

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:	Barns and Cistern Open Land Area
Survey Unit:	01	Description:	Red Room Roof / Limestone Fill / Cistern Burn Pit
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
L050119TSS00	Uniform	S	439.8	439.3	864486	826500	Surface 6-in grab
L050120TRS00	Uniform	S	439.3	434.8	864486	826500	Root Zone Composite
L050121TSS00	Uniform	S	435.0	434.5	864479	826526	Surface 6-in grab
L050122TRS00	Uniform	S	434.5	430.0	864479	826526	Root Zone Composite
L050125TRS00	Uniform	S	432.2	429.2	864505	826519	Root Zone Composite
L050127TRS00	Uniform	S	429.4	425.4	864498	826545	Root Zone Composite
L050128TES00	Uniform	S	425.4	424.9	864498	826545	Excavation 6-in Grab
L050131TRS00	Uniform	S	439.0	436.5	864531	826512	Root Zone Composite
L050132TES00	Uniform	S	436.5	436.0	864531	826512	Excavation 6-in Grab
L050133TRS00	Uniform	S	427.7	423.7	864524	826538	Root Zone Composite
L050139TES00	Uniform	S	427.7	427.2	864550	826531	Excavation 6-in Grab
L050140TRS00	Uniform	S	426.6	424.6	864543	826557	Root Zone Composite
L050146TSS00	Uniform	S	441.7	441.2	864576	826524	Surface 6-in grab
L050147TRS00	Uniform	S	441.2	436.7	864576	826524	Root Zone Composite
L050148TRS00	Uniform	S*	427.0	425.0	864569	826550	Root Zone Composite
L050154TRS00	Uniform	S*	429.1	428.6	864596	826543	Root Zone Composite
L050155TES00	Uniform	S*	428.6	428.1	864596	826543	Excavation 6-in Grab
L050156TRS00	Uniform	S	426.4	425.4	864589	826570	Root Zone Composite
L050157TES00	Uniform	S	425.4	424.9	864589	826570	Excavation 6-in Grab
L050162TRS00	Uniform	S	428.1	423.6	864615	826563	Root Zone Composite
L050163TES00	Uniform	S	427.6	427.1	864615	826563	Excavation 6-in Grab
L050164TRS00	Uniform	S	426.6	426.1	864608	826289	Root Zone Composite
L050165TES00	Uniform	S	426.1	425.6	864608	826289	Excavation 6-in Grab
L050169TSS00	Uniform	S	441.5	441.0	864641	826556	Surface 6-in grab
L050170TRS00	Uniform	S	441.0	436.5	864641	826556	Root Zone Composite
L050171TRS00	Uniform	S	428.6	426.1	864634	826582	Root Zone Composite
L050172TES00	Uniform	S	426.1	425.6	864634	826582	Excavation 6-in Grab
L050119TSQ00	Uniform	Q	439.8	439.3	864486	826500	QA Duplicate Sample
L050162TRQ00	Uniform	Q	428.1	427.6	864615	826563	QA Duplicate Sample
L050165TEQ00	Uniform	Q	426.6	426.1	864608	826289	QA Duplicate Sample
L050176TUB00	Uniform	B	427.8	427.3	864558	826554	Biased 6-in Grab
L050177TUB00	Uniform	B	427.3	426.8	864558	826554	Biased 6-in Grab
L050186TUB00	Uniform	B	427.5	427.0	864572	826559	Biased 6-in Grab
L050187TUB00	Uniform	B	427.0	426.5	864572	826559	Biased 6-in Grab
L050188TUB00	Uniform	B	427.3	426.8	864557	826548	Biased 6-in Grab
L050189TUB00	Uniform	B	426.8	426.3	864557	826548	Biased 6-in Grab
L050190TUB00	Uniform	B	426.9	426.4	864581	826553	Biased 6-in Grab
L050191TUB00	Uniform	B	426.4	425.9	864581	826553	Biased 6-in Grab
L050192TUB00	Uniform	B	427.1	426.6	864569	826551	Biased 6-in Grab
L050193TUB00	Uniform	B	426.6	426.1	864569	826551	Biased 6-in Grab
L050194TUB00	Uniform	B	427.4	426.9	864557	826546	Biased 6-in Grab
L050195TUB00	Uniform	B	426.9	426.4	864557	826546	Biased 6-in Grab
L050196TUB00	Uniform	B	427.6	427.1	864566	826548	Biased 6-in Grab
L050197TUB00	Uniform	B	427.1	426.6	864566	826548	Biased 6-in Grab
L050198TUB00	Uniform	B	427.4	426.9	864596	826553	Biased 6-in Grab
L050199TUB00	Uniform	B	429.3	429.3	864607	826549	Biased 6-in Horizontal Grab
L0501100TUB0	Uniform	B	433.2	433.2	864610	826545	Biased 6-in Horizontal Grab
L0501101TUB0	Uniform	B	428.8	428.8	864615	826558	Biased 6-in Horizontal Grab
L0501102TUB0	Uniform	B	434.4	434.4	864620	826550	Biased 6-in Horizontal Grab
L0501103TUB0	Uniform	B	426.8	426.8	864584	826538	Biased 6-in Horizontal Grab
L0501104TUB0	Uniform	B	426.6	426.1	864548	826537	Biased 6-in Grab
L0501105TUB0	Uniform	B	431.9	431.4	864555	826527	Biased 6-in Grab
L0501106TUB0	Uniform	B	436.9	436.4	864504	826511	Biased 6-in Grab
L0501107TUB0	Uniform	B	436.5	436.0	864553	826521	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] (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)

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

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

	Uniform
U-234	198.4
U-235	51.6
U-238	188.8
Tc-99	25.1
Th-232	2.0
Re-226	1.9

Step 8.4.5b

weighted SOF_{max} 0.13

	SS	RS	ES
fractions	0	0.25	0.75

EMC Dose

0.11

Step 8.4.5e SOF_{net,SW} Groundwater

0.16

Step 8.4.5g (c=1)

SOF_{max,SW} 0.40 PASS

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

10 (S) mrem

Infer U234 Step 8.3.4			
U-238/U235	U-234/U238	U-234	%
2.7	18.1	2.3	5.4
7.8	18.5	2.2	2.0
32.2	22.7	1.1	0.5
25.0	21.1	1.3	0.7
5.5	18.2	2.2	2.8
9.4	18.7	2.1	1.7
11.9	19.2	2.5	1.3
5.1	16.2	2.5	3.0
12.2	19.2	2.7	1.3
9.9	18.8	1.9	1.6
6.3	18.3	4.4	2.4
22.6	21.1	1.1	0.7
4.8	18.2	1.6	3.2
42.0	24.2	0.2	0.4
9.0	18.7	4.1	1.7
5.1	18.2	5.5	3.0
3.8	18.1	6.3	4.0
8.5	18.7	1.9	1.8
12.4	19.2	1.0	1.3
7.9	18.5	2.8	2.0
20.3	20.6	1.6	0.8
4.9	18.2	3.3	3.1
34.3	22.7	0.9	0.5
4.7	18.2	1.3	3.2
6.8	18.4	0.9	2.3
9.9	18.8	2.1	1.6
10.7	18.9	2.8	1.5
6.9	18.4	4.0	2.3
7.6	18.5	3.0	2.0
70.0	26.6	0.3	0.3
10.1	18.3	2.4	1.6
4.2	18.1	2.2	3.6
6.4	18.3	2.2	2.4
6.1	18.3	4.2	2.5
25.6	21.1	1.5	0.7
15.8	19.9	1.5	1.0
16.8	19.6	1.3	1.1
7.3	18.5	2.5	2.1
4.3	18.1	6.3	3.5
3.8	18.1	5.3	3.9
6.3	18.3	1.3	2.5
12.3	19.2	1.6	1.3
7.1	18.4	1.3	2.2
20.1	20.6	1.3	0.8
41.5	24.2	0.5	0.4
6.9	18.4	4.4	2.3
9.1	18.7	1.7	1.7
8.0	18.5	8.5	2.0
4.0	18.1	2.0	3.8
4.4	18.1	16.3	3.5
6.0	18.3	2.7	2.6
7.2	18.4	4.8	2.2
13.1	19.4	2.7	1.2
4.1	18.1	2.2	3.7
Average Enrichment (%)			2.04

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

3.81
4.26
5.46
8.95
8.39
3.56
3.65
2.37
6.34
3.77
2.75
3.79
1.92
2.90
2.44
2.37
2.54
2.05
3.07
3.34
5.14
3.27
5.46
2.73
2.02
3.01
5.68
3.40
4.82
9.06
4.67
6.00
3.74
3.17
9.38
5.32
4.75
3.40
3.03
2.77
3.98
4.44
2.88
5.12
6.77
8.09
3.19
9.64
3.44
7.62
2.01
5.34
4.46
1.99

[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)

[illegible]

HDP-PR-FSS-721 Final Status Survey Data Evaluation
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
L050148TRS00	6.16	S*	0.68	0.1	0.04	N/A	-0.39	0	51.4	51.4	5.19	0.22	N/A	0.14	0.05	0.07	N/A	-0.86	0	4.124	NA	NA	NA	0.22	0.09	0.13	N/A	1.99	0.61	0.61	N/A	2.08
L050154TRS00	9.38	S*	0.86	0.12	0.04	N/A	-0.21	0	67.5	67.5	6.71	0.36	N/A	0.11	0.05	0.08	N/A	-0.89	0	5.459	NA	NA	NA	0.3	0.1	0.13	N/A	1.52	0.29	0.5	N/A	2.73
L050155TES00	9.38	S*	0.86	0.12	0.04	N/A	-0.21	0	82.5	82.5	8.67	0.2	N/A	0.15	0.05	0.03	N/A	-0.85	0	6.338	NA	NA	NA	0.35	0.13	0.14	N/A	1.32	0.32	0.58	N/A	3.33
L0501103TUB0	8.79	B	0.88	0.21	0.17	N/A	-0.19	0	46.8	46.8	4.77	0.2	N/A	0.58	0.2	0.12	N/A	-0.42	0	16.32	NA	NA	NA	0.9	0.39	0.42	N/A	3.95	2.05	2.45	N/A	1.99
L0501105TUB0	9.192	B	1.15	0.17	0.06	N/A	0.08	0.08	58.4	58.4	6.49	0.31	N/A	0.73	0.15	0.16	N/A	-0.27	0	4.792	NA	NA	NA	0.26	0.17	0.29	U	1.86	0.9	1.05	N/A	2.41
L050192TUB00	15.65	B	0.782	0.138	0.0723	N/A	-0.288	0	16.5	16.5	1.77	0.25	N/A	0.249	0.1	0.079	N/A	-0.751	0	6.293	NA	NA	NA	0.347	0.151	0.167	N/A	1.5	0.48	0.859	N/A	0.71
L050193TUB00	15.65	B	0.939	0.142	0.0712	N/A	-0.131	0	4.32	4.32	0.573	0.25	N/A	0.672	0.117	0.095	N/A	-0.328	0	5.27	NA	NA	NA	0.291	0.113	0.153	N/A	1.12	0.347	0.833	N/A	0.21
L050196TUB00	4.91	B	0.765	0.119	0.0564	N/A	-0.305	0	0.299	0.299	0.0765	0.23	N/A	0.573	0.104	0.094	N/A	-0.427	0	1.268	NA	NA	NA	0.069	0.101	0.156	U	0.487	0.259	0.834	U	0.02
L050197TUB00	4.91	B	0.877	0.134	0.0671	N/A	-0.193	0	0.195	0.195	0.0206	0.26	U	0.656	0.126	0.08	N/A	-0.344	0	1.25	NA	NA	NA	0.061	0.153	0.249	U	1.22	0.673	0.812	N/A	0.02
			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	8.1563
Tc-99	297.13
Th-232	6.2381
U-234	1980.9
U-235	133.21
U-238	631.21

Step 8.6.7.e. "clean" systematic samples δ_i

0.044
1.453
0.068
2.151
0.114
1.050

Step 8.6.7.f.1)

t_i
0.01
36.43
0.00
5.68
0.31
1.66

$t_i - \delta_i$

-0.035
34.982
-0.068
3.529
0.197
0.613

Step 8.6.7.f.2)

f_{dev}
-0.004
0.118
-0.011
0.002
0.001
0.001

Step 8.6.7.f.3) $f_{EMC} = 0.107$

Step 8.6.7.g. Summed elevated radioactivity fractions for the SU = 0.107 = EMC SOF

Step 8.6.7.h. Total SOF for the SU = 0.401 PASS

Step 8.6.7.i.

weighted SOF_{MEAN} 0.13
SOF_{MEAN} Re-use Backfill Material (used off-site BF) 0.00
SOF_{MEAN} Groundwater 0.16

HDP-PR-FSS-721 Final Status Survey Data Evaluation
Step 8.6 Investigations

Step 8.6.6	Bounding samples:	L050154TRS00
Step 8.6.7b		L050155TES00
Need area from GIS.	87 m ²	L0501103TUB0
	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
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:

87
10.1
2.6
3.7
11.8
3.1
4.3

Step 8.6.7.e. $\bar{\delta}_i$ = average concentration of systematic "clean" samples for each "elevated" nuclide

(Use corrected net results.)

Step 8.6.7.f.1) $\bar{\epsilon}_i$ = average concentration of elevated sample(s) for each ROC

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

$\bar{\epsilon}_i - \bar{\delta}_i$
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.)

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	30	6.1
Over	100	4.1
Interpolated	87	4.3

Tc-99 Uniform Area Factors		
	Area (m ²)	AF
Under	30	34
Over	100	10.3
Interpolated	87	11.8

Th-232 Uniform Area Factors		
	Area (m ²)	AF
Under	30	4.2
Over	100	3.0
Interpolated	87	3.1

U-234 Uniform Area Factors		
	Area (m ²)	AF
Under	30	19.6
Over	100	9.3
Interpolated	87	10.1

U-235 Uniform Area Factors		
	Area (m ²)	AF
Under	30	3.3
Over	100	2.5
Interpolated	87	2.6

U-238 Uniform Area Factors		
	Area (m ²)	AF
Under	30	5.0
Over	100	3.6
Interpolated	87	3.7

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	1.31	2.310	54	54
9574-SS-140910-01-02	Reference	1.18	2.179	45	45
9574-SS-140910-01-03	Reference	1.06	2.064	40	40
9574-SS-140910-01-04	Reference	1.10	2.101	41	41
9574-SS-140910-01-05	Reference	1.29	2.293	53	53
9574-SS-140910-01-07	Reference	1.34	2.339	55	55
9574-SS-140910-01-08	Reference	1.15	2.154	44	44
9574-SS-140910-01-09	Reference	1.18	2.182	46	46
9574-SS-140910-01-10	Reference	1.23	2.227	51	51
9574-SS-140910-01-11	Reference	1.38	2.380	56	56
9574-SS-140910-01-12	Reference	1.05	2.055	39	39
9574-SS-140910-01-13	Reference	0.94	1.941	29	29
9574-SS-140910-01-14	Reference	1.12	2.119	42	42
9574-SS-140910-01-15	Reference	1.15	2.152	43	43
9574-SS-140910-01-16	Reference	1.03	2.028	36	36
9574-SS-140910-01-17	Reference	0.44	1.443	25	25
9574-SS-140910-01-18	Reference	1.19	2.188	48	48
9574-SS-140910-01-20	Reference	0.76	1.757	26	26
9574-SS-140910-01-21	Reference	1.02	2.023	35	35
9574-SS-140910-01-22	Reference	1.02	2.018	34	34
9574-SS-140910-01-23	Reference	1.00	2.002	31	31
9574-SS-140910-01-24	Reference	0.87	1.873	28	28
9574-SS-140910-01-25	Reference	1.04	2.040	38	38
9574-SS-140910-01-26	Reference	0.96	1.959	30	30
9574-SS-140910-01-27	Reference	1.20	2.204	49	49
9574-SS-140910-01-28	Reference	1.01	2.007	33	33
9574-SS-140910-01-29	Reference	1.22	2.223	50	50
9574-SS-140910-01-30	Reference	1.03	2.035	37	37
9574-SS-140910-01-31	Reference	1.00	2.005	32	32
9574-SS-140910-01-32	Reference	0.86	1.865	27	27
9574-SS-140910-01-33	Reference	1.24	2.238	52	52
9574-SS-140910-01-34	Reference	1.19	2.185	47	47
L050119TSS00	Survey Unit	1.02	1.024	11	0
L050120TRS00	Survey Unit	0.98	0.981	9	0
L050121TSS00	Survey Unit	0.99	0.992	10	0
L050122TRS00	Survey Unit	1.32	1.320	24	0
L050125TRS00	Survey Unit	1.16	1.159	17	0
L050127TRS00	Survey Unit	1.16	1.162	19	0
L050128TES00	Survey Unit	1.23	1.228	21	0
L050131TRS00	Survey Unit	0.64	0.643	8	0
L050132TES00	Survey Unit	1.12	1.117	15	0
L050133TRS00	Survey Unit	1.06	1.061	14	0
L050139TES00	Survey Unit	1.06	1.058	13	0
L050140TRS00	Survey Unit	0.64	0.639	7	0
L050146TSS00	Survey Unit	0.41	0.412	4	0
L050147TRS00	Survey Unit	0.33	0.334	2	0
L050148TRS00	Survey Unit	2.51	2.513	57	0
L050154TRS00	Survey Unit	3.24	3.240	58	0
L050155TES00	Survey Unit	3.86	3.862	59	0
L050156TRS00	Survey Unit	0.56	0.559	5	0
L050157TES00	Survey Unit	0.60	0.597	6	0
L050162TRS00	Survey Unit	1.16	1.159	18	0
L050163TES00	Survey Unit	1.03	1.029	12	0
L050164TRS00	Survey Unit	1.15	1.146	16	0
L050165TES00	Survey Unit	1.17	1.169	20	0
L050169TSS00	Survey Unit	0.33	0.335	3	0
L050170TRS00	Survey Unit	0.30	0.296	1	0
L050171TRS00	Survey Unit	1.27	1.266	22	0
L050172TES00	Survey Unit	1.30	1.295	23	0
Rank Sums				1770	1296
# Reference Area Measurements				m	32
# Survey Unit Measurements				n	27
Total Number of Measurements Step 8.5.3c				N	59
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	1069

Min adjusted bkg SOF:
1.44

No WRS test necessary
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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 P-1 Step 8. 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)	0.13
Shift	0.87
Relative Shift (Δ/σ)	7.55
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	12
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 05-01			Survey Unit Description:		Red Room Roof / Limestone Fill / Cistern Burn Pit					
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						
L050119TSS00	L050119TSQ00	Ra-226	0.970	0.07	0.870	0.060	0.92	1.9	0.1	0.269	0.403	N
L050119TSS00	L050119TSQ00	Tc-99	0.42	0.21	0.3	0.05	0.36	25.1	0.12	3.552	5.321	N
L050119TSS00	L050119TSQ00	Th-232	0.89	0.13	1.000	0.100	0.945	2.0	0.110	0.283	0.424	N
L050119TSS00	L050119TSQ00	U-234 ¹	7.255	NA	4.045	NA	5.650	195.4	3.210	27.649	41.425	N
L050119TSS00	L050119TSQ00	U-235	0.4	0.21	0.22	0.21	0.310	51.6	0.18	7.301	10.939	N
L050119TSS00	L050119TSQ00	U-238	1.09	0.94	1.09	0.94	1.09	168.8	0	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										
										Revision: 2		Page 1 of 1
FORM HDP-PR-FSS-703-1 FIELD DUPLICATE SAMPLE ASSESSMENT												
Survey Unit No.:		LSA 05-01			Survey Unit Description:		Red Room Roof / Limestone Fill / Cistern Burn Pit					
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						
L050162TRS00	L050162TRQ00	Ra-226	0.970	0.09	1.130	0.070	1.05	1.9	0.16	0.269	0.403	N
L050162TRS00	L050162TRQ00	Tc-99	1.5	0.22	1.75	0.17	1.625	25.1	0.25	3.552	5.321	N
L050162TRS00	L050162TRQ00	Th-232	1.13	0.07	1.190	0.110	1.160	2.0	0.060	0.283	0.424	N
L050162TRS00	L050162TRQ00	U-234 ¹	2.780	NA	2.965	NA	2.873	195.4	0.185	27.649	41.425	N
L050162TRS00	L050162TRQ00	U-235	0.15	0.18	0.16	0.16	0.155	51.6	NA	7.301	10.939	NA
L050162TRS00	L050162TRQ00	U-238	1.19	0.98	1.22	1.22	1.205	168.8	0.03	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										
										Revision: 2	Page 1 of 1	
FORM HDP-PR-FSS-703-1 FIELD DUPLICATE SAMPLE ASSESSMENT												
Survey Unit No.:		LSA 05-01			Survey Unit Description:		Red Room Roof / Limestone Fill / Cistern Burn Pit					
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						
L050165TES00	L050165TEQ00	Ra-226	1.090	0.05	1.080	0.100	1.085	1.9	0.01	0.269	0.403	N
L050165TES00	L050165TEQ00	Tc-99	0.16	0.22	0.2	0.23	0.18	25.1	NA	3.552	5.321	NA
L050165TES00	L050165TEQ00	Th-232	1.15	0.11	1.110	0.140	1.130	2.0	0.040	0.283	0.424	N
L050165TES00	L050165TEQ00	U-234 ¹	0.909	NA	0.266	NA	0.588	195.4	0.643	27.649	41.425	N
L050165TES00	L050165TEQ00	U-235	0.04	0.24	0.01	0.34	0.025	51.6	NA	7.301	10.939	NA
L050165TES00	L050165TEQ00	U-238	1.37	0.92	0.7	0.96	1.035	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						Reviewed by: Clark Evers						
Date:						Date:						
Quality Record												

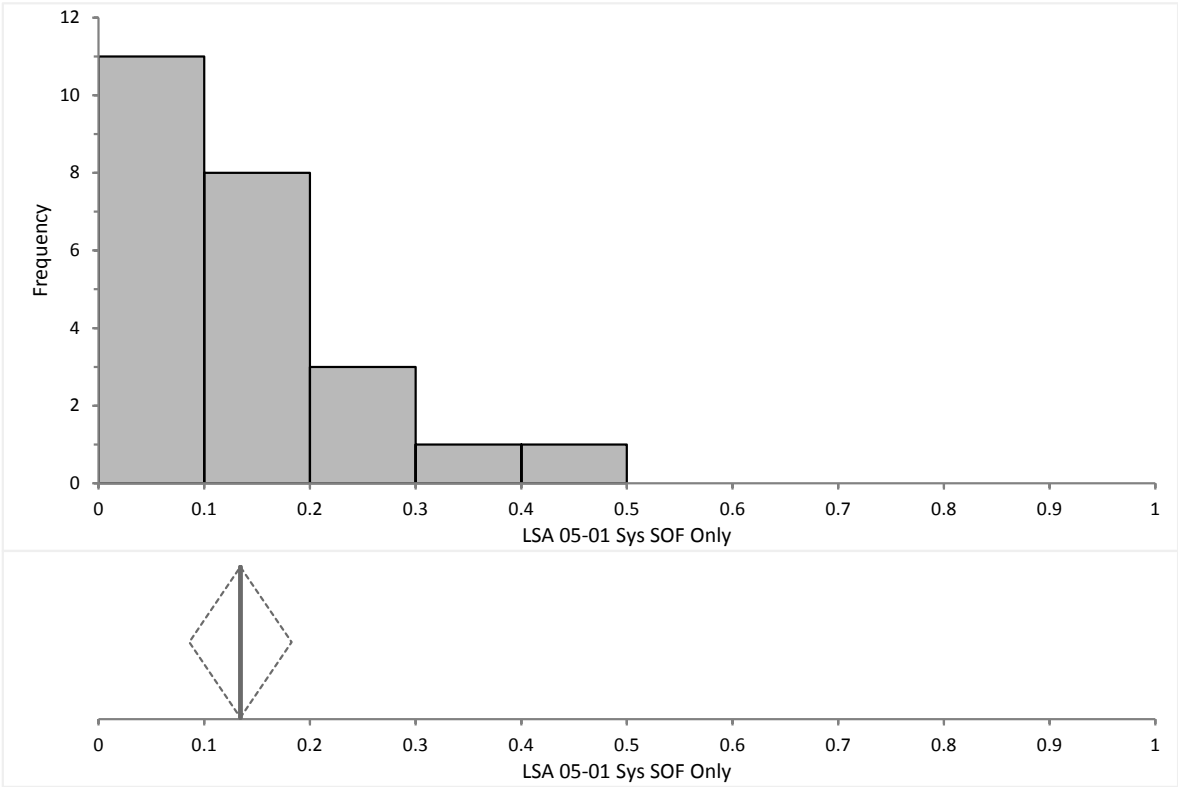
LSA 05-01 Sys SOF Only

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SOFn Only A1:A25

Last updated 2 March 2017 at 16:02 by W. Clark Evers

Descriptives



N		24						
	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 05-01 Sys SOF Only	0.13	0.09 to 0.18		0.023	0.11	0.01	1.6	3.20
	Minimum	1st quartile	Median	97.73% CI		3rd quartile	Maximum	IQR
LSA 05-01 Sys SOF Only	0.01	0.05	0.12	0.07 to 0.18		0.18	0.5	0.13