

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 05	Description:	Technetium-99 Soils Open Land Area
Survey Unit:	04	Description:	Survey Unit in "Barns Area - Area 16"
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
L05-04-01-T-S-S-00	Uniform	S	425.95	425.5	864605.0	826597.0	Surface 6-inch grab
L05-04-02-T-R-S-00	Uniform	S	425.46	421.0	864605.0	826597.0	Root 4.4-ft composite
L05-04-04-T-E-S-00	Uniform	S	422.973	422.5	864605.0	826653.0	Excavation 6-inch grab
L05-04-05-T-S-S-00	Uniform	S	429.846	429.4	864605.0	826709.0	Surface 6-inch grab
L05-04-06-T-R-S-00	Uniform	S	429.356	424.9	864605.0	826709.0	Root 4.4-ft composite
L05-04-08-T-S-S-00	Uniform	S	426.104	425.6	864557.0	826569.0	Surface 6-inch grab
L05-04-09-T-R-S-00	Uniform	S	425.614	421.2	864557.0	826569.0	Root 4.4-ft composite
L05-04-11-T-S-S-00	Uniform	S	425.355	424.9	864557.0	826625.0	Surface 6-inch grab
L05-04-12-T-R-S-00	Uniform	S	424.865	420.4	864557.0	826625.0	Root 4.4-ft composite
L05-04-14-T-S-S-00	Uniform	S	424.2	423.7	864557.0	826681.0	Surface 6-inch grab
L05-04-15-T-R-S-00	Uniform	S	423.7	419.3	864557.0	826681.0	Root 4.4-ft composite
L05-04-17-T-S-S-00	Uniform	S	430.0	429.5	864557.0	826737.0	Surface 6-inch grab
L05-04-18-T-R-S-00	Uniform	S	429.5	425.1	864557.0	826737.0	Root 4.4-ft composite
L05-04-20-T-S-S-00	Uniform	S	428.0	427.5	864508.0	826597.0	Surface 6-inch grab
L05-04-21-T-R-S-00	Uniform	S	427.5	423.1	864508.0	826597.0	Root 4.4-ft composite
L05-04-22-T-E-S-00	Uniform	S	423.1	422.6	864508.0	826597.0	Excavation 6-inch grab
L05-04-02-T-R-Q-00	Uniform	Q	425.5	421.0	864605.0	826597.0	QA Duplicate Sample
L05-04-22-T-E-Q-00	Uniform	Q	423.1	422.6	864508.0	826597.0	QA Duplicate Sample
L05-04-23-T-R-B-00	Uniform	B	426.6	426.6	864590.0	826700.0	Sidewall 6-in Grab
L05-04-24-T-S-B-00	Uniform	B	422.6	422.1	864617.0	826638.0	Biased 6-in Grab
L05-04-25-T-S-B-00	Uniform	B	426.3	425.8	864625.0	826642.0	Biased 6-in Grab
L05-04-26-T-S-B-00	Uniform	B	422.2	421.7	864592.0	826704.0	Biased 6-in 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

Quality Record

Steps 8.3 Preliminary Data Review and 8.4 Calculation of the Sum-of-Fractions (SOF)

[illegible]

Gross results in units of pCi/g.

* Background with ingrowth (1

**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.

[illegible]

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)

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

0.12
0.11
0.13
0.09
0.17
0.11
0.10
0.07
0.13
0.10
0.14
0.05
0.14
0.08
0.11
0.11
0.16
0.12
0.12
0.11
0.11
0.14

Step 8.4.1 DCLG_W 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 8.4.5b

weighted SOF _{MEAN}		0.11		
	SS	RS	ES	
fractions	0.3125	0.5625	0.125	

Step 8.4.5c SOF_{DEAN} Re-use Backfill Material

0.17 Stockpile 8b

Step 8.4.5e SOF_{DEAN} Groundwater

0.16

Step 8.4.5g (<=1)

SOF_{DEAN SU} 0.431 PASS

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

11.0 mrem

Infer U234 Step 8.3.4			
U-238/U235	U-234/U235	U-234	%
3.4	18.1	5.6	4.4
6.0	18.3	2.7	2.5
8.2	18.6	1.7	1.9
7.4	18.5	2.7	2.1
9.2	18.7	2.0	1.7
2.6	18.2	9.3	5.7
3.8	18.1	3.2	4.0
3.3	18.1	8.8	4.5
9.3	18.7	2.2	1.7
2.5	18.2	5.3	5.8
11.4	19.1	1.4	1.4
2.9	18.1	6.1	5.1
0.0	0.0	1.3	0.7
3.8	18.1	5.9	4.0
12.9	19.4	1.5	1.2
14.5	19.6	1.0	1.1
16.0	19.9	2.2	1.0
8.6	18.7	1.3	1.8
5.0	18.2	3.2	3.1
6.6	18.3	1.6	2.4
6.0	18.3	2.4	2.6
6.3	18.3	2.6	2.5
Average Enrichment (%)			2.79

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

3.49405
4.169153
4.313926
2.882538
5.417514
4.284628
2.879193
7.469238
4.180374
3.196511
4.977553
2.319592
0
3.223448
4.305002
4.762624
5.340481
4.274332
3.19987
5.101038
4.425159
5.384764

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)

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
0.000	0.073	0.030	2.743	0.150	0.894
-	-	-	-	-	-
-	-	-	-	-	-
0.140	0.000	0.060	2.043	0.109	1.000
0.000	4.200	0.000	9.314	0.513	1.320
0.000	0.772	0.000	3.223	0.178	0.668
-	-	-	-	-	-
0.000	0.416	0.000	2.156	0.115	1.070
-	-	-	-	-	-
0.090	0.005	0.140	1.446	0.076	0.867
0.000	0.131	0.000	6.143	0.339	0.985
0.000	0.061	0.000	1.320	-0.099	1.320
-	-	-	-	-	-
0.000	0.325	0.040	1.332	0.069	0.883
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
0.026	0.665	0.030	3.302	0.161	1.001
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	0.294	0.14	1.6902	0.0909	0.745
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
0	0.159	0	0.9545	0.0487	0.705
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
0.050	0.227	0.070	1.322	0.070	0.725

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	1.31	2.310	46	46
9574-SS-140910-01-02	Reference	1.18	2.179	37	37
9574-SS-140910-01-03	Reference	1.06	2.064	32	32
9574-SS-140910-01-04	Reference	1.10	2.101	33	33
9574-SS-140910-01-05	Reference	1.29	2.293	45	45
9574-SS-140910-01-07	Reference	1.34	2.339	47	47
9574-SS-140910-01-08	Reference	1.15	2.154	36	36
9574-SS-140910-01-09	Reference	1.18	2.182	38	38
9574-SS-140910-01-10	Reference	1.23	2.227	43	43
9574-SS-140910-01-11	Reference	1.38	2.380	48	48
9574-SS-140910-01-12	Reference	1.05	2.055	31	31
9574-SS-140910-01-13	Reference	0.94	1.941	21	21
9574-SS-140910-01-14	Reference	1.12	2.119	34	34
9574-SS-140910-01-15	Reference	1.15	2.152	35	35
9574-SS-140910-01-16	Reference	1.03	2.028	28	28
9574-SS-140910-01-17	Reference	0.44	1.443	17	17
9574-SS-140910-01-18	Reference	1.19	2.188	40	40
9574-SS-140910-01-20	Reference	0.76	1.757	18	18
9574-SS-140910-01-21	Reference	1.02	2.023	27	27
9574-SS-140910-01-22	Reference	1.02	2.018	26	26
9574-SS-140910-01-23	Reference	1.00	2.002	23	23
9574-SS-140910-01-24	Reference	0.87	1.873	20	20
9574-SS-140910-01-25	Reference	1.04	2.040	30	30
9574-SS-140910-01-26	Reference	0.96	1.959	22	22
9574-SS-140910-01-27	Reference	1.20	2.204	41	41
9574-SS-140910-01-28	Reference	1.01	2.007	25	25
9574-SS-140910-01-29	Reference	1.22	2.223	42	42
9574-SS-140910-01-30	Reference	1.03	2.035	29	29
9574-SS-140910-01-31	Reference	1.00	2.005	24	24
9574-SS-140910-01-32	Reference	0.86	1.865	19	19
9574-SS-140910-01-33	Reference	1.24	2.238	44	44
9574-SS-140910-01-34	Reference	1.19	2.185	39	39
L05-04-01-T-S-S-00	Survey Unit	1.24	1.244	16	0
L05-04-02-T-R-S-00	Survey Unit	1.02	1.019	10	0
L05-04-04-T-E-S-00	Survey Unit	1.21	1.212	15	0
L05-04-05-T-S-S-00	Survey Unit	0.80	0.805	2	0
L05-04-06-T-R-S-00	Survey Unit	1.19	1.185	13	0
L05-04-08-T-S-S-00	Survey Unit	1.15	1.153	12	0
L05-04-09-T-R-S-00	Survey Unit	1.01	1.015	9	0
L05-04-11-T-S-S-00	Survey Unit	1.01	1.010	8	0
L05-04-12-T-R-S-00	Survey Unit	0.95	0.954	5	0
L05-04-14-T-S-S-00	Survey Unit	0.99	0.986	6	0
L05-04-15-T-R-S-00	Survey Unit	1.19	1.195	14	0
L05-04-17-T-S-S-00	Survey Unit	0.33	0.331	1	0
L05-04-18-T-R-S-00	Survey Unit	1.00	1.000	7	0
L05-04-20-T-S-S-00	Survey Unit	0.87	0.875	3	0
L05-04-21-T-R-S-00	Survey Unit	1.05	1.049	11	0
L05-04-22-T-E-S-00	Survey Unit	0.90	0.903	4	0
Rank Sums				1176	1040
# Reference Area Measurements				m	32
# Survey Unit Measurements				n	16
Total Number of Measurements Step 8.5.3c				N	48
(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	860

TEST: **PASS** Step 8.5.3f

HDP-PR-FSS-701 Final Status Survey Plan Development
Appendix P-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.	0.11
DCGL _{SOF}	1
LBGR (Mean)	0.11
Shift	0.89
Relative Shift (Δ/σ)	7.93
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
<p>"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

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FORM HDP-PR-FSS-703-1 FIELD DUPLICATE SAMPLE ASSESSMENT												
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Survey Unit No.:	LSA 05-04				Survey Unit Description:	Survey Unit in "Barns Area - Area 16"						
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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						
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	Ra-226	0.909	0.0596	0.909	0.0905	0.909	1.9	0	0.269	0.403	N
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	Tc-99	0.0725	0.234	0.0878	0.0905	0.080	25.1	NA	3.552	5.321	NA
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	Th-232	1.03	0.0922	0.574	0.225	0.802	2.0	0.456	0.283	0.424	Y
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	U-234 ¹	2.743	N/A	2.243	N/A	2.493	195.4	0.499	27.649	41.425	N
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	U-235	0.15	0.228	0.113	0.269	0.132	51.6	NA	7.301	10.939	NA
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	U-238	0.894	0.775	1.81	1.05	1.352	168.8	0.916	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: Thomas Yardy	Reviewed by: Clark Evers
Date:	Date:

Quality Record

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												
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Survey Unit No.:	LSA 05-04				Survey Unit Description:	Survey Unit in "Barns Area - Area 16"						
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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						
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	Ra-226	0.846	0.073	0.912	0.0834	0.879	1.9	0.066	0.269	0.403	N
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	Tc-99	0.159	0.227	0.134	0.223	0.147	25.1	NA	3.552	5.321	NA
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	Th-232	0.882	0.106	0.972	0.113	0.927	2.0	0.090	0.283	0.424	N
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	U-234 ¹	0.955	N/A	1.338	N/A	1.146	195.4	0.384	27.649	41.425	N
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	U-235	0.0487	0.243	0.0717	0.229	0.060	51.6	NA	7.301	10.939	NA
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	U-238	0.705	0.799	0.619	0.794	0.662	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: Thomas Yardy

Date:

Reviewed by: Clark Evers

Date:

Quality Record

LSA 05-04 Sys SOF

0.2

0.0

0.1

0.0

0.1

0.2

0.1

0.4

0.0

0.0

0.1

0.0

0.0

0.2

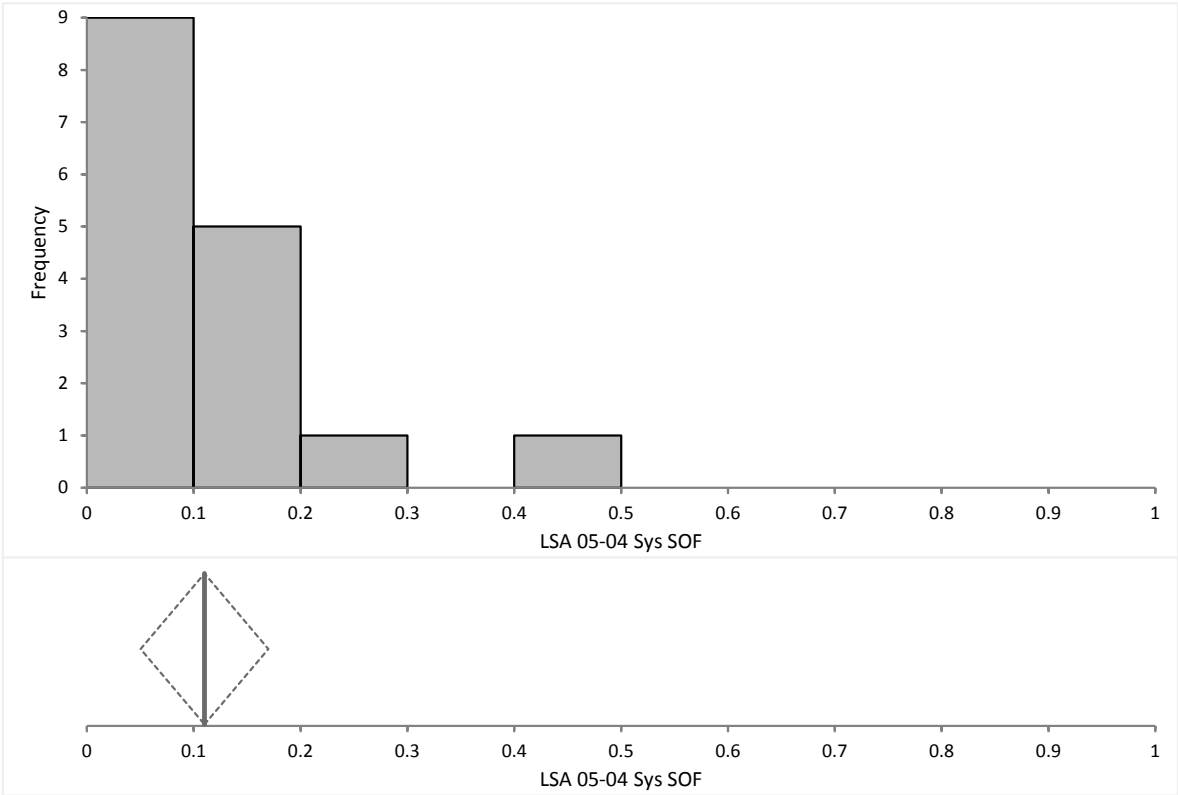
0.0

0.0

SOFn Only A1:A17

Last updated 13 March 2017 at 9:15 by W. Clark Evers

Descriptives



N		16						
	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 05-04 Sys SOF	0.11	0.05 to 0.17		0.028	0.11	0.01	2.0	4.81
	Minimum	1st quartile	Median	97.87% CI		3rd quartile	Maximum	IQR
LSA 05-04 Sys SOF	0.02	0.04	0.05	0.04 to 0.16		0.16	0.4	0.12