

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 08	Description:	Technetium SEA Open Land Area
Survey Unit:	13	Description:	Central Open Land Area
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
L08-13-01-T-E-S-00	Deep	S	428.1	427.6	864864	827423	Excavation 6-inch grab
L08-13-02-T-E-S-00	Deep	S	429.3	428.8	864864	827463	Excavation 6-inch grab
L08-13-03-T-E-S-00	Deep	S	427.2	426.7	864830	827403	Excavation 6-inch grab
L08-13-04-T-E-S-00	Deep	S	427.1	426.6	864830	827443	Excavation 6-inch grab
L08-13-05-T-E-S-00	Deep	S	430.8	430.3	864830	827482	Excavation 6-inch grab
L08-13-06-T-E-S-00	Deep	S	427.7	427.2	864796	827423	Excavation 6-inch grab
L08-13-07-T-E-S-00	Deep	S	427.5	427.1	864796	827463	Excavation 6-inch grab
L08-13-08-T-E-S-00	Deep	S	429.3	428.8	864796	827502	Excavation 6-inch grab
L08-13-09-T-R-S-00	Root	S	433.2	430.1	864796	827542	Root 3.1-ft composite
L08-13-10-T-E-S-00	Deep	S	430.1	429.6	864796	827542	Excavation 6-inch grab
L08-13-11-T-E-S-00	Deep	S	425.9	425.4	864761	827443	Excavation 6-inch grab
L08-13-12-T-E-S-00	Deep	S	429.5	429.0	864761	827482	Excavation 6-inch grab
L08-13-11-T-E-Q-00	Deep	Q	425.9	425.4	864761	827443	Excavation 6-inch grab
L08-13-13-T-E-B-00	Deep	B	429.5	429.0	864753	827480	Sidewall Sample
L08-13-14-T-E-B-00	Deep	B	427.7	427.2	864792	827420	Bias 6-inch grab
L08-13-15-T-E-B-00	Deep	B	425.7	425.2	864744	827458	Bias 6-inch grab
L08-13-16-T-E-B-00	Deep	B	429.1	428.6	864785	827505	Bias 6-inch grab
L08-13-17-T-E-B-00	Deep	B	430.8	430.3	864831	827475	Bias 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)

XC * ratio of U-234:U-235 @ that sample's enrichment

**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	1.13	2.130	36	36
9574-SS-140910-01-02	Reference	0.72	1.721	12	12
9574-SS-140910-01-03	Reference	0.97	1.970	23	23
9574-SS-140910-01-04	Reference	0.97	1.967	22	22
9574-SS-140910-01-05	Reference	0.95	1.952	19	19
9574-SS-140910-01-07	Reference	0.83	1.829	14	14
9574-SS-140910-01-08	Reference	0.99	1.987	26	26
9574-SS-140910-01-09	Reference	0.90	1.904	16	16
9574-SS-140910-01-10	Reference	1.14	2.144	37	37
9574-SS-140910-01-11	Reference	0.96	1.958	20	20
9574-SS-140910-01-12	Reference	1.16	2.160	39	39
9574-SS-140910-01-13	Reference	0.98	1.9826	25	25
9574-SS-140910-01-14	Reference	0.95	1.9513	18	18
9574-SS-140910-01-15	Reference	0.82	1.824	13	13
9574-SS-140910-01-16	Reference	1.17	2.171	40	40
9574-SS-140910-01-17	Reference	1.12	2.124	34	34
9574-SS-140910-01-18	Reference	1.24	2.241	42	42
9574-SS-140910-01-20	Reference	1.11	2.115	33	33
9574-SS-140910-01-21	Reference	1.01	2.009	28	28
9574-SS-140910-01-22	Reference	1.05	2.053	29	29
9574-SS-140910-01-23	Reference	1.23	2.234	41	41
9574-SS-140910-01-24	Reference	1.28	2.277	43	43
9574-SS-140910-01-25	Reference	1.09	2.091	31	31
9574-SS-140910-01-26	Reference	1.13	2.127	35	35
9574-SS-140910-01-27	Reference	1.16	2.160	38	38
9574-SS-140910-01-28	Reference	1.31	2.314	44	44
9574-SS-140910-01-29	Reference	1.00	1.999	27	27
9574-SS-140910-01-30	Reference	0.89	1.891	15	15
9574-SS-140910-01-31	Reference	1.06	2.064	30	30
9574-SS-140910-01-32	Reference	1.10	2.097	32	32
9574-SS-140910-01-33	Reference	0.98	1.975	24	24
9574-SS-140910-01-34	Reference	0.41	1.411	7	7
L08-13-01-T-E-S-00	Survey Unit	1.96	1.964	21	0
L08-13-02-T-E-S-00	Survey Unit	1.34	1.339	4	0
L08-13-03-T-E-S-00	Survey Unit	1.37	1.371	5	0
L08-13-04-T-E-S-00	Survey Unit	1.47	1.468	10	0
L08-13-05-T-E-S-00	Survey Unit	1.92	1.916	17	0
L08-13-06-T-E-S-00	Survey Unit	1.44	1.438	8	0
L08-13-07-T-E-S-00	Survey Unit	1.18	1.176	2	0
L08-13-08-T-E-S-00	Survey Unit	0.99	0.991	1	0
L08-13-09-T-R-S-00	Survey Unit	1.59	1.586	11	0
L08-13-10-T-E-S-00	Survey Unit	1.22	1.216	3	0
L08-13-11-T-E-S-00	Survey Unit	1.38	1.378	6	0
L08-13-12-T-E-S-00	Survey Unit	1.44	1.442	9	0
Rank Sums				990	893
# Reference Area Measurements				m	32
# Survey Unit Measurements				n	12
Total Number of Measurements Step 8.5.3c				N	44
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	783

Step 8.5.1
Min adjusted bkg SOF: 1.41
Stratum
Perform WRS test EXCAVATION
No WRS test necessary EXCAVATION
No WRS test necessary EXCAVATION
Perform WRS test EXCAVATION
Perform WRS test EXCAVATION
Perform WRS test EXCAVATION
No WRS test necessary EXCAVATION
No WRS test necessary EXCAVATION
Perform WRS test ROOT
No WRS test necessary EXCAVATION
No WRS test necessary EXCAVATION
Perform WRS test EXCAVATION

W_r Step 8.5.3e

$\alpha = 0.05$

TEST: **PASS** Step 8.5.3f

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

Background Soil Locations - Surface and Sub-Surface Soil - Statistical and Analytical Sample Results
Surface and Sub-Surface - Background Soil - Analytical Results

Sample ID	Ra-226 w/ 21-Day Ingrowth			Th-232			U-234*			U-235*			U-238*			SOF
	(pCi/g)			(pCi/g)			(pCi/g)			(pCi/g)			(pCi/g)			
	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	
9574-SS-140910-01-01	1.150	0.164	0.068	1.150	0.178	0.133	0.671	0.181	0.050	0.022	0.040	0.071	0.724	0.189	0.050	1.13
9574-SS-140910-01-02	0.719	0.103	0.045	0.749	0.120	0.090	0.353	0.129	0.051	0.011	0.028	0.063	0.379	0.135	0.068	0.72
9574-SS-140910-01-03	1.040	0.166	0.077	0.936	0.183	0.145	0.518	0.164	0.062	0.015	0.030	0.044	0.723	0.195	0.036	0.97
9574-SS-140910-01-04	1.010	0.138	0.051	0.962	0.171	0.090	0.390	0.138	0.034	0.014	0.029	0.043	0.591	0.172	0.060	0.97
9574-SS-140910-01-05	0.995	0.160	0.085	0.948	0.178	0.091	0.345	0.163	0.083	0.000	0.009	0.068	0.421	0.179	0.055	0.95
9574-SS-140910-01-07	0.858	0.133	0.064	0.831	0.150	0.110	0.512	0.160	0.035	0.038	0.051	0.075	0.453	0.150	0.035	0.83
9574-SS-140910-01-08	1.030	0.143	0.064	0.979	0.139	0.087	0.832	0.210	0.075	0.000	0.005	0.043	0.632	0.179	0.053	0.99
9574-SS-140910-01-09	1.080	0.169	0.070	0.768	0.188	0.184	0.484	0.159	0.055	0.043	0.053	0.069	0.493	0.161	0.063	0.90
9574-SS-140910-01-10	1.170	0.174	0.077	1.160	0.191	0.143	0.571	0.169	0.064	0.034	0.050	0.080	0.757	0.196	0.034	1.14
9574-SS-140910-01-11	0.972	0.136	0.084	0.977	0.142	0.079	0.606	0.174	0.059	0.028	0.040	0.042	0.575	0.168	0.034	0.96
9574-SS-140910-01-12	1.220	0.184	0.086	1.140	0.210	0.139	0.747	0.199	0.054	0.056	0.060	0.067	0.997	0.233	0.036	1.16
9574-SS-140910-01-13	1.020	0.140	0.076	0.978	0.157	0.096	0.724	0.198	0.037	0.046	0.053	0.046	0.744	0.201	0.056	0.98
9574-SS-140910-01-14	1.050	0.146	0.061	0.889	0.156	0.080	0.705	0.193	0.061	0.029	0.042	0.044	0.607	0.178	0.067	0.95
9574-SS-140910-01-15	0.805	0.121	0.058	0.871	0.140	0.110	0.434	0.145	0.058	-0.003	0.005	0.064	0.594	0.171	0.034	0.82
9574-SS-140910-01-16	1.320	0.201	0.090	1.070	0.189	0.153	0.513	0.152	0.054	0.049	0.052	0.059	0.835	0.198	0.031	1.17
9574-SS-140910-01-17	1.190	0.165	0.070	1.100	0.179	0.129	0.639	0.183	0.062	0.024	0.043	0.077	0.844	0.213	0.036	1.12
Min	0.72			0.75			0.35			0.00			0.38			0.72
Max	1.32			1.16			0.83			0.06			1.00			
Mean	1.04			0.97			0.57			0.03			0.65			
Stdev	0.16			0.13			0.15			0.02			0.17			

Use Root DCGLs.

Sub-Surface

Sample ID	Ra-226 w/ 21-Day Ingrowth			Th-232			U-234*			U-235*			U-238*			SOF
	(pCi/g)			(pCi/g)			(pCi/g)			(pCi/g)			(pCi/g)			
	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	Conc.	Error	MDC	
9574-SS-140910-01-18	1.340	0.193	0.085	1.190	0.200	0.117	0.808	0.200	0.062	0.038	0.047	0.062	0.745	0.191	0.049	1.24
9574-SS-140910-01-20	1.260	0.206	0.109	1.010	0.197	0.176	1.120	0.241	0.057	0.068	0.061	0.041	0.710	0.187	0.050	1.11
9574-SS-140910-01-21	1.070	0.156	0.074	0.982	0.153	0.124	1.040	0.232	0.050	0.028	0.039	0.041	0.705	0.187	0.050	1.01
9574-SS-140910-01-22	0.922	0.131	0.057	1.210	0.170	0.106	0.829	0.215	0.065	0.013	0.032	0.071	0.981	0.236	0.037	1.05
9574-SS-140910-01-23	1.130	0.170	0.084	1.370	0.229	0.115	1.140	0.254	0.055	0.073	0.068	0.069	0.994	0.235	0.036	1.23
9574-SS-140910-01-24	1.200	0.165	0.065	1.390	0.221	0.131	1.090	0.247	0.055	0.024	0.043	0.078	0.992	0.234	0.055	1.28
9574-SS-140910-01-25	1.230	0.164	0.065	0.990	0.156	0.126	0.887	0.216	0.053	0.069	0.065	0.065	0.959	0.226	0.070	1.09
9574-SS-140910-01-26	1.080	0.159	0.079	1.210	0.179	0.106	0.730	0.219	0.078	0.019	0.037	0.056	0.764	0.223	0.045	1.13
9574-SS-140910-01-27	1.310	0.185	0.082	1.050	0.163	0.110	1.160	0.255	0.036	0.059	0.059	0.044	0.956	0.228	0.062	1.16
9574-SS-140910-01-28	1.280	0.188	0.089	1.390	0.201	0.131	0.871	0.217	0.055	0.060	0.060	0.045	0.895	0.220	0.036	1.31
9574-SS-140910-01-29	1.080	0.154	0.081	0.955	0.160	0.146	0.842	0.208	0.059	0.011	0.029	0.064	0.708	0.189	0.051	1.00
9574-SS-140910-01-30	0.960	0.161	0.086	0.851	0.166	0.156	0.744	0.196	0.035	0.072	0.065	0.043	0.787	0.203	0.053	0.89
9574-SS-140910-01-31	1.060	0.146	0.050	1.100	0.159	0.089	0.572	0.170	0.070	0.099	0.075	0.043	0.986	0.228	0.052	1.06
9574-SS-140910-01-32	1.060	0.157	0.071	1.170	0.177	0.078	0.598	0.174	0.060	0.058	0.058	0.043	0.758	0.198	0.060	1.10
9574-SS-140910-01-33	1.030	0.147	0.069	0.954	0.153	0.119	0.772	0.196	0.050	0.014	0.028	0.041	0.828	0.203	0.033	0.98
9574-SS-140910-01-34	0.618	0.099	0.040	0.225	0.085	0.099	0.389	0.138	0.052	0.014	0.029	0.043	0.494	0.156	0.035	0.41
Min	0.62			0.23			0.39			0.01			0.49			0.41
Max	1.34			1.39			1.16			0.0992			0.994			
Mean	1.10			1.07			0.85			0.04			0.83			
Stdev	0.18			0.28			0.22			0.03			0.14			

Use Root DCGLs.

	DCLG _w , Measure Tc-99, All SEAs		
	Surface	Root	Excavation
U-234	508.5	235.6	872.4
U-235	102.3	64.1	208.1
U-238	297.6	183.3	551.1
Tc-99	151	30.1	74
Th-232	4.7	2	5.2
Ra-226	5	2.1	5.4

No Tc-99 expected in background area.

* alpha spectroscopy results.

Dataset Min = 0.618 0.225 0.345 -0.00262 0.379

HDP-PR-FSS-701 Final Status Survey Plan Development
Appendix P-1 Step 8. Calculate the Number of Samples in the Statistical Survey Population

DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	SOF (Ra/Tc/Th/Iso U)
St. Dev.	0.16
DCGL _{SOF}	1
LBGR (Mean)	0.23
Shift	0.77
Relative Shift (Δ/σ)	4.93
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	11
Verification Check	SUFFICIENT MEASUREMENTS
<p align="center">"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test</p>	

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

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

Survey Unit No.:	LSA 08-13				Survey Unit Description:	Central Open Land Area						
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						
L08-13-11-T-E-S-00	L08-13-11-T-E-Q-00	Ra-226	1.440	0.0788	1.240	0.069	1.340	5.4	0.200	0.764	1.145	N
L08-13-11-T-E-S-00	L08-13-11-T-E-Q-00	Tc-99	1.87	0.241	1.250	0.236	1.560	74	0.620	10.471	15.688	N
L08-13-11-T-E-S-00	L08-13-11-T-E-Q-00	Th-232	1.190	0.163	1.270	0.119	1.230	5.2	0.080	0.736	1.102	N
L08-13-11-T-E-S-00	L08-13-11-T-E-Q-00	U-234 ¹	5.580	N/A	3.188	N/A	4.384	872.4	2.392	123.445	184.949	N
L08-13-11-T-E-S-00	L08-13-11-T-E-Q-00	U-235	0.308	0.253	0.175	0.232	0.242	208.1	NA	29.446	44.117	NA
L08-13-11-T-E-S-00	L08-13-11-T-E-Q-00	U-238	1.22	0.832	0.928	0.832	1.074	551.1	0.292	77.981	116.833	N

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: Thomas Yardy _____

Reviewed by: Clark Evers _____

Date: _____

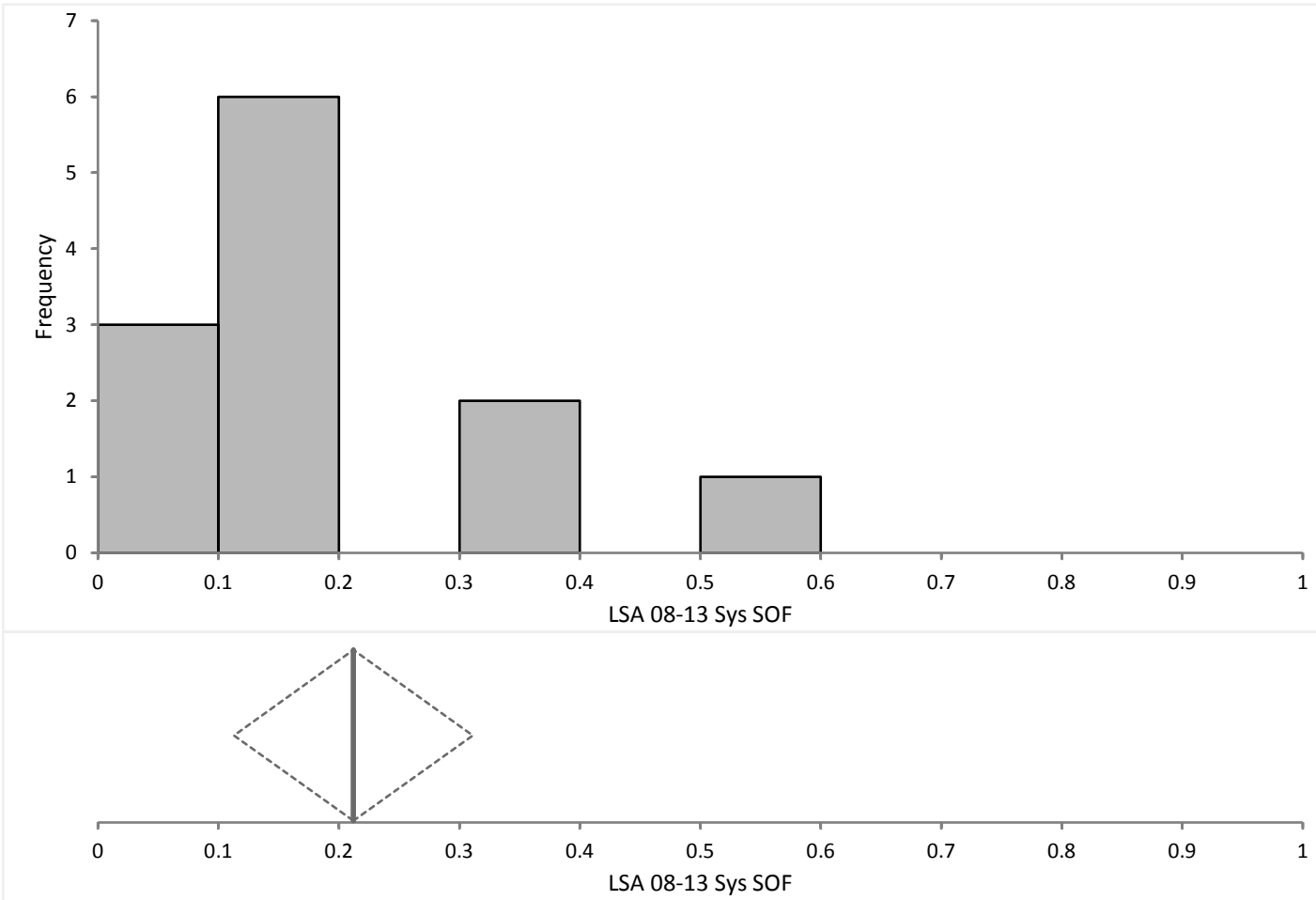
Date: _____

Quality Record

LSA 08-13 Sys SOF

0.4
0.1
0.2
0.2
0.4
0.2
0.1
0.1
0.6
0.1
0.1
0.2

Descriptives



N	12						
LSA 08-13 Sys SOF	Mean	95% CI	Mean SE	SD	Variance	Skewness	Kurtosis
	0.21	0.11 to 0.31	0.045	0.16	0.02	1.5	1.45
LSA 08-13 Sys SOF	Minimum	1st quartile	Median	96.14% CI	3rd quartile	Maximum	IQR
	0.06	0.11	0.16	0.09 to 0.39	0.30	0.6	0.19