

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**

<b>Survey Area:</b>	LSA 08	<b>Description:</b>	Plant Soils SEA Open Land Area
<b>Survey Unit:</b>	16	<b>Description:</b>	Central Open Land Area
<b>Survey Type:</b>	FSS	<b>Classification:</b>	Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L08-16-01-T-S-S-00	Uniform	S	433.881	433.4	864788.2	826970.4	Surface 6-inch grab
L08-16-02-T-R-S-00	Uniform	S	433.391	429.0	864788.2	826970.4	Root 4.4-ft composite
L08-16-03-T-E-S-00	Uniform	S	428.961	428.5	864788.2	826970.4	Excavation 6-inch grab
L08-16-04-T-R-S-00	Uniform	S	430.794	429.3	864788.2	827013.7	Root 1.5-ft composite
L08-16-05-T-E-S-00	Uniform	S	429.311	428.8	864788.2	827013.7	Excavation 6-inch grab
L08-16-06-T-S-S-00	Uniform	S	433.25	432.8	864825.6	826992.0	Surface 6-inch grab
L08-16-07-T-R-S-00	Uniform	S	432.76	428.3	864825.6	826992.0	Root 4.4-ft composite
L08-16-08-T-E-S-00	Uniform	S	428.33	427.8	864825.6	826992.0	Excavation 6-inch grab
L08-16-09-T-E-S-00	Uniform	S	428.962	428.5	864825.6	827035.3	Excavation 6-inch grab
L08-16-10-T-E-S-00	Uniform	S	427.1	426.6	864863.0	827057.0	Excavation 6-inch grab
L08-16-11-T-E-S-00	Uniform	S	426.3	425.8	864900.4	827078.7	Excavation 6-inch grab
L08-16-13-T-R-S-00	Uniform	S	433.5	429.1	864937.8	827100.3	Root 4.4-ft composite
L08-16-14-T-E-S-00	Uniform	S	429.1	428.6	864937.8	827100.3	Excavation 6-inch grab
L08-16-15-T-S-S-00	Uniform	S	434.6	434.1	864975.2	827122.0	Surface 6-inch grab
L08-16-16-T-R-S-00	Uniform	S	434.1	429.7	864975.2	827122.0	Root 4.4-ft composite
L08-16-17-T-E-S-00	Uniform	S	429.7	429.2	864975.2	827122.0	Excavation 6-inch grab
L08-16-02-T-R-Q-00	Uniform	Q	433.4	429.0	864788.2	826970.4	Root 4.4-ft composite
L08-16-18-T-E-B-00	Uniform	B	429.0	428.5	864799.8	827034.6	6-inch Biased Sample
L08-16-19-T-E-B-00	Uniform	B	426.8	426.3	864959.3	827131.5	6-inch Biased Sample
L08-16-20-T-E-B-00	Uniform	B	426.2	425.7	864881.2	827063.8	6-inch Biased Sample

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

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)

Evaluate Final Status Survey Data: LSA-08-16

Sample ID	Sample Depth (ft)	Type (Systematic, Res, 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	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result						
LOB-16-01-TS-S-00	0.20	S	0.840	0.121	0.051	N/A	-0.230	0.000	0.571	0.571	0.069	0.214	N/A	0.930	0.167	0.078	N/A	-0.070	0.000	5.572	N/A	N/A	N/A	0.307	0.144	0.176	N/A	0.810	0.246	0.653	N/A							
Systematic Minimum			0.000				0.011					0.000								1.016				0.051				0.810										
Systematic Maximum			0.240				0.571					0.960								5.572				0.307				1.860										
Systematic Mean			0.100				0.111					0.103								2.879				0.156				1.098										
Systematic Standard Deviation			0.083				0.072					0.076								1.304				0.146				1.046										
Step 8.3.3			With ingrowth, use Ra226 bkg = 1.07						Th232 bkg = 1.0																													
Step 8.4.2			NOTES:																																			
			Gross results in units of cCi/a.																																			
			* Background with ingrowth (1.07 pCi/a) subtracted from gross result.																																			
			** Background (1.0 pCi/a) 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	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
0.000	0.571	0.000	5.572	0.307	0.810
0.240	0.116	0.290	3.769	0.204	1.540
0.040	0.035	0.100	2.230	0.121	0.838
0.093	0.241	0.130	3.857	0.211	1.063
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
0.050	0.048	0.120	4.998	0.276	1.040
0.190	0.068	0.060	2.409	0.131	0.891
0.190	0.099	0.020	3.396	0.186	1.050
0.070	0.011	0.000	1.381	0.069	1.200
0.100	0.061	0.270	3.060	0.168	0.889
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
0.1	0.0817	0.08	1.0165	0.0512	0.842
0.11	0.0655	0.05	1.4933	0.0783	0.905
0.02	0.075	0.07	1.7503	0.0893	1.33
0.18	0.0582	0.12	2.566	0.138	1.18
0.23	0.113	0.36	4.4478	0.24	1.86
0	0.239	0	2.8271	0.153	1.14
0	0.0385	0.02	2.1371	0.114	1.05
0.08	0.0929	0.08	3.0037	0.164	1.02
0.090	0.096	0.098	2.405	0.128	1.163

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 (S=soil, B=base, OC=organic)	Enrichment (%)	SOF	Root Status	Verification (unexcavated not backfilled only) Step 8.4.4.1	In Sample In Stream?	In Root? Sample Depth > 1.0 ft?	root count	enrichment count	background count	MDC MDC Step 8.1.1.6
L08-16-01-T-S-S-00	0.20	S	5.6	0.05	SURFACE	good						0.10
L08-16-02-T-R-S-00	0.70	S	4.0	0.13	ROOT	good		1				0.12
L08-16-03-T-E-S-00	4.95	S	1.0	0.11	EXCAVATION	good			1			0.13
L08-16-04-T-R-S-00	2.30	S	2.3	0.15	ROOT	good		1				0.09
L08-16-05-T-E-S-00	4.95	S	1.4	0.16	EXCAVATION	good			1			0.09
L08-16-06-T-S-S-00	0.20	S	2.1	0.31	SURFACE	good				1		0.10
L08-16-07-T-R-S-00	0.70	S	2.7	0.14	ROOT	good		1				0.12
L08-16-08-T-E-S-00	4.95	S	1.1	0.07	EXCAVATION	good			1			0.10
L08-16-09-T-E-S-00	4.95	S	1.9	0.18	EXCAVATION	good			1			0.11
L08-16-10-T-E-S-00	5.90	S	2.0	0.34	EXCAVATION	good			1			0.12
L08-16-11-T-E-S-00	5.70	S	2.1	0.55	EXCAVATION	good			1			0.08
L08-16-13-T-R-S-00	0.50	S	0.9	0.05	ROOT	good		1				0.12
L08-16-14-T-E-S-00	4.95	S	1.7	0.05	EXCAVATION	good			1			0.10
L08-16-15-T-S-S-00	0.40	S	2.2	0.09	SURFACE	good				1		0.09
L08-16-16-T-R-S-00	0.90	S	2.9	0.21	ROOT	good		1				0.11
L08-16-17-T-E-S-00	4.95	S	2.5	0.11	EXCAVATION	good			1			0.09
L08-16-02-T-R-O-00	5.70	O	5.3	0.07								0.08
L08-16-18-T-E-B-00	5.00	B	1.9	0.14								0.12
L08-16-19-T-E-B-00	7.20	B	3.1	0.05								0.13
L08-16-20-T-E-B-00	7.80	B	4.7	0.54								0.11
Average Enrichment (%)												
2.8												
0.06												
0.13												
0.11												
0.05												
count tot												
16												
5												
8												
3												

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

Step 8.4.1 DCLG<sub>net</sub> Measure Tc-99, All SEAs

U-234	195.4
U-235	51.6
U-238	165.6
Tc-99	25.1
Th-232	2.0
Ra-226	1.9

Step 8.4.5b

fractions	SS	RS	ES
weighted SOF <sub>max</sub>	0.1875	0.3125	0.5

Step 8.4.5c SOF<sub>net</sub> Re-use Backfill Material

0

Step 8.4.6 SOF<sub>net</sub> Groundwater

0.16

Step 8.4.5d (c=1)

SOF<sub>net</sub> SS U-235 PASS

Infer U234 Step 8.3.4			
U-238/U-235	U-234/U-235	U-234	%
2.5	16.1	5.6	6.6
3.8	18.1	5.0	4.0
16.4	19.9	1.0	1.0
6.8	18.4	2.4	2.3
11.6	18.1	1.5	1.4
7.5	18.5	3.8	2.1
5.6	18.3	3.4	2.7
14.9	18.6	1.8	1.1
8.4	18.6	2.6	1.8
7.8	18.5	4.4	2.0
7.5	18.5	2.8	2.1
17.5	20.2	1.4	0.9
9.2	18.7	2.1	1.7
6.9	18.4	2.2	2.2
6.3	18.2	5.1	2.9
6.2	18.3	3.0	2.5
2.6	18.1	7.9	5.3
8.3	18.6	2.9	1.9
5.0	18.2	3.0	3.1
3.2	18.1	45.5	4.7
Average Enrichment (%)			2.57

Infer U-234 MDC using U-235 MDC \* ratio of U-234/U-235 @ that sample's enrichment

3.194176
4.038114
5.082951
4.210594
4.119437
3.141227
3.778627
4.884424
4.351155
3.576763
3.242254
5.001117
4.536540
4.294057
3.151250
3.186901
3.281765
4.888818
3.254413
5.305704

Step 8.4.6 Calculate the dose contribution for the SU by multiplying SOF<sub>net</sub>(SU) (including contribution from Re-use backfill and Groundwater) by 25 mrem.

7.3 mrem



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.	0.09
DCGL <sub>SOF</sub>	1
LBGR (Mean)	0.13
Shift	0.87
Relative Shift ( $\Delta/\sigma$ )	9.51
MARSSIM Table 5.1 ( $P_r$ )	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	<b>SUFFICIENT MEASUREMENTS</b>
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

$\Delta/\sigma$	$P_r$
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,  $\alpha = 0.05$ ,  $\beta = 0.10$

$\alpha$ (or $\beta$ )	$Z_{1-\alpha}$ (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

$\alpha$   
 $\beta$

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 08-16					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 <sup>2</sup>	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)	
			Activity (x <sub>i</sub> )	MDC	Activity (x <sub>i</sub> )	MDC							
L08-16-02-T-R-S-00	L08-16-02-T-R-Q-00	Ra-226	1.12	0.0677	0.962	0.0553	1.041	1.9	0.158	0.269	0.403	N	
L08-16-02-T-R-S-00	L08-16-02-T-R-Q-00	Tc-99	0.0482	0.214	0.343	0.22	0.196	25.1	NA	3.552	5.321	NA	
L08-16-02-T-R-S-00	L08-16-02-T-R-Q-00	Th-232	1.12	0.0951	0.813	0.0783	0.967	2.0	0.307	0.283	0.424	Y	
L08-16-02-T-R-S-00	L08-16-02-T-R-Q-00	U-234 <sup>1</sup>	4.998	N/A	7.905	N/A	6.452	195.4	2.907	27.649	41.425	N	
L08-16-02-T-R-S-00	L08-16-02-T-R-Q-00	U-235	0.276	0.223	0.436	0.181	0.356	51.6	0.16	7.301	10.939	N	
L08-16-02-T-R-S-00	L08-16-02-T-R-Q-00	U-238	1.04	0.783	1.22	0.681	1.130	168.8	0.180	23.885	35.786	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: \_\_\_\_\_

Reviewed by: \_\_\_\_\_

Date: \_\_\_\_\_

Date: \_\_\_\_\_

Quality Record