.19		good					
L100612BLB00	7.50	B	1.7	0.08		good					
			2.0	0.08				9	1	8	0

Use corrected net results for all DE calcs T21 Sec. 8.4.2

MDC SF Step 8.4.1a
0.19
0.13
0.16
0.15
0.18
0.11
0.17
0.13
0.15
0.15
0.15
0.15
0.15

Step 8.4.1 DCLG_{av} Measure Tc-99, All SEAs

U-234	195.4
U-235	51.6
U-238	169.8
Tc-99	25.1
Th-232	2.0
Ra-226	1.9

Step 8.4.5b
 Weighted SOF_{mean} = 0.11

fractions	SS	RS	ES
	0	0.111111111	0.386666667

Step 8.4.5c SOF_{mean} Re-use Backfill Material = 0

Step 8.4.5e SOF_{mean} Groundwater = 0.16

Step 8.4.5g (<=1)
 SOF_{mean, SU} = 0.27 PASS

Step 8.4.6 Calculate the dose contribution for the SU by multiplying SOF_{mean, SU} (including contribution from Re-use backfill and Groundwater) by 25 mrem.

6.7 mrem

Infer U234 Step 8.3.4			
U-238/U235	U-234/U235	U-234	%
13.0	19.4	2.6	1.2
6.4	16.3	3.0	2.4
4.1	16.1	7.0	3.7
13.7	16.4	2.1	1.2
8.4	18.7	2.8	1.7
13.9	19.4	1.7	1.2
8.5	18.6	2.2	1.9
7.8	18.5	2.2	2.0
7.1	19.4	2.6	2.5
32.3	22.7	0.7	0.5
7.6	18.5	2.3	2.1
3.4	16.1	16.1	4.4
9.4	18.7	2.7	1.7
Average Enrichment (%)			2.92

Infer U-234 MDC using U-235 MDC - ratio of U-234-U235 @ that sample's enrichment	
5.390946	
3.137890	
4.115433	
4.828553	
3.67423	
3.626993	
5.596946	
4.447780	
4.736396	
6.773512	
4.506565	
4.70753	
4.142852	

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 ($X_{i,ref}$, $Y_{i,SU}$) 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	33	33
9574-SS-140910-01-02	Reference	0.76	1.757	11	11
9574-SS-140910-01-03	Reference	1.02	2.023	20	20
9574-SS-140910-01-04	Reference	1.02	2.018	19	19
9574-SS-140910-01-05	Reference	1.00	2.002	16	16
9574-SS-140910-01-07	Reference	0.87	1.873	13	13
9574-SS-140910-01-08	Reference	1.04	2.040	23	23
9574-SS-140910-01-09	Reference	0.96	1.959	15	15
9574-SS-140910-01-10	Reference	1.20	2.204	34	34
9574-SS-140910-01-11	Reference	1.01	2.007	18	18
9574-SS-140910-01-12	Reference	1.22	2.223	35	35
9574-SS-140910-01-13	Reference	1.03	2.035	22	22
9574-SS-140910-01-14	Reference	1.00	2.005	17	17
9574-SS-140910-01-15	Reference	0.86	1.865	12	12
9574-SS-140910-01-16	Reference	1.24	2.238	37	37
9574-SS-140910-01-17	Reference	1.19	2.185	32	32
9574-SS-140910-01-18	Reference	1.31	2.310	39	39
9574-SS-140910-01-20	Reference	1.18	2.179	30	30
9574-SS-140910-01-21	Reference	1.06	2.064	25	25
9574-SS-140910-01-22	Reference	1.10	2.101	26	26
9574-SS-140910-01-23	Reference	1.29	2.293	38	38
9574-SS-140910-01-24	Reference	1.34	2.339	40	40
9574-SS-140910-01-25	Reference	1.15	2.154	29	29
9574-SS-140910-01-26	Reference	1.18	2.182	31	31
9574-SS-140910-01-27	Reference	1.23	2.227	36	36
9574-SS-140910-01-28	Reference	1.38	2.380	41	41
9574-SS-140910-01-29	Reference	1.05	2.055	24	24
9574-SS-140910-01-30	Reference	0.94	1.941	14	14
9574-SS-140910-01-31	Reference	1.12	2.119	27	27
9574-SS-140910-01-32	Reference	1.15	2.152	28	28
9574-SS-140910-01-33	Reference	1.03	2.028	21	21
9574-SS-140910-01-34	Reference	0.44	1.443	10	10
L100601BES00	Survey Unit	1.21	1.213	7	0
L100602BES00	Survey Unit	1.10	1.098	1	0
L100603BES00	Survey Unit	1.22	1.215	8	0
L100604BES00	Survey Unit	1.18	1.182	6	0
L100605BRS00	Survey Unit	1.13	1.127	2	0
L100606BES00	Survey Unit	1.15	1.154	5	0
L100607BES00	Survey Unit	1.24	1.236	9	0
L100608BES00	Survey Unit	1.14	1.143	4	0
L100609BES00	Survey Unit	1.14	1.141	3	0
Rank Sums				861	816
# Reference Area Measurements				m	32
# Survey Unit Measurements				n	9
Total Number of Measurements Step 8.5.3c				N	41
(1-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	725

Step 8.5.1
 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
 No WRS test necessary
 No WRS test necessary
 No WRS test necessary
 No WRS test necessary

W_r Step 8.5.3e

$\alpha = 0.05$

TEST: PASS

Step 8.5.3f

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

Appendix B.1 Step 8. Calculate the Number of Samples in the Statistical Population

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	SOF (Ra/Tc/Th/Iso U)
St. Dev.	0.04
DCGL _{SOF}	1
LBGR (Mean)	0.11
Shift	0.89
Relative Shift (Δ/σ)	20.85
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										
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**FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT**

Survey Unit No.:	LSA 10-06				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						
L100605BRS00	L100605BRQ00	Ra-226	1.07	0.0931	1.15	0.0609	1.110	1.9	0.08	0.269	0.403	N
L100605BRS00	L100605BRQ00	Tc-99	0.0829	0.224	-0.0176	0.231	0.033	25.1	NA	3.552	5.321	NA
L100605BRS00	L100605BRQ00	Th-232	1.07	0.187	1.14	0.135	1.105	2.0	0.070	0.283	0.424	N
L100605BRS00	L100605BRQ00	U-234 ¹	2.849	N/A	0.675	N/A	1.762	195.4	2.174	27.649	41.425	N
L100605BRS00	L100605BRQ00	U-235	0.152	0.196	0.0297	0.254	0.091	51.6	NA	7.301	10.939	NA
L100605BRS00	L100605BRQ00	U-238	1.43	1.04	0.96	0.807	1.195	168.8	0.470	23.885	35.786	N

Comments:

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

Performed by: _____

Reviewed by: _____

Date: _____

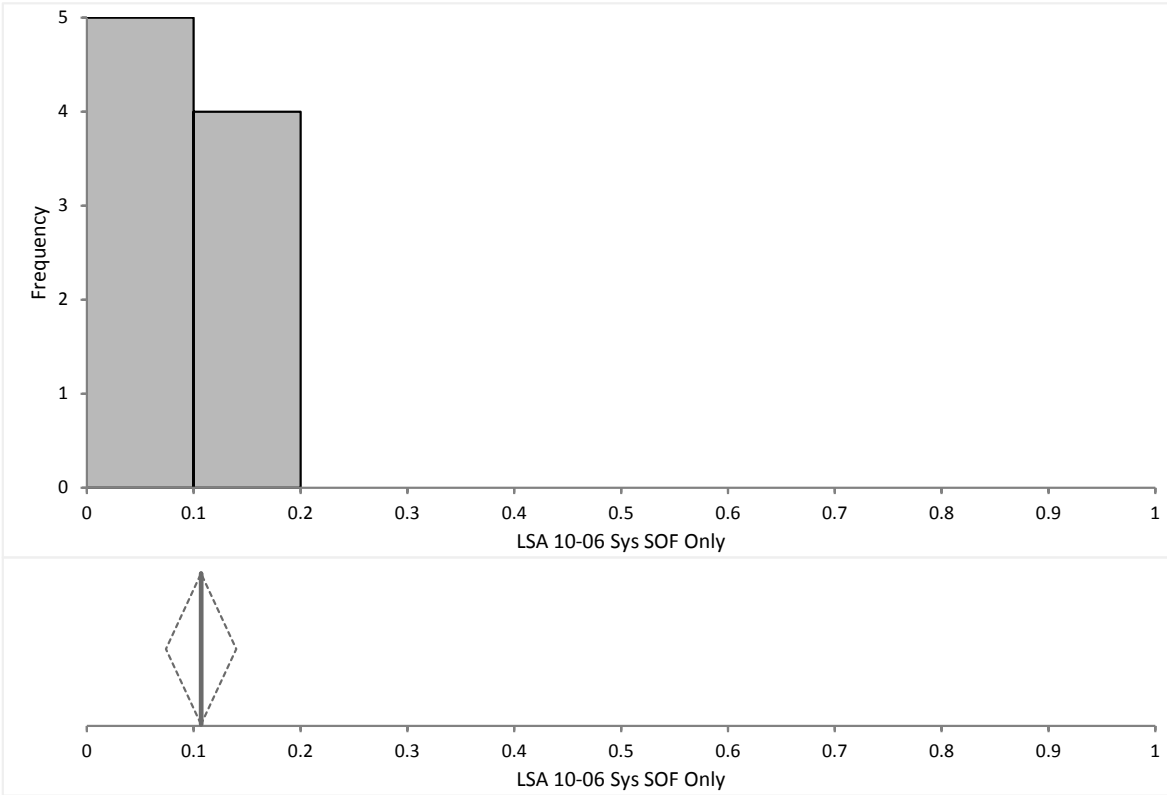
Date: _____

Quality Record

LSA 10-06 Sys SOF Only

0.1
0.1
0.2
0.1
0.1
0.1
0.2
0.1
0.1

Descriptives



N 9		Mean	95% CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 10-06 Sys SOF Only		0.11	0.07 to 0.14	0.014	0.04	0.00	0.4	-1.53
		Minimum	1st quartile	Median	96.09% CI	3rd quartile	Maximum	IQR
LSA 10-06 Sys SOF Only		0.1	0.07	0.09	0.06 to 0.15	0.15	0.2	0.08