



ORISE TABLE 1

CONCENTRATIONS OF SELECTED  
GAMMA EMITTING RADIONUCLIDES  
IN SOIL SAMPLES  
BY GAMMA SPECTROSCOPY CP1, REVISION 13  
KERR-McGEE CUSHING REFINERY  
CUSHING, OKLAHOMA

ESSAP Sample ID	NRC Region IV Sample ID	Radionuclide Concentrations (pCi/g dry weight) <sup>f</sup>							
		U-234 <sup>b</sup>	U-235	U-238 by Th-234	Total U <sup>c</sup>	Ra-226 by Pb-214	Th-228 by Pb-212	Th-232 by Ac-228	Total Th <sup>d</sup>
1611S001	04-03-01	1.56 ± 0.73 <sup>e</sup>	0.03 ± 0.10	1.56 ± 0.73	3.2 ± 1.0	0.98 ± 0.11	1.23 ± 0.10	1.23 ± 0.20	2.47 ± 0.22
1611S002	04-03-02	1.58 ± 0.89	0.04 ± 0.15	1.58 ± 0.89	3.2 ± 1.3	0.91 ± 0.13	3.48 ± 0.25	3.28 ± 0.39	6.76 ± 0.46
1611S003	04-03-03	2.5 ± 1.1	0.04 ± 0.15	2.5 ± 1.1	5.0 ± 1.6	1.29 ± 0.15	3.55 ± 0.26	3.30 ± 0.40	6.85 ± 0.47
1611S004	04-03-04	0.96 ± 0.50	0.06 ± 0.09	0.96 ± 0.50	1.97 ± 0.72	0.92 ± 0.10	1.31 ± 0.10	1.24 ± 0.20	2.55 ± 0.22
1611S005	04-03-05	0.97 ± 0.77	0.02 ± 0.12	0.97 ± 0.77	2.0 ± 1.1	0.75 ± 0.12	1.56 ± 0.14	1.93 ± 0.29	3.49 ± 0.32
1611S006	04-03-06	3.0 ± 2.1	0.14 ± 0.10	1.05 ± 0.46	4.2 ± 2.1	0.74 ± 0.08	1.01 ± 0.08	0.99 ± 0.14	1.99 ± 0.16
1611S007	04-03-07	0.93 ± 0.48	-0.02 ± 0.07	0.93 ± 0.48	1.83 ± 0.68	0.60 ± 0.07	0.88 ± 0.07	0.95 ± 0.14	1.83 ± 0.16
1611S008	04-03-08	1.00 ± 0.78	-0.01 ± 0.12	1.00 ± 0.78	2.0 ± 1.1	0.60 ± 0.10	2.50 ± 0.18	2.61 ± 0.30	5.11 ± 0.35
1611S009	04-03-09	2.3 ± 2.2	0.11 ± 0.10	1.75 ± 0.78	4.2 ± 2.3	0.79 ± 0.11	1.03 ± 0.09	1.12 ± 0.20	2.15 ± 0.22
1611S010	04-03-10	1.01 ± 0.59	0.06 ± 0.08	1.01 ± 0.59	2.08 ± 0.84	0.78 ± 0.09	1.12 ± 0.09	1.18 ± 0.17	2.30 ± 0.19
1611S011	04-03-11	4.9 ± 3.4	0.22 ± 0.16	1.04 ± 0.60	6.1 ± 3.5	0.79 ± 0.11	1.12 ± 0.10	1.14 ± 0.21	2.26 ± 0.23
1611S012	04-03-12	5.4 ± 4.6	0.25 ± 0.21	2.30 ± 0.93	7.9 ± 4.7	0.78 ± 0.13	4.53 ± 0.32	4.02 ± 0.44	8.54 ± 0.54
1611S013	04-03-13	2.1 ± 1.7	0.10 ± 0.08	0.79 ± 0.48	3.0 ± 1.8	0.56 ± 0.07	1.31 ± 0.10	1.43 ± 0.17	2.74 ± 0.20
1611S014	04-03-14	1.48 ± 0.67	0.08 ± 0.10	1.48 ± 0.67	3.05 ± 0.95	0.72 ± 0.11	1.31 ± 0.11	1.24 ± 0.22	2.55 ± 0.25
1611S015	04-03-15	3.6 ± 2.9	0.17 ± 0.13	1.41 ± 0.84	5.2 ± 3.0	0.87 ± 0.13	2.56 ± 0.19	2.79 ± 0.35	5.35 ± 0.40
1611S016	04-03-16	3.3 ± 3.3	0.15 ± 0.15	3.0 ± 1.2	6.5 ± 3.5	1.06 ± 0.15	2.12 ± 0.17	2.41 ± 0.34	4.53 ± 0.38
1611S017	04-03-17	1.48 ± 0.96	0.00 <sup>f</sup> ± 0.16	1.48 ± 0.96	3.0 ± 1.4	1.11 ± 0.14	3.20 ± 0.24	3.25 ± 0.42	6.45 ± 0.49

ORISE TABLE 1 (continued)

CONCENTRATIONS OF SELECTED  
GAMMA EMITTING RADIONUCLIDES  
IN SOIL SAMPLES  
BY GAMMA SPECTROSCOPY CP1, REVISION 13  
KERR-McGEE CUSHING REFINERY  
CUSHING, OKLAHOMA

ESSAP Sample ID	NRC Region IV Sample ID	Radionuclide Concentrations (pCi/g dry weight) <sup>a</sup>							
		U-234 <sup>b</sup>	U-235	U-238 by Th-234	Total U <sup>c</sup>	Ra-226 by Pb-214	Th-228 by Pb-212	Th-232 by Ac-228	Total Th <sup>d</sup>
1611S018	04-03-18	1.17 ± 0.74	0.01 ± 0.11	1.17 ± 0.74	2.4 ± 1.0	0.90 ± 0.11	1.50 ± 0.12	1.49 ± 0.22	2.99 ± 0.25
1611S019	04-03-19	2.3 ± 1.8	0.10 ± 0.09	1.11 ± 0.52	3.5 ± 1.9	0.83 ± 0.09	1.31 ± 0.10	1.35 ± 0.19	2.66 ± 0.22
1611S020	04-03-20	1.09 ± 0.81	0.11 ± 0.13	1.09 ± 0.81	2.3 ± 1.1	0.83 ± 0.13	2.11 ± 0.17	2.08 ± 0.32	4.19 ± 0.36
1611S021	04-03-21	0.80 ± 0.55	-0.01 ± 0.09	0.80 ± 0.55	1.59 ± 0.78	0.88 ± 0.11	1.49 ± 0.12	1.40 ± 0.20	2.89 ± 0.24
1611S022	04-03-22	2.2 ± 1.7	0.10 ± 0.08	0.90 ± 0.43	3.2 ± 1.8	0.84 ± 0.09	1.18 ± 0.09	1.10 ± 0.16	2.28 ± 0.19
1611S023	04-03-23	1.37 ± 0.76	-0.04 ± 0.12	1.37 ± 0.76	2.7 ± 1.1	0.81 ± 0.10	3.21 ± 0.24	3.06 ± 0.35	6.26 ± 0.42
1611S024	04-03-24	4.8 ± 2.9	0.22 ± 0.13	1.39 ± 0.60	6.4 ± 3.0	0.86 ± 0.10	2.57 ± 0.18	2.50 ± 0.27	5.07 ± 0.33
1611S025	04-03-25	1.28 ± 0.72	0.08 ± 0.11	1.28 ± 0.72	2.6 ± 1.0	0.89 ± 0.11	1.33 ± 0.11	1.42 ± 0.22	2.76 ± 0.25
1611S026	04-03-26	3.2 ± 3.2	0.15 ± 0.15	1.35 ± 0.94	4.7 ± 3.4	1.02 ± 0.13	4.51 ± 0.33	4.49 ± 0.50	8.99 ± 0.60
1611S027	04-03-27	2.9 ± 2.5	0.13 ± 0.12	1.35 ± 0.71	4.4 ± 2.6	0.71 ± 0.10	1.39 ± 0.11	1.43 ± 0.22	2.82 ± 0.25
1611S028	04-03-28	6.9 ± 2.7	0.32 ± 0.12	1.27 ± 0.47	8.5 ± 2.7	0.73 ± 0.08	1.06 ± 0.08	1.04 ± 0.15	2.09 ± 0.17
1611S029	04-03-29	31.8 ± 5.3	1.47 ± 0.24	3.35 ± 0.80	36.6 ± 5.3	0.74 ± 0.10	1.50 ± 0.12	1.35 ± 0.22	2.85 ± 0.25
1611S030	04-03-30	1.5 ± 1.7	0.07 ± 0.08	0.75 ± 0.48	2.3 ± 1.7	0.78 ± 0.09	1.10 ± 0.09	1.05 ± 0.15	2.15 ± 0.18
1611S031	04-03-31	2.3 ± 1.9	0.11 ± 0.09	1.14 ± 0.55	3.6 ± 2.0	0.85 ± 0.10	1.30 ± 0.10	1.23 ± 0.18	2.54 ± 0.21

<sup>a</sup>The average MDCs for these radionuclides range from 0.05 pCi/g for Th-228 by Pb-212 to 0.78 pCi/g for U-238 by Th-234.

<sup>b</sup>The concentrations of U-234 are set equal to U-235 \* 21.7 when the U-235 concentrations are statistically positive above the MDC. Otherwise the concentration is set equal to the U-238 concentrations.

<sup>c</sup>Total U is the sum of U-234, U-235, and U-238.

<sup>d</sup>Total thorium is the sum of Th-228 and Th-232.

<sup>e</sup>Uncertainties represent the 95% confidence level, based on total propagated uncertainties.

<sup>f</sup>Zero value due to rounding.

ORISE TABLE 2

CONCENTRATIONS OF THORIUM AND URANIUM  
ALPHA EMITTING RADIONUCLIDES  
IN SOIL SAMPLES  
BY ALPHA SPECTROSCOPY AP11, REVISION 2 AND ALPHA SPECTROSCOPY CP2, REVISION 12  
KERR-McGEE CUSHING REFINERY  
CUSHING, OKLAHOMA

ESSAP Sample ID	NRC Region IV Sample ID	Radionuclide Concentrations (pCi/g dry weight) <sup>a</sup>							
		U-234	U-235	U-238	Total U <sup>b</sup>	Th-228	Th-230	Th-232	Total Th <sup>c</sup>
1611S012	04-03-12	3.66 ± 0.33 <sup>d</sup>	0.23 ± 0.05	1.48 ± 0.16	5.37 ± 0.37	4.10 ± 0.35	1.38 ± 0.14	4.17 ± 0.35	8.27 ± 0.49
1611S016	04-03-13	1.67 ± 0.17	0.12 ± 0.04	1.80 ± 0.17	3.60 ± 0.24	1.90 ± 0.18	1.69 ± 0.17	1.63 ± 0.16	3.53 ± 0.24
1611S024	04-03-24	2.19 ± 0.21	0.12 ± 0.04	1.31 ± 0.14	3.62 ± 0.26	2.16 ± 0.20	1.13 ± 0.12	2.08 ± 0.20	4.24 ± 0.28
1611S026	04-03-26	1.58 ± 0.16	0.13 ± 0.04	1.19 ± 0.13	2.89 ± 0.22	4.11 ± 0.35	1.48 ± 0.15	4.10 ± 0.35	8.21 ± 0.49
1611S028	04-03-28	5.00 ± 0.43	0.25 ± 0.06	1.16 ± 0.13	6.41 ± 0.45	0.95 ± 0.11	0.96 ± 0.11	1.01 ± 0.11	1.96 ± 0.16
1611S029	04-03-29	28.0 ± 1.2 <sup>e</sup>	1.44 ± 0.09 <sup>e</sup>	3.86 ± 0.20 <sup>e</sup>	33.3 ± 1.3	1.46 ± 0.16	1.07 ± 0.12	1.43 ± 0.15	2.89 ± 0.22

<sup>a</sup>The average MDCs by alpha spectroscopy for Th isotopes are 0.03 pCi/g and for U isotopes are 0.03 pCi/g.

<sup>b</sup>Total U is the sum of U-234, U-235, and U-238.

<sup>c</sup>Total thorium is the sum of Th-228 and Th-232.

<sup>d</sup>Uncertainties represent the 95% confidence level, based on total propagated uncertainties.

<sup>e</sup>U-234, U-235, and U-238 concentrations were generated averaging the results from three separate sample aliquots.