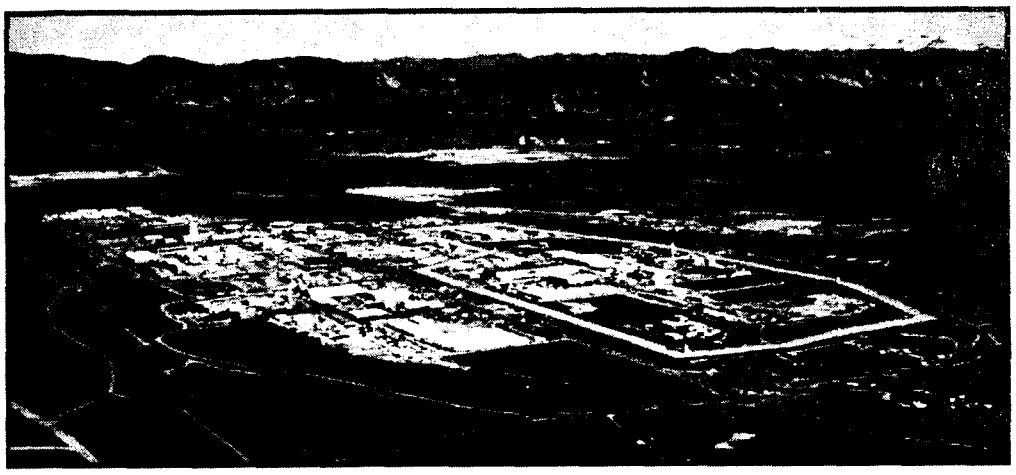
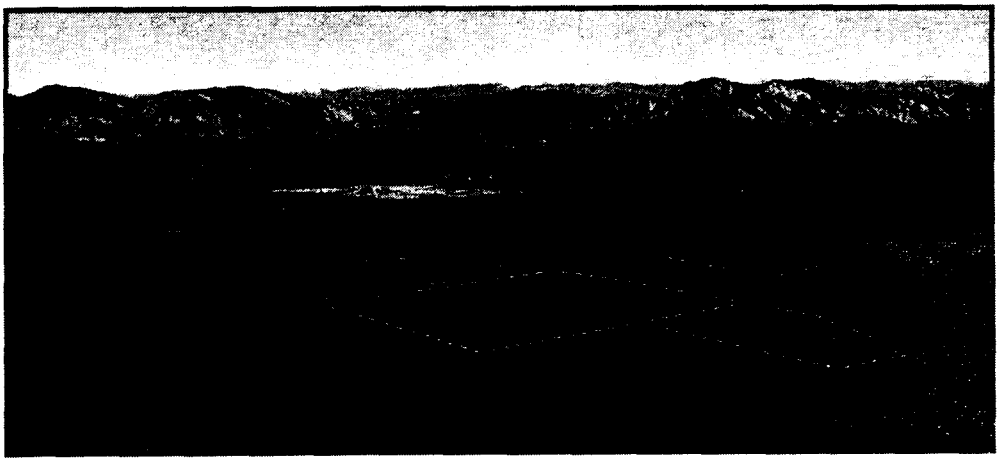
Accelerating Cleanup: Focus on 2006

Rocky Flats Environmental Technology Site

Discussion Draft - Volume I



Rocky Flats - 1996



Rocky Flats End State

June 1997

"REVIEWED FOR CLASSIFICATION/UNCL"
BY: J. D. McLaughlin (UNCL)
DATE: 5/23/97

#000067645

RMRS Rocky Mountain Remediation Services, L.L.C.
. . . protecting the environment

INTEROFFICE MEMORANDUM

DATE: October 10, 1997

TO: J.M. Langsted, RMRS Project Compliance, T893A, X2542, DP 505-7628

FROM: S.M. Paris, RMRS Environmental Restoration Projects, T893B, X3656, DP 4624

SUBJECT: HIGH PURITY GERMANIUM (HPGe) DETECTOR USAGE ON RMRS ENVIRONMENTAL RESTORATION PROJECTS - SMP-001-97

Purpose

The purpose of this memorandum is to provide RMRS Project Compliance with information detailing the generation of data from onsite HPGe gamma spectroscopy associated with RMRS Environmental Restoration Projects group since July 1, 1995. Information is also provided on data generated from RFETS (Site) and offsite analytical laboratories which will hereafter be referenced as isotopic analyses. This information is included to demonstrate that decisions were also based on isotopic analysis and may provide useful information for comparison purposes.

Onsite HPGe gamma spectroscopy has been used to analyze soil and debris samples to:

1. Determine requirements associated with Site radiological operating procedures;
2. Compare treated and untreated soils to Rocky Flats Cleanup Agreement (RFCA) Action Level Framework (ALF) for soil putback decisions;
3. Support waste acceptance criteria requirements of offsite disposal facilities; and
4, Support waste acceptance criteria requirements of onsite waste storage facilities.

The following specific information was derived from project completion/closeout reports and data summaries.

Ryan's Pit Remedial Action

The Ryan's Pit Remedial Action was initiated in July 1995, treated soils were returned to the excavation in September 1996. Treated debris was shipped offsite to the Nevada Test Site (NTS) along with Trenches 3 & 4 (T-3/T-4) treated debris in September 1997.

Cleanup standards included in the Ryan's Pit Proposed Action Memorandum (PAM) were based on proposed preliminary remediation goals (PPRGs). These PPRGs were replaced by the Tier I and Tier II action levels established in the ALF of the RFCA which were negotiated during the implementation of the Ryan's Pit Remedial Action. The Ryan's Pit PAM included the preliminary Tier I and Tier II action levels for radionuclides which were applied to this remedial action as agreed to by Department of Energy (DOE), Kaiser-Hill (K-H), Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE). These preliminary Tier I and Tier II action levels were accepted as the final action levels.

Contaminated soils from Ryan's Pit were excavated and stored in nine roll-off containers prior to treatment. One composite sample from each roll-off was collected for isotopic analyses. These data are provided in Table 4, Results of the Radioisotopic Analysis from Excavated Ryan's Pit Soils, provided in the Closeout Report for the Remediation of Individual Hazardous Substance Site 109, Ryan's Pit (previously provided). These data were to be used to evaluate the soil with respect to the hazardous waste criteria for metals established in 6 CFR 1007-3, Section 261.24, and PPRGs for radionuclides prior to returning the soils to the excavation. Samples from six of the nine roll-off containers exceeded the PPRGs criteria established in the Ryan's Pit PAM and three roll-offs exceeded the Tier I ALF. As a result the returning of soils following the volatile organic compound (VOC) treatment process was delayed pending resolution of radiological issues.

Confirmation samples were collected from the base and sidewalls of the excavation to confirm all soils in excess of cleanup levels negotiated in the PAM had been removed and that excavation activities have been completed. Ten soil samples were collected from the excavation and analyzed for isotopic composition. The results of the excavation samples are provided in Table 2, Excavation Boundary Radiological Confirmation Sample Results, provided in the Ryan's Pit Closeout Report (previously provided).

The excavated soils in the nine roll-offs was then treated by low-temperature thermal desorption methods and was placed into eleven roll-offs. It was determined that the soils and original characterization data of the nine roll-offs could not be traced to the post-treatment roll-off containers. Therefore, the original data was no longer representative of soils in roll-offs and the soils would require additional radiological characterization. RMRS prepared a new sampling and analysis plan and resampled the eleven roll-off containers for radionuclides. Three samples from each roll-off were generated by compositing four subsamples using a statistical method to ensure representative sampling. A total of thirty-three samples were collected and analyzed using onsite HPGe gamma spectroscopy. The sums of ratios for these samples were calculated with respect to the Tier II action levels and were well below 1.0, indicating no exceedance of the Tier II action levels. Therefore, the soils were returned to the excavation. The results of the gamma spectroscopy analysis are provide in Appendix 3 of the Ryan's Pit Closeout Report (previously provided).

Some drums were unearthed during the excavation and treated by thermal desorption methods. These drums were later stored in a roll-off container and subsequently were mixed with drums generated and treated during the T-3/T-4 Remedial Action. These drums may have been selected for radiological characterization using onsite HPGe gamma spectroscopy. The debris section provided in the Trench 3/Trench 4 Remedial Action section below provides information on debris sampling and analysis for this project.

Trench3/Trench 4 Remedial Action

The T-3/T-4 remediation project field effort was completed in fiscal year 1996 (FY96), treated soils were returned to the excavation in September 1996. Treated debris was shipped offsite to the NTS along with Ryan's Pit treated debris in September 1997. During the remediation of T-3/T-4, 1,706 cubic yards were removed from T-3, and 2,090 cubic yards were removed from T-4.

The soils excavated from the trenches were initially screened using a field instrument for the detection of low energy radiation (FIDLER) and material removed from the trenches were stockpiled in two separate piles. Soils above 5,000 cpm were segregated and kept separate from soils below 5,000 cpm during treatment. Confirmation samples were obtained from the base and sidewalls of the completed excavation, however, no samples were analyzed for radionuclides.

Stockpiled soils were sampled for radionuclides for comparison to RFCA ALF. Following treatment both stockpiles of treated soils were marked off into approximately equal grids. At least one sample was collected per 100 cubic yards of the post-treatment non-radiologically contaminated soils (soils

HPGe gamma spectroscopy. The results were used to remove radiological requirements from the soil stockpile area. These data are provided in RMRS Memorandum RCG-0002-97 (previously transmitted).

Actinide Migration

Pond B-1 sediment samples were collected in 1997 and were to be shipped to the Colorado School of Mines (CSM) for radiochemical analysis. These samples were expected to be radiologically contaminated and required a radiological screening analysis to be shipped offsite. Onsite HPGe gamma spectroscopy was selected to be used to replace the radiological screening usually performed in the 559 Laboratory. The HPGe data was used to determine if the Radiological Work Permit for 881 Laboratory would be exceeded if the samples were sent there. Samples were planned to be sent to 881 Laboratory for a radiological screen for shipping purposes. The HPGe samples results (Attachment 3) were within the 2 nanocuries RWP limit of 881 Laboratory. However, when screened by the 881 Lab, one sample was found to be above 3 nanocuries. Radiological screening results for gross alpha and gross beta from 881 Laboratory are provided as Attachment 4.

The HPGe results were provided to RMRS Surface Water, and are provided as Attachment 3. The sediment samples were sent to CSM for analysis in support of the Actinide Migration Panel investigation. Results were obtained for CSM plutonium-239/240 analysis and are provided as Attachment 5.

IHSS 119.1 Pre-Remedial Investigation

Five radiological hot spots were removed from this site in 1994, and a plume of VOC contaminated groundwater is present. Previous investigation samples were analyzed and results were below Tier II levels. Post-hot spot removal FIDLER surveys also did not indicate a radiological concern. However, samples were collected and analyzed using onsite HPGe gamma spectroscopy to verify that radiological controls would not be required during the planned remedial action. No VOC contamination above action levels was discovered during the investigation, and the remedial action was canceled. Therefore no decisions were made based on the data generated.

If you have any questions concerning this information please contact me at X3656.

Attachments (5)

cc: J.L. Anderson (w/o attach.)
M.C. Broussard (w/o attach.)
G.D. DiGregorio (w/o attach.)
L.A. Dunstan (w/o attach.)
S.L. Garner (w/o attach.)
J.K. Hopkins (w/o attach.)
J. E. Law (w/o attach.)
A.L. Primrose (w/o attach.)
H. Solomon (w/o attach.)
W.R. Sproles (w/o attach.)

KAISER • HILL
COMPANY

INTEROFFICE MEMORANDUM

DATE: September 19, 1996

TO: S. L. Garner, RMRS Project Manager, Bldg T893B, X6588

FROM: R. S. Tyson, Radiological Engineering, Bldg T690B, X8172/D7982

SUBJECT: REPORT OF RESULTS FROM GAMMA RAY SPECTROSCOPY OF TRENCH T-3/T-4 WASTE MATERIALS - RST-019-96

Radiological Engineering (RE) was tasked with performing gamma ray spectroscopy of various waste materials from Trenches T-3 and T-4 to characterize this material for disposal following treatment for volatile organic constituents. Samples of these materials were collected, and 6 samples were transferred to RE for data acquisition. The samples were weighed and net weights calculated.

Gamma spectroscopy measurements were acquired in accordance with RE Procedure 4-W03-REP-1401, Operation of the Gamma Spectroscopy Systems. This procedure provides the guidance to perform measurements in various geometries and system configurations. Additionally, the equipment used for data acquisition was previously calibrated and characterized in accordance with procedure 4-R29-REP-1402, Routine Characterization of a High Purity Germanium Detector (HPGe). This process included characterization and calibration for the geometry of 250ml plastic sample jars.

The system utilized for acquisition of data was an EG&G Ortec Lo-Ax HPGe detector coupled to an EG&G Nomad™ 92X multichannel analyzer. The microprocessor used was a Compaq 386S/20™ laptop computer. EG&G Ortec Maestro II™ software was used for data collection, and the Environmental Gamma-Ray Analysis Software (EGAS) was used for data reduction and analysis.

Data Collection Methodology

After calibration of the instrument, a 3600 second background measurement was performed so as to be able to subtract any natural radiation contributions from the acquired data. Then, the sample jar was placed 1 centimeter (cm) from the face of the detector, and a 3600 second acquisition was performed of the sample. Once collected, the data was transferred to the EGAS software for analysis.

less than 5,000 cpm). Approximately 500 cubic yards were considered as potentially radiologically-contaminated treated material (soils greater than 5,000 cpm), and were sampled at a frequency of about one sample for every 35 cubic yards.

A total of 54 soil samples were collected and analyzed from post-treatment soil stockpiles using onsite HPGe gamma spectroscopy. The results of these samples were previously provided to Project Compliance. Based on these results, all soils were below Tier I ALF values, and all but 250 cubic yards were below Tier II ALF values. The soils below Tier II ALF values were returned to the trenches in bulk. The soils above Tier II ALF values were placed within a geotextile liner, to mark their location, and putback in the west end of T-4.

Onsite gamma spectroscopy was used to support waste acceptance criteria for the characterization of approximately 70 post-treatment crushed drums generated from the T-3/T-4 project and Ryan's Pit project. A total of 42 debris samples were analyzed in order to appropriately disposition these materials. These results were previously provided to Project Compliance and may also be found in the T-3/T-4 Completion Report.

Radiological screens were performed on T-3/T-4 soils prior to performing HPGe analysis. The radiological screen results for these samples have not been located as of this date.

Miscellaneous waste materials were also analyzed using onsite gamma spectroscopy to support waste storage requirements for interim storage at the RFETS. Gamma spectroscopy was performed on debris samples including asphalt, wood, and sediment generated from decontamination operations. Results from these analysis are provided in K-H Interoffice Memorandum RST-019-96 (Attachment 1). Gamma spectroscopy was also performed on condensate generated in the oil/water separation unit used for the T 3/T-4 project. The analysis was performed to meet the WAC of the 891 Consolidate Water Treatment Facility. Results from these analysis are provided in K-H Interoffice Memorandum RST-021-96 (Attachment 2) .

Mound Site Remedial Action

The Mound remediation project was completed in FY97, treated soils were returned to the excavation in September 1997. The site was re-excavated in late September 1997 to retrieve T-3/T-4 soils found to exceed Tier I ALF and subsequently backfilled for the final time. Soil retrieved from the re-excavation activity were shipped offsite to the NTS in late September 1997.

Pre-remedial characterization of the Mound Site used radiochemical analyses of soil samples to determine that these soils were below Tier II action levels. All Mound Site soils were screened using the FIDLER during excavation and results were within the background range. However, during initial FIDLER surveys of the Contaminated Soil Feed Stockpile (located in the East Trenches area outside of the Mound Site area), material related to T-3/T-4 was discovered and was drummed. Samples from these drums were analyzed using onsite HPGe gamma spectroscopy, results were determined to be slightly below the Tier II ALF values. Based on this information, and with the concurrence of EPA, CDPHE, DOE RFFO, Kaiser-Hill, SSOC Radiological Engineering, and RMRS, this drummed material was placed into the Mound excavation during backfill operations. After backfilling was complete, questions about the validity of the data were brought up. The original sample material was reanalyzed using the recalibrated and baselined HPGe equipment, and the results were slightly above Tier II values. In response to additional questions and concerns, the sample material was sent offsite to a laboratory where the material was crushed, dried, and homogenized prior to gamma spectroscopy analysis. Results showed activity levels twice that originally calculated. Based on these results, the soils were re-excavated from the Mound Site and shipped to the NTS for disposal.

Onsite gamma spectroscopy was also utilized to determine radiological positing requirements of pre-treated soil stockpile. Fourteen soil samples were collected from the stockpile and analyzed using

Results

Photopeaks, or energy lines corresponding to the normal mixture of naturally occurring radioisotopes were present in the spectra, and corresponded to typical levels of activity in the background measurements. Additionally, photopeaks above background were identified for the following isotopes: Uranium-235 (^{235}U), Uranium-238 (^{238}U), and Americium-241 (^{241}Am). Based on empirically established ratios of ^{241}Am to Plutonium-239/240 ($^{239/240}Pu$) of 1 to 5, a concentration of $^{239/240}Pu$ was calculated and included in the summary report provided as Attachment 1. Provided as Attachment 2 are the individual data analysis reports for each of the six samples.

Summary

Attachment 1 provides a summary report of the acquired data after analysis, including sample weights, and the activity per unit mass of each isotope. This information is provided to properly characterize the material for disposition. Additional RE analyis may be required for each waste stream prior to disposal. Please contact me at extension 8172 or on digital pager 7982 with any questions regarding this matter.

Concurrence:

B. P. Colby 9/19/96
Date

rst

Attachments
As stated

cc (w/o attachment 2):
J. L. Anderson
M. C. Broussard
B. P. Colby
R. S. Roberts
A. K. Sieben
A. M. Tyson

GAMMA SPECTROSCOPY ANALYSIS:
TRENCH T3/T4 DEBRIS SAMPLES

Sample Number	Net Wt (g)	Activity (picoCuries)				Concentration (picoCuries/gram)				
		U-235 (b)	U-238	Am-241 (c)	Pu-239/240	U-235	U-238	Am-241	Pu-239/240	Total
DB00022RM	273.90	158.00	4,230.00	NDA	NDA	0.58	15.44	NDA	NDA	16.02
DB00023RM	280.30	NDA	1,850.00	NDA	NDA	NDA	6.60	NDA	NDA	6.60
DB00024RM	58.10	155.00	2,340.00	294.00	1,470.00	2.67	40.28	5.06	25.30	73.30
DB00025RM	86.70	263.00	13,900.00	NDA	NDA	3.03	160.32	NDA	NDA	163.36
DB00026RM	281.00	447.00	22,300.00	504.00	2,520.00	1.59	79.36	1.79	8.97	91.71
~~DB00027RM~~	~~231.70~~	~~NDA~~	~~NDA~~	NDA	NDA	NDA	NDA	NDA	NDA	NDA

NDA: No Detectable Activity above Background

Attachment 2

Received from K-H on 10/9/96

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COMPANY

INTEROFFICE MEMORANDUM

DATE: September 26, 1996

TO: S. L. Garner, RMRS Project Manager, Bldg T893B, X6588

FROM: R. S. Tyson, Radiological Engineering, Bldg T690B, ~~X8172/D7982~~

SUBJECT: REPORT OF RESULTS FROM GAMMA RAY SPECTROSCOPY OF TRENCH T-3/T-4 WASTE MATERIALS - RST-021-96

Radiological Engineering (RE) was tasked with performing gamma ray spectroscopy of various waste materials from Trenches T-3 and T-4 to characterize this material for disposal following treatment for volatile organic constituents. A sample of this material was collected, and transferred to RE for data acquisition.

Gamma spectroscopy measurements were acquired in accordance with RE Procedure 4-W03-REP-1401, Operation of the Gamma Spectroscopy Systems. This procedure provides the guidance to perform measurements in various geometries and system configurations. Additionally, the equipment used for data acquisition was previously calibrated and characterized in accordance with procedure 4-R29-REP-1402, Routine Characterization of a High Purity Germanium Detector (HPGe). This process included characterization and calibration for the geometry of 250ml plastic sample jars.

The system utilized for acquisition of data was an EG&G Ortec Lo-Ax HPGe detector coupled to an EG&G Nomad™ 92X multichannel analyzer. The microprocessor used was a Compaq 386S/20™ laptop computer. EG&G Ortec Maestro II™ software was used for data collection, and the Environmental Gamma-Ray Analysis Software (EGAS) was used for data reduction and analysis.

Data Collection Methodology

After calibration of the instrument, a 3600 second ~~background measurement was~~ performed so as to be able to subtract any natural radiation contributions from the acquired data. Then, the sample jar was placed 1 centimeter (cm) from the face of the detector, and a 3600 second acquisition was performed of the sample. Once collected, the data was transferred to the EGAS software for analysis.

Results

Photopeaks, or energy lines corresponding to the normal mixture of naturally occurring radioisotopes were present in the spectra, and corresponded to typical levels of activity in the background measurements. Additionally, photopeaks above background were identified for the following isotopes: Uranium-235 (^{235}U) and Uranium-238 (^{238}U). This information is detailed in the summary report provided as Attachment 1. Provided as Attachment 2 is the individual data analysis report for the sample.

Summary

Attachment 1 provides a summary report of the acquired data after analysis, including sample weights, and the activity per unit mass of each isotope. This information is provided to properly characterize the material for disposition. Additional RE analysis may be required for each waste stream prior to disposal. Please contact me at extension 8172 or on digital pager 7982 with any questions regarding this matter.

Peer review:

J. Anderson 10/9/96

Date

rst

Attachments
As stated

cc (w/o attachment 2):
J. L. Anderson
M. C. Broussard
B. P. Colby
R. S. Roberts
A. K. Sieben
A. M. Tyson

SUMMARY REPORT

Sample Number	Net Weight, grams	U-235 activity, pCi	U-238 activity, pCi	U-235 activity, pCi/g	U-238 activity, pCi/g	Total Activity, pCi/g
DB00014RM	250.00	163.00	2430.00	0.65	9.72	10.35

SmplDB00014RM,det20677,1cm,3600s,082896,250ml pbs,LNAPL

** Software Version: 110595/ 20677/Q by R. T. Reiman *

Energy (keV)	Resolution FWHM (keV)	Live Time Seconds	Real Time Seconds	Quad Value	Gain (kev/ch)	OFFSET (keV)	HEIGHT (cm)
1460.7	1.98	3600	3611	.313E-08	.187	.573E-01	1

Nuclide Summary

Isotope	Activity Ci	Error %
K- 40	.239E-07	4.7
U- 238	.243E-08	14.8
Ra 226	.876E-09	7.8
U- 235	.163E-09	24.8
Th 232	.505E-09	11.3

ENERGY (keV)	NET COUNT	BACKGROUND COUNT	ERROR (%)	ISOTOPE	PHOTO-PEAK	ACTIVITY (Ci)		EXPOSURE (uR/Hr)
13.6	150.0	1763.0	40	Pa 231	12.6	.20E-08	.00	.11E-05
				Th 231	13.3	.14E-09	.00	
				Th 234	13.3	.13E-08	.00	
				Pa 234	13.6	.32E-07	.00	
				Pu 238	13.6	.32E-08	.00	
				AM 241	13.9	.45E-09	.00	
				Am 243	13.9	.76E-09	.00	
				Y- 88	14.1	.24E-09	.00	
				Cm 244	14.3	.12E-08	.00	
				Co 57	14.4	.13E-08	.00	
24.8	206.1	1495.9	27	Sn 113	24.0	.58E-09	.00	.20E-05
				In 115	24.2	.12E-09	.00	
				Sn 113	24.2	.31E-09	.00	
				Cd 109	24.9	.84E-09	.00	
				Cd 109	25.5	.50E-08	.00	
63.7	310.3	2203.7	22	TH 234	63.2	.27E-08	.00	.45E-05
				U- 238	63.2	.27E-08	.00	
87.6	257.6	2458.4	28	Am 243	86.8	.24E-07	.00	.48E-05
				Th 234	87.0	.11E-05	.00	
				Ac 225	87.0	.28E-07	.00	
				Pb 212	87.2	.13E-08	.00	
				Cd 109	88.0	.22E-08	.00	
				Th 227	88.5	.29E-08	.00	
92.9	417.6	2703.4	18	TH 234	92.6	.25E-08	.00	.82E-05
				U- 238	92.6	.25E-08	.00	
				U- 235	93.3	.53E-08	.00	
186.2	224.5	1420.5	25	Un 235	185.7	.96E-10	.00	.15E-04
				Un 238	186.1	.20E-08	.00	
				U- 235	185.7	.22E-09	.00	
				U 238	186.1	.35E-08	.00	
238.6	215.6	836.4	20	Pb 212	238.6	.35E-09	.00	.24E-04

				Th 232	238.6	.33E-09	.00	
295.3	178.4	551.6	20	Pb 214	295.2	.83E-09	.00	.31E-04
				EU 152	296.0	.39E-07	.00	
352.0	249.7	333.3	12	Ra 226	351.9	.77E-09	.00	.63E-04
				Pb 214	352.0	.74E-09	.00	
				Co 57	352.2	.84E-05	.00	
511.2	187.6	242.4	14	I- 133	510.4	.20E-07	.00	.10E-03
				TL 208	510.8	.13E-08	.00	
				Na 22	511.0	.17E-09	.00	
				ZN 65	511.0	.11E-07	.00	
				Y 88	511.0	.76E-07	.00	
				Ru 106	511.8	.15E-08	.00	
583.1	137.0	145.0	15	Tl 208	583.1	.30E-09	.00	.10E-03
				Th 232	583.1	.86E-09	.00	
609.3	194.1	170.9	12	Xe 135	608.6	.15E-07	.00	.16E-03
				Bi 214	609.3	.81E-09	.00	
				Ra 226	609.3	.89E-09	.00	
				Ru 103	610.3	.71E-08	.00	
911.3	118.9	78.1	14	Ac 228	911.1	.15E-08	.00	.22E-03
				Th 232	911.1	.15E-08	.00	
969.1	60.0	81.0	25	Ac 228	968.9	.13E-08	.00	.13E-03
1120.7	88.0	72.0	17	Bi 214	1120.4	.20E-08	.00	.25E-03
				Ra 226	1120.4	.20E-08	.00	

SUM OF ESTIMATED EXTERNAL EXPOSURE RATE: .112E-02uR/Hr

Attachment 3

RFETS

881 GENERAL LABORATORY

RAD SCREEN RESULTS

Lab Report Number - 97L2022
Analysis Requested - Rad Screen Level II
30-Jun-97

881 Sample ID	Customer Sample ID	Matrix	Gross Alpha pCi/G	Gross Alpha 2σ	Gross Beta pCi/G	Gross Beta 2σ	Total Activity pCi/G	DOT Class	Maximum Shipping Amt (g) for Category I	Maximum Shipping Amt (g) for Category II
NA	97-06-24-B101	Soil	159	20	18	5	203.00	NONRAD	55.87	558.66
NA	97-06-24-B102	Soil	364	37	15	5	421.00	NONRAD	24.94	249.38
NA	97-06-24-B103	Soil	3385	323	-189	19	3727.00	RAD	DO NOT SHIP AS CAT I	26.97
NA	97-06-24-B105	Soil	782	73	21	8	884.00	NONRAD	11.70	116.96
NA	97-06-24-B106	Soil	1058	95	-8	9	1163.00	NONRAD	8.67	86.66
NA	97-06-24-B107	Soil	338	33	11	5	387.00	NONRAD	26.95	269.54

Category I Shipping Limits: Alpha = <0.01 uCi/sample; Beta = <0.1 uCi/sample

Category II Shipping Limit: Alpha = <0.1 uCi/sample; Beta = <1 uCi/sample

DOT Classification: <2000 pCi/g total activity is NONRAD
> = 2000 pCi/g total activity is RAD

Total Activity: Calculated as the sum of the gross alpha and beta activities AND the measurement uncertainties for these two measurements. If the measured activity is negative, 0 pCi/G (instead of the negative value) is used to calculate the total activity.

Analysis Methods: Sample Preparation Procedure: L-6283-A, "Sample Preparation for Radiological Screening of Soil Samples by Gas Proportional Counting"
Counting Procedure: L-6295-A, "Operation of Tennelec LB4100 Gas Proportional Counters".

Laboratory Approval [signature] Date 6/30/97

Frozen core
~1120 grams

4.1 uCi

110

in Quarry

110 uCi = Ca

40 yrs old PU mixture

Det#40279/Plus 3600s 1cm B-1 Pond Sam001 336g 6-24-97

** Software Version: 122095/ 0/Q by R. T. Reiman •

Energy (keV)	Resolution FWHM (keV)	Live Time Seconds	Real Time Seconds	Quad Value	Gain (kev/ch)	OFFSET (keV)	HEIGHT (cm)
609.0	1.43	3600	3672	.428E-07	.375	-.187	1

Nuclide Summary

Isotope	Activity Ci	Error %
K- 40	.120E-08	1.0
U- 238	.588E-10	12.2
Ra 226	.286E-10	2.5
U- 235	.130E-11	26.6
Th 232	.269E-10	2.7
Cs 137	.306E-11	13.5
Am 241	.301E-10	4.2

ENERGY (keV)	NET COUNT	BACKGROUND COUNT	ERROR (%)	ISOTOPE	PHOTO-PEAK	ACTIVITY (Ci)		EXPOSURE (uR/Hr)
12.9	2118.4	2297.6	4	Pa 231	12.6	.97E-10	.00	.52E-07
				Th 231	13.3	.65E-11	.00	
				Th 234	13.3	.61E-10	.00	
				Pa 234	13.6	.15E-08	.00	
				Pu 238	13.6	.15E-09	.00	
				AM 241	13.9	.21E-10	.00	
				Am 243	13.9	.36E-10	.00	
16.3	731.3	4893.7	14	Pa 231	15.7	.26E-10	.00	.22E-07
				Y- 88	15.8	.23E-10	.00	
24.0	1363.8	4669.2	8	Sn 113	24.0	.18E-10	.00	.59E-07
				In 115	24.2	.37E-11	.00	
				Sn 113	24.2	.95E-11	.00	
				Cd 109	24.9	.26E-10	.00	
46.7	299.9	8287.1	43					.24E-07
59.6	4406.9	13827.1	4	Th 231	58.6	.20E-08	.00	.45E-06
				U- 235	58.6	.11E-07	.00	
				Am 241	59.5	.31E-10	.00	
				Eu 155	60.0	.87E-09	.00	
63.6	764.4	14911.6	23	TH 234	63.2	.51E-10	.00	.84E-07
				U- 238	63.2	.51E-10	.00	
74.9	586.0	17985.0	33	Am 243	74.7	.23E-11	.00	.76E-07
				Pb 212	74.8	.16E-10	.00	
				U- 235	74.9	.15E-06	.00	
				Px 82	75.0	.15E-11	.00	
77.4	523.8	18146.2	37	Lu 174	76.5	.17E-10	.00	.71E-07
				Pu 241	77.0	.57E-05	.00	
				Pb 212	77.1	.78E-11	.00	

				PU 239	77.6	.32E-06	.00	
87.6	531.2	18010.8	36	Am 243	86.8	.42E-09	.00	.82E-07
				Th 234	87.0	.19E-07	.00	
				Ac 225	87.0	.48E-09	.00	
				Pb 212	87.2	.22E-10	.00	
				Cd 109	88.0	.37E-10	.00	
				Th 227	88.5	.50E-10	.00	
92.8	1151.3	17808.7	17	TH 234	92.6	.56E-10	.00	.19E-06
				U- 238	92.6	.56E-10	.00	
				U- 235	93.3	.12E-09	.00	
122.9	789.8	14381.2	22	Co 57	122.1	.25E-11	.00	.17E-06
				AM 241	123.0	.21E-06	.00	
185.9	541.3	9459.7	26	Un 235	185.7	.14E-11	.00	.21E-06
				Un 238	186.1	.29E-10	.00	
				U- 235	185.7	.32E-11	.00	
				U 238	186.1	.51E-10	.00	
209.8	379.9	7438.1	33	Ac 228	209.4	.28E-10	.00	.18E-06
				Th 227	210.6	.11E-09	.00	
238.4	2224.8	6069.2	5	Pb 212	238.6	.18E-10	.00	.12E-05
				Th 232	238.6	.17E-10	.00	
241.8	312.5	5923.5	35	U- 235	240.9	.16E-08	.00	.18E-06
				Pb 214	241.9	.15E-10	.00	
270.2	270.8	4280.2	35	Ac 228	270.3	.27E-10	.00	.18E-06
				U- 232	270.5	.28E-07	.00	
				Th 227	270.6	.13E-07	.00	
				Th 227	270.7	.32E-08	.00	
				Np 240	270.8	.11E-10	.00	
295.0	943.0	3651.0	10	Pb 214	295.2	.20E-10	.00	.74E-06
				EU 152	296.0	.94E-09	.00	
300.2	205.8	3360.2	40	TH 227	299.9	.38E-10	.00	.17E-06
				U- 235	299.9	.42E-10	.00	
				Pb 212	300.1	.24E-10	.00	
				Pa 231	300.1	.36E-10	.00	
				AM 241	300.1	.14E-04	.00	
328.3	201.4	2907.6	39	Ac 228	328.0	.26E-10	.00	.19E-06
				La 140	328.8	.43E-11	.00	
				EU 152	329.4	.86E-09	.00	
338.1	614.0	2610.0	12	Ac 228	338.4	.26E-10	.00	.61E-06
				U- 235	338.6	.96E-10	.00	
351.6	1892.1	2845.9	5	Ra 226	351.9	.24E-10	.00	.20E-05
				Pb 214	352.0	.24E-10	.00	
				Co 57	352.2	.27E-06	.00	
462.6	333.9	1688.1	18	Pa 228	463.0	.14E-10	.00	.56E-06
				Ac 228	463.0	.39E-10	.00	
				Sb 125	463.4	.17E-10	.00	
477.6	160.1	1681.9	37	Pb 211	478.0	.69E-08	.00	.28E-06
510.6	1585.9	1585.1	4	I- 133	510.4	.61E-09	.00	.31E-05
				TL 208	510.8	.40E-10	.00	
				Na 22	511.0	.51E-11	.00	
				ZN 65	511.0	.32E-09	.00	
				Y 88	511.0	.23E-08	.00	
				Ru 106	511.8	.45E-10	.00	
583.0	1721.8	1301.2	4	Tl 208	583.1	.13E-10	.00	.42E-05
				Th 232	583.1	.36E-10	.00	
609.0	2044.9	1230.1	3	Xe 135	608.6	.51E-09	.00	.54E-05
				Bi 214	609.3	.28E-10	.00	
				Ra 226	609.3	.31E-10	.00	
661.4	366.9	1103.1	14	Cs 137	661.6	.30E-11	.00	.11E-05
				AM 241	662.4	.73E-06	.00	

				I- 131	723.0	.39E-10	.00	
				Eu 154	723.3	.31E-11	.00	
				Zr 95	724.2	.15E-11	.00	
727.1	353.6	1113.4	14	AC 228	727.0	.32E-08	.00	.13E-05
				Bi 212	727.2	.22E-10	.00	
				U- 239	727.5	.11E-06	.00	
				BI 214	727.8	.16E-07	.00	
				PU 239	727.9	.22E-02	.00	
755.6	122.9	934.1	36	AM 241	755.9	.13E-04	.00	.46E-06
				PU 239	756.4	.27E-04	.00	
				Zr 95	756.7	.17E-11	.00	
768.0	260.7	971.3	18	Rh 102	766.8	.58E-11	.00	.10E-05
				AM 241	766.9	.39E-04	.00	
				Bi 214	768.4	.40E-10	.00	
				PU 239	769.4	.18E-04	.00	
794.6	274.3	890.7	17	Pa 228	794.7	.11E-09	.00	.11E-05
				Ac 228	794.8	.44E-10	.00	
				TL 210	795.0	.21E-11	.00	
				CS 134	795.8	.25E-11	.00	
806.6	116.1	793.9	36	Pu 238	805.4	.65E-03	.00	.49E-06
				Bi 214	806.2	.74E-09	.00	
860.3	280.5	868.5	16	Tl 208	860.4	.19E-10	.00	.13E-05
873.4	157.8	843.2	27	Eu 154	873.2	.11E-10	.00	.76E-06
910.9	1385.7	827.3	4	Ac 228	911.1	.47E-10	.00	.72E-05
				Th 232	911.1	.47E-10	.00	
933.8	225.3	722.7	18	Bi 214	934.1	.61E-10	.00	.12E-05
950.3	145.3	727.7	28	Pa 234	949.0	.16E-10	.00	.80E-06
				In 116	950.0	.13E-08	.00	
				Pb 211	951.0	.59E-08	.00	
964.3	129.4	1049.6	36	EU 152	964.0	.78E-11	.00	.73E-06
				Ac 228	964.6	.21E-10	.00	
				Pa 228	964.6	.11E-10	.00	
968.7	704.1	960.9	7	Ac 228	968.9	.42E-10	.00	.40E-05
1001.0	144.4	752.6	28	PA 234	1001.0	.15E-09	.00	.87E-06
				Pa 234	1001.0	.15E-09	.00	
				U- 238	1001.0	.15E-09	.00	
				Pu 238	1001.1	.10E-03	.00	
1119.9	694.3	781.7	7	Bi 214	1120.4	.40E-10	.00	.51E-05
				Ra 226	1120.4	.40E-10	.00	
1237.8	362.4	887.6	13	I- 133	1237.5	.24E-09	.00	.31E-05
				Bi 214	1238.1	.64E-10	.00	
1274.2	156.8	676.2	25	Al 29	1273.3	.18E-11	.00	.14E-05
				Na 22	1274.5	.17E-11	.00	
				Eu 154	1274.5	.50E-11	.00	
1280.5	112.3	636.7	33	BI 214	1281.0	.81E-10	.00	.10E-05
1377.4	216.3	371.7	14	Bi 214	1377.7	.60E-10	.00	.22E-05
1385.3	93.4	363.6	31	Ag 110	1384.3	.43E-11	.00	.97E-06
				Bi 214	1385.3	.14E-09	.00	
1401.0	118.7	375.3	25	Pa 234	1399.7	.59E-09	.00	.13E-05
				BI 214	1401.5	.97E-10	.00	
1408.1	135.8	384.2	22	Bi 214	1408.0	.62E-10	.00	.15E-05
				EU 152	1408.0	.74E-11	.00	
				Al 28	1408.8	.13E-09	.00	
1460.7	11381.5	388.5	1	K- 40	1460.8	.12E-08	.00	.13E-03
1508.7	144.1	182.9	16	Bi 214	1509.2	.78E-10	.00	.17E-05
				Pa 234	1510.5	.19E-07	.00	
1587.9	246.1	226.9	11					.32E-05
1621.0	89.0	174.0	23	Bi 212	1620.6	.40E-10	.00	.12E-05
				Al 28	1622.6	.34E-10	.00	

1729.4	154.4	121.6	13	Bi 214	1729.6	.66E-10	.00	.23E-05
1764.4	791.5	127.5	4	Bi 214	1764.0	.62E-10	.00	.12E-04
				Pa 234	1765.4	.17E-06	.00	
1846.9	88.9	133.1	21	BI 214	1847.4	.57E-10	.00	.15E-05
2103.4	251.8	122.2	9	TL 208	2103.5	.38E-10	.00	.53E-05
2118.4	89.3	108.7	20	BI 214	2118.5	.11E-09	.00	.19E-05
2203.6	242.9	135.1	9	Bi 214	2204.1	.75E-10	.00	.55E-05
2224.6	68.5	96.5	24	H- 1	2223.0	.11E-11	.00	.16E-05
2447.7	96.0	82.0	17	Bi 214	2447.7	.10E-09	.00	.26E-05
2614.5	1773.9	39.1	2	TL 208	2614.6	.31E-10	.00	.53E-04

SUM OF ESTIMATED EXTERNAL EXPOSURE RATE: .283E-03uR/Hr

Det#40279/Plus 3600s1cm B-1 Pond Sam002 400g 6-24-97

** Software Version: 122095/ 0/Q by R. T. Reiman *

Energy (keV)	Resolution FWHM (keV)	Live Time Seconds	Real Time Seconds	Quad Value	Gain (kev/ch)	OFFSET (keV)	HEIGHT (cm)
608.9	1.55	3600	3673	.435E-07	.375	-.201	1

Nuclide Summary

Isotope	Activity Ci	Error %
K- 40	.122E-08	1.0
U- 238	.558E-10	12.8
Ra 226	.288E-10	2.5
U- 235	.221E-11	20.6
Th 232	.264E-10	2.7
Cs 137	.336E-11	12.2
Am 241	.892E-10	1.6

ENERGY (keV)	NET COUNT	BACKGROUND COUNT	ERROR (%)	ISOTOPE	PHOTO-PEAK	ACTIVITY (Ci)		EXPOSURE (uR/Hr)
12.9	2092.1	2252.9	4	Pa 231	12.6	.95E-10	.00	.51E-07
				Th 231	13.3	.64E-11	.00	
				Th 234	13.3	.60E-10	.00	
				Pa 234	13.6	.15E-08	.00	
				Pu 238	13.6	.15E-09	.00	
16.0	700.1	4750.9	14	Pa 231	15.7	.25E-10	.00	.21E-07
				Y- 88	15.8	.22E-10	.00	
19.7	231.5	4447.5	41	Pu 238	20.3	.50E-10	.00	.83E-08
24.0	1172.5	4782.5	9	Sn 113	24.0	.15E-10	.00	.51E-07
				In 115	24.2	.32E-11	.00	
				Sn 113	24.2	.82E-11	.00	
				Cd 109	24.9	.22E-10	.00	
27.5	379.2	4644.8	26	Th 231	26.6	.54E-11	.00	.19E-07
				Sn 113	27.3	.93E-11	.00	
				Pa 231	27.4	.11E-10	.00	
				Sn 113	27.9	.49E-10	.00	
59.5	12753.6	14430.4	2	Th 231	58.6	.58E-08	.00	.13E-05
				U- 235	58.6	.33E-07	.00	
				Am 241	59.5	.91E-10	.00	
				Eu 155	60.0	.25E-08	.00	
63.2	718.7	14749.3	24	TH 234	63.2	.48E-10	.00	.78E-07
				U- 238	63.2	.48E-10	.00	
66.9	321.4	15930.6	56	Th 230	67.7	.22E-09	.00	.37E-07
74.9	679.0	17894.0	28	Am 243	74.7	.27E-11	.00	.88E-07
				Pb 212	74.8	.18E-10	.00	
				U- 235	74.9	.18E-06	.00	
				Px 82	75.0	.18E-11	.00	

				Pu 241	77.0	.44E-05	.00	
				Pb 212	77.1	.61E-11	.00	
				Bi 209	77.1	.11E-11	.00	
				PU 239	77.6	.25E-06	.00	
92.5	1057.7	17486.3	18	TH 234	92.6	.52E-10	.00	.17E-06
				U- 238	92.6	.52E-10	.00	
				U- 235	93.3	.11E-09	.00	
123.2	540.2	14539.8	32	AM 241	123.0	.14E-06	.00	.12E-06
185.5	714.5	9467.5	20	Un 235	185.7	.18E-11	.00	.28E-06
				Un 238	186.1	.38E-10	.00	
				U- 235	185.7	.42E-11	.00	
				U 238	186.1	.67E-10	.00	
238.4	2177.4	6129.6	6	Pb 212	238.6	.18E-10	.00	.12E-05
				Th 232	238.6	.17E-10	.00	
241.7	340.8	5881.2	32	U- 235	240.9	.17E-08	.00	.20E-06
				Pb 214	241.9	.16E-10	.00	
295.0	960.9	3585.1	9	Pb 214	295.2	.20E-10	.00	.75E-06
				EU 152	296.0	.96E-09	.00	
300.2	309.8	3324.2	27	TH 227	299.9	.57E-10	.00	.25E-06
				U- 235	299.9	.63E-10	.00	
				Pb 212	300.1	.37E-10	.00	
				Pa 231	300.1	.54E-10	.00	
				AM 241	300.1	.22E-04	.00	
306.6	196.7	3179.3	41					.16E-06
328.3	190.8	2862.2	40	Ac 228	328.0	.24E-10	.00	.18E-06
				La 140	328.8	.41E-11	.00	
				EU 152	329.4	.82E-09	.00	
338.1	696.9	2697.1	11	Ac 228	338.4	.29E-10	.00	.69E-06
				U- 235	338.6	.11E-09	.00	
351.7	1744.7	2968.3	5	Ra 226	351.9	.22E-10	.00	.18E-05
				Pb 214	352.0	.22E-10	.00	
				Co 57	352.2	.24E-06	.00	
462.7	285.1	1727.9	21	Pa 228	463.0	.12E-10	.00	.47E-06
				Ac 228	463.0	.33E-10	.00	
				Sb 125	463.4	.14E-10	.00	
510.6	1667.9	1557.1	4	I- 133	510.4	.64E-09	.00	.33E-05
				TL 208	510.8	.42E-10	.00	
				Na 22	511.0	.53E-11	.00	
				ZN 65	511.0	.34E-09	.00	
				Y 88	511.0	.24E-08	.00	
				Ru 106	511.8	.47E-10	.00	
582.7	1680.6	1349.4	4	Tl 208	583.1	.12E-10	.00	.41E-05
				Th 232	583.1	.35E-10	.00	
609.0	2155.6	1219.4	3	Xe 135	608.6	.54E-09	.00	.57E-05
				Bi 214	609.3	.30E-10	.00	
				Ra 226	609.3	.33E-10	.00	
632.5	108.2	1032.8	43	PU 239	633.2	.31E-04	.00	.30E-06
661.4	414.2	1072.8	12	Cs 137	661.6	.34E-11	.00	.13E-05
				AM 241	662.4	.82E-06	.00	
723.0	111.1	1172.9	45	AM 241	721.9	.44E-06	.00	.39E-06
				I- 131	723.0	.51E-10	.00	
				Eu 154	723.3	.40E-11	.00	
				Zr 95	724.2	.19E-11	.00	
727.1	383.3	1102.7	13	AC 228	727.0	.35E-08	.00	.14E-05
				Bi 212	727.2	.24E-10	.00	
				U- 239	727.5	.11E-06	.00	
				BI 214	727.8	.18E-07	.00	
				PU 239	727.9	.23E-02	.00	
768.0	218.9	1050.1	22	Pa 234	766.6	.80E-09	.00	.85E-06

				Rh 102	766.8	.49E-11	.00	
				AM 241	766.9	.33E-04	.00	
				Bi 214	768.4	.34E-10	.00	
				PU 239	769.4	.15E-04	.00	
772.5	103.4	971.6	44	AC 228	772.1	.48E-10	.00	.41E-06
				I- 132	772.7	.10E-11	.00	
				Th 227	773.0	.61E-06	.00	
				AC 228	773.5	.90E-09	.00	
785.3	202.5	904.5	22	Bi 212	785.4	.78E-10	.00	.82E-06
				Pa 234	786.3	.45E-08	.00	
				Pu 238	786.3	.44E-04	.00	
794.7	314.1	833.9	14	Pa 228	794.7	.12E-09	.00	.13E-05
				Ac 228	794.8	.51E-10	.00	
				TL 210	795.0	.24E-11	.00	
				CS 134	795.8	.29E-11	.00	
855.0	100.0	826.0	42	I- 133	856.1	.68E-10	.00	.46E-06
860.3	277.4	861.6	16	Tl 208	860.4	.18E-10	.00	.13E-05
910.9	1425.8	876.2	4	Ac 228	911.1	.48E-10	.00	.74E-05
				Th 232	911.1	.48E-10	.00	
933.8	183.9	785.1	23	Bi 214	934.1	.50E-10	.00	.99E-06
964.2	233.2	988.8	20	EU 152	964.0	.14E-10	.00	.13E-05
				Ac 228	964.6	.38E-10	.00	
				Pa 228	964.6	.21E-10	.00	
968.7	800.6	891.4	6	Ac 228	968.9	.47E-10	.00	.46E-05
1000.7	156.4	851.6	28	PA 234	1001.0	.17E-09	.00	.94E-06
				Pa 234	1001.0	.17E-09	.00	
				U- 238	1001.0	.17E-09	.00	
				Pu 238	1001.1	.11E-03	.00	
1120.0	694.1	784.9	7	Bi 214	1120.4	.40E-10	.00	.51E-05
				Ra 226	1120.4	.40E-10	.00	
1237.8	350.2	820.8	13	I- 133	1237.5	.23E-09	.00	.30E-05
				Bi 214	1238.1	.62E-10	.00	
1274.2	147.3	650.7	26	Al 29	1273.3	.17E-11	.00	.13E-05
				Na 22	1274.5	.16E-11	.00	
				Eu 154	1274.5	.47E-11	.00	
1327.9	82.9	410.1	36					.80E-06
1377.4	211.1	430.9	16	Bi 214	1377.7	.59E-10	.00	.22E-05
1401.4	101.0	378.0	29	Pa 234	1399.7	.50E-09	.00	.11E-05
				BI 214	1401.5	.83E-10	.00	
1407.5	129.2	374.8	23	Bi 214	1408.0	.59E-10	.00	.14E-05
				EU 152	1408.0	.71E-11	.00	
				Al 28	1408.8	.12E-09	.00	
1460.7	11538.4	380.6	1	K- 40	1460.8	.12E-08	.00	.13E-03
1496.0	83.5	192.5	26	AC 228	1495.8	.94E-10	.00	.99E-06
				Np 240	1496.9	.76E-10	.00	
1509.2	84.9	189.1	25	Bi 214	1509.2	.46E-10	.00	.10E-05
				Pa 234	1510.5	.11E-07	.00	
1588.0	225.6	242.4	12					.29E-05
1620.2	90.8	159.2	22	Bi 212	1620.6	.41E-10	.00	.12E-05
1630.0	100.6	174.4	21	AC 228	1630.4	.65E-10	.00	.14E-05
1729.5	173.4	128.6	12	Bi 214	1729.6	.74E-10	.00	.26E-05
1764.4	703.6	138.4	4	Bi 214	1764.0	.55E-10	.00	.11E-04
				Pa 234	1765.4	.15E-06	.00	
1838.7	45.3	122.7	38					.76E-06
1847.4	126.4	120.6	15	BI 214	1847.4	.81E-10	.00	.21E-05
2103.4	275.9	129.1	8	TL 208	2103.5	.41E-10	.00	.58E-05
2118.4	70.8	115.2	25	BI 214	2118.5	.88E-10	.00	.15E-05
2204.1	230.2	121.8	9	Bi 214	2204.1	.71E-10	.00	.52E-05
2447.4	100.8	74.2	16	Bi 214	2447.7	.11E-09	.00	.27E-05
2614.5	1859.1	44.0	3	TL 208	2614.6	[illegible]	[illegible]	.56E-04

SUM OF ESTIMATED EXTERNAL EXPOSURE RATE: .286E-03uR/Hr

Det#40279/Plus 3600s1cm B-1Pond Sed Sam003 443g 6-24-97

** Software Version: 122095/ 0/Q by R. T. Reiman •

Energy (keV)	Resolution FWHM (keV)	Live Time Seconds	Real Time Seconds	Quad Value	Gain (kev/ch)	OFFSET (keV)	HEIGHT (cm)
608.9	1.49	3600	3672	.433E-07	.375	-.193	1

Nuclide Summary

Isotope	Activity Ci	Error %
K- 40	.119E-08	1.0
U- 238	.487E-10	14.6
Ra 226	.263E-10	2.7
U- 235	.242E-11	19.9
Th 232	.281E-10	2.6
Cs 137	.366E-11	11.0
Am 241	.158E-09	1.0

ENERGY (keV)	NET COUNT	BACKGROUND COUNT	ERROR (%)	ISOTOPE	PHOTO-PEAK	ACTIVITY (Ci)		EXPOSURE (uR/Hr)
12.9	2055.7	2254.3	4	Pa 231	12.6	.94E-10	.00	.50E-07
				Th 231	13.3	.63E-11	.00	
				Th 234	13.3	.59E-10	.00	
				Pa 234	13.6	.15E-08	.00	
				Pu 238	13.6	.15E-09	.00	
				AM 241	13.9	.21E-10	.00	
				Am 243	13.9	.35E-10	.00	
16.1	542.9	4706.1	18	Pa 231	15.7	.19E-10	.00	.16E-07
				Y- 88	15.8	.17E-10	.00	
24.0	1220.1	4662.9	8	Sn 113	24.0	.16E-10	.00	.53E-07
				In 115	24.2	.33E-11	.00	
				Sn 113	24.2	.85E-11	.00	
				Cd 109	24.9	.23E-10	.00	
27.6	337.8	4585.2	29	Th 231	26.6	.49E-11	.00	.17E-07
				Sn 113	27.3	.83E-11	.00	
				Pa 231	27.4	.98E-11	.00	
				Sn 113	27.9	.43E-10	.00	
49.7	793.2	12185.8	20	Th 227	50.2	.24E-10	.00	.68E-07
				Am 243	50.6	.71E-07	.00	
59.5	22493.6	15891.4	1	Th 231	58.6	.10E-07	.00	.23E-05
				U- 235	58.6	.57E-07	.00	
				Am 241	59.5	.16E-09	.00	
				Eu 155	60.0	.44E-08	.00	
63.6	501.6	14798.4	35	TH 234	63.2	.33E-10	.00	.55E-07
				U- 238	63.2	.33E-10	.00	
74.8	615.0	17659.0	31	Am 243	74.7	.24E-11	.00	.80E-07
				Pb 212	74.8	.17E-10	.00	

				Px 82	75.0	.16E-11	.00	
77.1	744.5	17484.5	25	Lu 174	76.5	.24E-10	.00	.10E-06
				Pu 241	77.0	.81E-05	.00	
				Pb 212	77.1	.11E-10	.00	
				Bi 209	77.1	.19E-11	.00	
				PU 239	77.6	.45E-06	.00	
92.5	922.1	17559.9	21	TH 234	92.6	.45E-10	.00	.15E-06
				U- 238	92.6	.45E-10	.00	
				U- 235	93.3	.97E-10	.00	
123.2	724.8	13854.2	23	AM 241	123.0	.19E-06	.00	.16E-06
185.6	678.5	9074.5	20	Un 235	185.7	.17E-11	.00	.27E-06
				Un 238	186.1	.36E-10	.00	
				U- 235	185.7	.40E-11	.00	
				U 238	186.1	.64E-10	.00	
209.4	331.4	7406.6	37	Ac 228	209.4	.24E-10	.00	.16E-06
238.4	2422.2	6082.8	5	Pb 212	238.6	.20E-10	.00	.14E-05
				Th 232	238.6	.19E-10	.00	
241.7	266.3	5910.7	41	U- 235	240.9	.14E-08	.00	.15E-06
				Pb 214	241.9	.13E-10	.00	
295.0	977.8	3389.2	9	Pb 214	295.2	.21E-10	.00	.77E-06
				EU 152	296.0	.98E-09	.00	
338.1	623.0	2713.0	12	Ac 228	338.4	.26E-10	.00	.61E-06
				U- 235	338.6	.97E-10	.00	
351.6	1652.0	2764.0	5	Ra 226	351.9	.21E-10	.00	.17E-05
				Pb 214	352.0	.21E-10	.00	
				Co 57	352.2	.23E-06	.00	
442.4	164.6	1788.4	37					.25E-06
462.7	316.5	1656.5	19	Pa 228	463.0	.13E-10	.00	.53E-06
				Ac 228	463.0	.37E-10	.00	
				Sb 125	463.4	.16E-10	.00	
510.7	1711.9	1592.1	4	I- 133	510.4	.66E-09	.00	.34E-05
				TL 208	510.8	.43E-10	.00	
				Na 22	511.0	.55E-11	.00	
				ZN 65	511.0	.35E-09	.00	
				Y 88	511.0	.25E-08	.00	
				Ru 106	511.8	.48E-10	.00	
583.0	1700.5	1271.5	4	Tl 208	583.1	.12E-10	.00	.42E-05
				Th 232	583.1	.36E-10	.00	
609.0	1944.5	1151.5	3	Xe 135	608.6	.49E-09	.00	.51E-05
				Bi 214	609.3	.27E-10	.00	
				Ra 226	609.3	.29E-10	.00	
661.4	442.5	1015.5	11	Cs 137	661.6	.36E-11	.00	.13E-05
				AM 241	662.4	.88E-06	.00	
694.1	102.2	1020.8	45	AM 241	693.4	.23E-04	.00	.33E-06
723.3	187.0	1164.0	27	I- 131	723.0	.85E-10	.00	.66E-06
				Eu 154	723.3	.67E-11	.00	
				Zr 95	724.2	.32E-11	.00	
727.1	399.1	1054.9	13	AC 228	727.0	.37E-08	.00	.14E-05
				Bi 212	727.2	.25E-10	.00	
				U- 239	727.5	.12E-06	.00	
				BI 214	727.8	.19E-07	.00	
				PU 239	727.9	.24E-02	.00	
768.0	198.8	1034.2	24	Pa 234	766.6	.73E-09	.00	.77E-06
				PA 234	766.6	.73E-09	.00	
				Rh 102	766.8	.44E-11	.00	
				AM 241	766.9	.30E-04	.00	
				Bi 214	768.4	.31E-10	.00	
				PU 239	769.4	.14E-04	.00	
772.1	89.1	896.9	49	AM 241	770.9	.10E-04	.00	.35E-06

				AC 228	772.1	.42E-10	.00	
				I- 132	772.7	.90E-12	.00	
				Th 227	773.0	.52E-06	.00	
				AC 228	773.5	.78E-09	.00	
785.6	218.0	881.0	20	Bi 212	785.4	.84E-10	.00	.88E-06
				Pa 234	786.3	.49E-08	.00	
				Pu 238	786.3	.48E-04	.00	
794.6	288.7	896.3	16	Pa 228	794.7	.11E-09	.00	.12E-05
				Ac 228	794.8	.47E-10	.00	
				TL 210	795.0	.22E-11	.00	
				CS 134	795.8	.26E-11	.00	
806.2	112.0	799.0	37	Pu 238	805.4	.63E-03	.00	.47E-06
				Bi 214	806.2	.71E-09	.00	
860.3	239.6	883.4	19	Tl 208	860.4	.16E-10	.00	.11E-05
910.9	1452.5	819.5	4	Ac 228	911.1	.49E-10	.00	.75E-05
				Th 232	911.1	.49E-10	.00	
933.8	145.3	804.7	29	Bi 214	934.1	.40E-10	.00	.78E-06
964.2	145.1	1060.9	33	EU 152	964.0	.88E-11	.00	.82E-06
				Ac 228	964.6	.24E-10	.00	
				Pa 228	964.6	.13E-10	.00	
968.7	745.8	951.2	7	Ac 228	968.9	.44E-10	.00	.43E-05
1001.0	174.2	769.8	24	PA 234	1001.0	.19E-09	.00	.11E-05
				Pa 234	1001.0	.19E-09	.00	
				U- 238	1001.0	.19E-09	.00	
				Pu 238	1001.1	.12E-03	.00	
1119.9	645.2	740.8	7	Bi 214	1120.4	.37E-10	.00	.47E-05
				Ra 226	1120.4	.37E-10	.00	
1237.8	361.8	844.2	13	I- 133	1237.5	.24E-09	.00	.31E-05
				Bi 214	1238.1	.64E-10	.00	
1274.5	171.4	616.6	22	Al 29	1273.3	.20E-11	.00	.16E-05
				Na 22	1274.5	.18E-11	.00	
				Eu 154	1274.5	.54E-11	.00	
1280.9	129.5	555.5	27	BI 214	1281.0	.94E-10	.00	.12E-05
1377.7	191.0	404.0	17	Bi 214	1377.7	.53E-10	.00	.20E-05
1401.0	88.9	376.1	33	Pa 234	1399.7	.44E-09	.00	.94E-06
				BI 214	1401.5	.73E-10	.00	
1407.8	121.8	354.2	24	Bi 214	1408.0	.56E-10	.00	.13E-05
				EU 152	1408.0	.67E-11	.00	
				Al 28	1408.8	.12E-09	.00	
1460.7	11197.1	373.9	1	K- 40	1460.8	.12E-08	.00	.13E-03
1509.1	122.3	179.7	18	Bi 214	1509.2	.67E-10	.00	.15E-05
				Pa 234	1510.5	.16E-07	.00	
1538.4	62.8	158.2	31	AC 228	1537.7	.15E-08	.00	.78E-06
				BI 214	1538.5	.18E-09	.00	
				Np 240	1539.6	.96E-10	.00	
				TL 210	1540.0	.38E-10	.00	
1587.9	262.3	211.7	10					.34E-05
1620.9	128.9	150.1	16	Bi 212	1620.6	.59E-10	.00	.17E-05
				Al 28	1622.6	.49E-10	.00	
1630.7	83.0	146.0	23	AC 228	1630.4	.53E-10	.00	.11E-05
1661.5	69.7	114.3	25	BI 214	1661.3	.77E-10	.00	.98E-06
1729.4	133.7	121.3	15	Bi 214	1729.6	.57E-10	.00	.20E-05
1764.3	665.3	115.7	5	Bi 214	1764.0	.52E-10	.00	.10E-04
				Pa 234	1765.4	.14E-06	.00	
1847.3	100.2	92.8	17	BI 214	1847.4	.64E-10	.00	.17E-05
2103.4	273.1	108.9	8	TL 208	2103.5	.41E-10	.00	.57E-05
2118.4	92.0	99.0	19	BI 214	2118.5	.11E-09	.00	.19E-05
2204.0	235.4	123.6	9	Bi 214	2204.1	.72E-10	.00	.53E-05
2447.7	74.8	75.2	20	Bi 214	2447.7	.79E-10	.00	.20E-05

SUM OF ESTIMATED EXTERNAL EXPOSURE RATE: .281E-03uR/Hr

Det#40279/Plus 3600s 1cm B1005 333g 6-24-97

** Software Version: 122095/ 0/Q by R. T. Reiman *

Energy (keV)	Resolution FWHM (keV)	Live Time Seconds	Real Time Seconds	Quad Value	Gain (kev/ch)	OFFSET (keV)	HEIGHT (cm)
608.9	1.49	3600	3672	.433E-07	.375	-.193	1

Nuclide Summary

Isotope	Activity Ci	Error %
K- 40	.119E-08	1.0
U- 238	.487E-10	14.6
Ra 226	.263E-10	2.7
U- 235	.242E-11	19.9
Th 232	.281E-10	2.6
Cs 137	.366E-11	11.0
Am 241	.158E-09	1.0

ENERGY (keV)	NET COUNT	BACKGROUND COUNT	ERROR (%)	ISOTOPE	PHOTO-PEAK	ACTIVITY (Ci)		EXPOSURE (uR/Hr)
12.9	2055.7	2254.3	4	Pa 231	12.6	.94E-10	.00	.50E-07
				Th 231	13.3	.63E-11	.00	
				Th 234	13.3	.59E-10	.00	
				Pa 234	13.6	.15E-08	.00	
				Pu 238	13.6	.15E-09	.00	
				AM 241	13.9	.21E-10	.00	
				Am 243	13.9	.35E-10	.00	
16.1	542.9	4706.1	18	Pa 231	15.7	.19E-10	.00	.16E-07
				Y- 88	15.8	.17E-10	.00	
24.0	1220.1	4662.9	8	Sn 113	24.0	.16E-10	.00	.53E-07
				In 115	24.2	.33E-11	.00	
				Sn 113	24.2	.85E-11	.00	
				Cd 109	24.9	.23E-10	.00	
27.6	337.8	4585.2	29	Th 231	26.6	.49E-11	.00	.17E-07
				Sn 113	27.3	.83E-11	.00	
				Pa 231	27.4	.98E-11	.00	
				Sn 113	27.9	.43E-10	.00	
49.7	793.2	12185.8	20	Th 227	50.2	.24E-10	.00	.68E-07
				Am 243	50.6	.71E-07	.00	
59.5	22493.6	15891.4	1	Th 231	58.6	.10E-07	.00	.23E-05
				U- 235	58.6	.57E-07	.00	
				Am 241	59.5	.16E-09	.00	
				Eu 155	60.0	.44E-08	.00	
63.6	501.6	14798.4	35	TH 234	63.2	.33E-10	.00	.55E-07
				U- 238	63.2	.33E-10	.00	
74.8	615.0	17659.0	31	Am 243	74.7	.24E-11	.00	.80E-07
				Pb 212	74.8	.17E-10	.00	

				Px 82	75.0	.16E-11	.00	
77.1	744.5	17484.5	25	Lu 174	76.5	.24E-10	.00	.10E-06
				Pu 241	77.0	.81E-05	.00	
				Pb 212	77.1	.11E-10	.00	
				Bi 209	77.1	.19E-11	.00	
				PU 239	77.6	.45E-06	.00	
92.5	922.1	17559.9	21	TH 234	92.6	.45E-10	.00	.15E-06
				U- 238	92.6	.45E-10	.00	
				U- 235	93.3	.97E-10	.00	
123.2	724.8	13854.2	23	AM 241	123.0	.19E-06	.00	.16E-06
185.6	678.5	9074.5	20	Un 235	185.7	.17E-11	.00	.27E-06
				Un 238	186.1	.36E-10	.00	
				U- 235	185.7	.40E-11	.00	
				U 238	186.1	.64E-10	.00	
209.4	331.4	7406.6	37	Ac 228	209.4	.24E-10	.00	.16E-06
238.4	2422.2	6082.8	5	Pb 212	238.6	.20E-10	.00	.14E-05
				Th 232	238.6	.19E-10	.00	
241.7	266.3	5910.7	41	U- 235	240.9	.14E-08	.00	.15E-06
				Pb 214	241.9	.13E-10	.00	
295.0	977.8	3389.2	9	Pb 214	295.2	.21E-10	.00	.77E-06
				EU 152	296.0	.98E-09	.00	
338.1	623.0	2713.0	12	Ac 228	338.4	.26E-10	.00	.61E-06
				U- 235	338.6	.97E-10	.00	
351.6	1652.0	2764.0	5	Ra 226	351.9	.21E-10	.00	.17E-05
				Pb 214	352.0	.21E-10	.00	
				Co 57	352.2	.23E-06	.00	
442.4	164.6	1788.4	37					.25E-06
462.7	316.5	1656.5	19	Pa 228	463.0	.13E-10	.00	.53E-06
				Ac 228	463.0	.37E-10	.00	
				Sb 125	463.4	.16E-10	.00	
510.7	1711.9	1592.1	4	I- 133	510.4	.66E-09	.00	.34E-05
				TL 208	510.8	.43E-10	.00	
				Na 22	511.0	.55E-11	.00	
				ZN 65	511.0	.35E-09	.00	
				Y 88	511.0	.25E-08	.00	
				Ru 106	511.8	.48E-10	.00	
583.0	1700.5	1271.5	4	Tl 208	583.1	.12E-10	.00	.42E-05
				Th 232	583.1	.36E-10	.00	
609.0	1944.5	1151.5	3	Xe 135	608.6	.49E-09	.00	.51E-05
				Bi 214	609.3	.27E-10	.00	
				Ra 226	609.3	.29E-10	.00	
661.4	442.5	1015.5	11	Cs 137	661.6	.36E-11	.00	.13E-05
				AM 241	662.4	.88E-06	.00	
694.1	102.2	1020.8	45	AM 241	693.4	.23E-04	.00	.33E-06
723.3	187.0	1164.0	27	I- 131	723.0	.85E-10	.00	.66E-06
				Eu 154	723.3	.67E-11	.00	
				Zr 95	724.2	.32E-11	.00	
727.1	399.1	1054.9	13	AC 228	727.0	.37E-08	.00	.14E-05
				Bi 212	727.2	.25E-10	.00	
				U- 239	727.5	.12E-06	.00	
				BI 214	727.8	.19E-07	.00	
				PU 239	727.9	.24E-02	.00	
768.0	198.8	1034.2	24	Pa 234	766.6	.73E-09	.00	.77E-06
				PA 234	766.6	.73E-09	.00	
				Rh 102	766.8	.44E-11	.00	
				AM 241	766.9	.30E-04	.00	
				Bi 214	768.4	.31E-10	.00	
				PU 239	769.4	.14E-04	.00	
772.1	89.1	896.9	49	AM 241	770.9	.10E-04	.00	.35E-06

				AC 228	772.1	.42E-10	.00	
				I- 132	772.7	.90E-12	.00	
				Th 227	773.0	.52E-06	.00	
				AC 228	773.5	.78E-09	.00	
785.6	218.0	881.0	20	Bi 212	785.4	.84E-10	.00	.88E-06
				Pa 234	786.3	.49E-08	.00	
				Pu 238	786.3	.48E-04	.00	
794.6	288.7	896.3	16	Pa 228	794.7	.11E-09	.00	.12E-05
				Ac 228	794.8	.47E-10	.00	
				TL 210	795.0	.22E-11	.00	
				CS 134	795.8	.26E-11	.00	
806.2	112.0	799.0	37	Pu 238	805.4	.63E-03	.00	.47E-06
				Bi 214	806.2	.71E-09	.00	
860.3	239.6	883.4	19	Tl 208	860.4	.16E-10	.00	.11E-05
910.9	1452.5	819.5	4	Ac 228	911.1	.49E-10	.00	.75E-05
				Th 232	911.1	.49E-10	.00	
933.8	145.3	804.7	29	Bi 214	934.1	.40E-10	.00	.78E-06
964.2	145.1	1060.9	33	EU 152	964.0	.88E-11	.00	.82E-06
				Ac 228	964.6	.24E-10	.00	
				Pa 228	964.6	.13E-10	.00	
968.7	745.8	951.2	7	Ac 228	968.9	.44E-10	.00	.43E-05
1001.0	174.2	769.8	24	PA 234	1001.0	.19E-09	.00	.11E-05
				Pa 234	1001.0	.19E-09	.00	
				U- 238	1001.0	.19E-09	.00	
				Pu 238	1001.1	.12E-03	.00	
1119.9	645.2	740.8	7	Bi 214	1120.4	.37E-10	.00	.47E-05
				Ra 226	1120.4	.37E-10	.00	
1237.8	361.8	844.2	13	I- 133	1237.5	.24E-09	.00	.31E-05
				Bi 214	1238.1	.64E-10	.00	
1274.5	171.4	616.6	22	Al 29	1273.3	.20E-11	.00	.16E-05
				Na 22	1274.5	.18E-11	.00	
				Eu 154	1274.5	.54E-11	.00	
1280.9	129.5	555.5	27	BI 214	1281.0	.94E-10	.00	.12E-05
1377.7	191.0	404.0	17	Bi 214	1377.7	.53E-10	.00	.20E-05
1401.0	88.9	376.1	33	Pa 234	1399.7	.44E-09	.00	.94E-06
				BI 214	1401.5	.73E-10	.00	
1407.8	121.8	354.2	24	Bi 214	1408.0	.56E-10	.00	.13E-05
				EU 152	1408.0	.67E-11	.00	
				Al 28	1408.8	.12E-09	.00	
1460.7	11197.1	373.9	1	K- 40	1460.8	.12E-08	.00	.13E-03
1509.1	122.3	179.7	18	Bi 214	1509.2	.67E-10	.00	.15E-05
				Pa 234	1510.5	.16E-07	.00	
1538.4	62.8	158.2	31	AC 228	1537.7	.15E-08	.00	.78E-06
				BI 214	1538.5	.18E-09	.00	
				Np 240	1539.6	.96E-10	.00	
				TL 210	1540.0	.38E-10	.00	
1587.9	262.3	211.7	10					.34E-05
1620.9	128.9	150.1	16	Bi 212	1620.6	.59E-10	.00	.17E-05
				Al 28	1622.6	.49E-10	.00	
1630.7	83.0	146.0	23	AC 228	1630.4	.53E-10	.00	.11E-05
1661.5	69.7	114.3	25	BI 214	1661.3	.77E-10	.00	.98E-06
1729.4	133.7	121.3	15	Bi 214	1729.6	.57E-10	.00	.20E-05
1764.3	665.3	115.7	5	Bi 214	1764.0	.52E-10	.00	.10E-04
				Pa 234	1765.4	.14E-06	.00	
1847.3	100.2	92.8	17	BI 214	1847.4	.64E-10	.00	.17E-05
2103.4	273.1	108.9	8	TL 208	2103.5	.41E-10	.00	.57E-05
2118.4	92.0	99.0	19	BI 214	2118.5	.11E-09	.00	.19E-05
2204.0	235.4	123.6	9	Bi 214	2204.1	.72E-10	.00	.53E-05
2447.7	74.8	75.2	20	Bi 214	2447.7	.79E-10	.00	.20E-05

SUM OF ESTIMATED EXTERNAL EXPOSURE RATE: .281E-03uR/Hr

Det#40279/Plus 3600s1cm B-1 PondSed Sam006 398g 6-25-97

** Software Version: 122095/ 0/Q by R. T. Reiman *

Energy (keV)	Resolution FWHM (keV)	Live Time Seconds	Real Time Seconds	Quad Value	Gain (kev/ch)	OFFSET (keV)	HEIGHT (cm)
609.0	1.44	3600	3676	.225E-07	.375	-.460	1

Nuclide Summary

Isotope	Activity Ci	Error %
K- 40	.119E-08	1.0
U- 238	.752E-10	9.6
Ra 226	.319E-10	2.3
U- 235	.173E-11	22.2
Th 232	.274E-10	2.6
Cs 137	.457E-11	9.3
Am 241	.254E-09	.7

ENERGY (keV)	NET COUNT	BACKGROUND COUNT	ERROR (%)	ISOTOPE	PHOTO-PEAK	ACTIVITY (Ci)		EXPOSURE (uR/Hr)
12.7	2243.5	2381.5	4	Pa 231	12.6	.10E-09	.00	.54E-07
				Th 231	13.3	.69E-11	.00	
				Th 234	13.3	.65E-10	.00	
				Pa 234	13.6	.16E-08	.00	
				Pu 238	13.6	.16E-09	.00	
16.1	635.6	5125.4	16	Pa 231	15.7	.23E-10	.00	.19E-07
				Y- 88	15.8	.20E-10	.00	
23.9	1200.6	4907.4	9	Sn 113	24.0	.16E-10	.00	.52E-07
				In 115	24.2	.33E-11	.00	
				Sn 113	24.2	.83E-11	.00	
				Cd 109	24.9	.23E-10	.00	
26.9	410.3	4852.8	25	AM 241	26.3	.44E-10	.00	.20E-07
				Th 231	26.6	.59E-11	.00	
				Sn 113	27.3	.10E-10	.00	
				Pa 231	27.4	.12E-10	.00	
49.4	1049.0	14488.0	17	Th 227	50.2	.32E-10	.00	.89E-07
59.3	36477.3	17221.7	1	Th 231	58.6	.17E-07	.00	.37E-05
				U- 235	58.6	.93E-07	.00	
				Am 241	59.5	-.26E-09	.00	
				Eu 155	60.0	.72E-08	.00	
63.1	998.5	15048.5	18	TH 234	63.2	.66E-10	.00	.11E-06
				U- 238	63.2	.66E-10	.00	
74.9	794.0	18186.0	24	Am 243	74.7	.31E-11	.00	.10E-06
				Pb 212	74.8	.22E-10	.00	
				U- 235	74.9	.21E-06	.00	
				Px 82	75.0	.21E-11	.00	
77.2	711.4	18161.6	27	Lu 174	76.5	.23E-10	.00	.96E-07

				Pb 212	77.1	.11E-10	.00	
				Bi 209	77.1	.19E-11	.00	
				PU 239	77.6	.43E-06	.00	
87.3	451.4	18147.6	42	Eu 155	86.5	.37E-11	.00	.69E-07
				Am 243	86.8	.35E-09	.00	
				Th 234	87.0	.16E-07	.00	
				Ac 225	87.0	.41E-09	.00	
				Pb 212	87.2	.19E-10	.00	
				Cd 109	88.0	.31E-10	.00	
92.6	1339.2	17975.8	14	TH 234	92.6	.65E-10	.00	.22E-06
				U- 238	92.6	.65E-10	.00	
				U- 235	93.3	.14E-09	.00	
123.3	462.4	14521.6	37	AM 241	123.0	.12E-06	.00	.10E-06
185.6	722.4	9524.6	19	Un 235	185.7	.19E-11	.00	.28E-06
				Un 238	186.1	.38E-10	.00	
				U- 235	185.7	.43E-11	.00	
				U 238	186.1	.68E-10	.00	
238.5	2366.0	6138.0	5	Pb 212	238.6	.19E-10	.00	.13E-05
				Th 232	238.6	.19E-10	.00	
241.6	383.7	5857.3	29	U- 235	240.9	.19E-08	.00	.22E-06
				Pb 214	241.9	.18E-10	.00	
295.1	1091.7	3593.3	8	Pb 214	295.2	.23E-10	.00	.86E-06
				EU 152	296.0	.11E-08	.00	
338.2	659.1	2708.9	12	Ac 228	338.4	.28E-10	.00	.65E-06
				U- 235	338.6	.10E-09	.00	
351.7	2029.5	2910.5	4	Ra 226	351.9	.26E-10	.00	.21E-05
				Pb 214	352.0	.25E-10	.00	
				Co 57	352.2	.28E-06	.00	
409.5	251.7	2043.3	26	Ac 228	409.4	.56E-10	.00	.34E-06
				Pa 234	409.8	.31E-09	.00	
				Ra 224	410.0	.31E-07	.00	
				U- 235	410.3	.42E-07	.00	
				Pa 231	410.5	.81E-07	.00	
462.8	305.7	1753.3	20	Pa 228	463.0	.12E-10	.00	.51E-06
				Ac 228	463.0	.36E-10	.00	
				Sb 125	463.4	.15E-10	.00	
510.4	1567.8	1628.2	4	I- 133	510.4	.60E-09	.00	.31E-05
				TL 208	510.8	.39E-10	.00	
				Na 22	511.0	.50E-11	.00	
				ZN 65	511.0	.32E-09	.00	
				Y 88	511.0	.23E-08	.00	
533.6	150.1	1525.9	38	Ru 103	532.7	.81E-10	.00	.32E-06
582.8	1654.9	1358.1	4	Tl 208	583.1	.12E-10	.00	.41E-05
				Th 232	583.1	.35E-10	.00	
609.1	2288.6	1187.4	3	Xe 135	608.6	.57E-09	.00	.60E-05
				Bi 214	609.3	.32E-10	.00	
				Ra 226	609.3	.35E-10	.00	
				Ru 103	610.3	.27E-09	.00	
619.2	148.2	1059.8	32	AM 241	618.9	.18E-05	.00	.40E-06
				Am 243	620.0	.31E-06	.00	
661.6	593.7	1078.3	9	Cs 137	661.6	.48E-11	.00	.18E-05
				AM 241	662.4	.12E-05	.00	
723.1	174.9	1099.1	28	AM 241	721.9	.69E-06	.00	.61E-06
				I- 131	723.0	.80E-10	.00	
				Eu 154	723.3	.63E-11	.00	
				Zr 95	724.2	.30E-11	.00	
727.2	403.9	1050.1	12	AC 228	727.0	.37E-08	.00	.14E-05
				Bi 212	727.2	.25E-10	.00	
				U- 239	727.5	.12E-06	.00	

				PU 239	727.9	.25E-02	.00	
768.1	277.3	981.7	17	Rh 102	766.8	.62E-11	.00	.11E-05
				AM 241	766.9	.41E-04	.00	
				Bi 214	768.4	.43E-10	.00	
				PU 239	769.4	.19E-04	.00	
772.6	92.0	933.0	48	AC 228	772.1	.43E-10	.00	.36E-06
				I- 132	772.7	.93E-12	.00	
				Th 227	773.0	.54E-06	.00	
				AC 228	773.5	.81E-09	.00	
785.7	191.3	867.7	23	Bi 212	785.4	.74E-10	.00	.77E-06
				Pa 234	786.3	.43E-08	.00	
				Pu 238	786.3	.42E-04	.00	
794.7	324.3	843.7	14	Pa 228	794.7	.13E-09	.00	.13E-05
				Ac 228	794.8	.52E-10	.00	
				TL 210	795.0	.25E-11	.00	
				CS 134	795.8	.29E-11	.00	
835.6	104.2	808.8	40	Kr 88	834.7	.64E-11	.00	.47E-06
				Mn 54	834.8	.84E-12	.00	
				Ac 228	835.6	.46E-10	.00	
839.8	122.5	838.5	35	AC 228	840.2	.10E-09	.00	.55E-06
860.4	272.3	917.7	17	Tl 208	860.4	.18E-10	.00	.13E-05
873.2	123.9	863.1	35	Eu 154	873.2	.87E-11	.00	.60E-06
904.3	156.3	845.7	28	AC 228	904.2	.15E-09	.00	.80E-06
				BI 214	904.3	.13E-08	.00	
				Pu 238	904.4	.13E-02	.00	
				Pa 234	904.8	.26E-09	.00	
				PU 239	905.5	.13E-01	.00	
911.0	1524.8	840.2	4	Ac 228	911.1	.52E-10	.00	.79E-05
				Th 232	911.1	.52E-10	.00	
933.9	264.3	730.7	16	Bi 214	934.1	.72E-10	.00	.14E-05
964.3	161.3	1064.7	30	EU 152	964.0	.98E-11	.00	.92E-06
				Ac 228	964.6	.26E-10	.00	
				Pa 228	964.6	.14E-10	.00	
968.8	679.4	960.6	8	Ac 228	968.9	.40E-10	.00	.39E-05
1001.1	221.0	802.0	19	PA 234	1001.0	.24E-09	.00	.13E-05
				Pa 234	1001.0	.24E-09	.00	
				U- 238	1001.0	.24E-09	.00	
				Pu 238	1001.1	.15E-03	.00	
1120.0	825.4	807.6	6	Bi 214	1120.4	.47E-10	.00	.60E-05
				Ra 226	1120.4	.47E-10	.00	
1154.9	181.9	768.1	23	BI 214	1155.2	.11E-09	.00	.14E-05
1238.2	367.2	838.8	12	I- 133	1237.5	.24E-09	.00	.32E-05
				Bi 214	1238.1	.65E-10	.00	
1274.2	174.4	612.6	21	Al 29	1273.3	.20E-11	.00	.16E-05
				Na 22	1274.5	.19E-11	.00	
				Eu 154	1274.5	.55E-11	.00	
1280.9	109.1	600.9	33	BI 214	1281.0	.79E-10	.00	.99E-06
1377.7	219.9	390.1	14	Bi 214	1377.7	.61E-10	.00	.23E-05
1401.7	63.4	452.6	49	BI 214	1401.5	.52E-10	.00	.67E-06
1407.8	142.6	415.4	22	Bi 214	1408.0	.66E-10	.00	.15E-05
				EU 152	1408.0	.78E-11	.00	
				Al 28	1408.8	.14E-09	.00	
1460.7	11264.2	388.8	1	K- 40	1460.8	.12E-08	.00	.13E-03
1495.9	77.6	197.4	28	AC 228	1495.8	.88E-10	.00	.92E-06
				Np 240	1496.9	.70E-10	.00	
1509.4	117.5	195.5	19	Bi 214	1509.2	.64E-10	.00	.14E-05
				Pa 234	1510.5	.15E-07	.00	
1588.2	165.5	268.5	16	Al 28	1590.0	.20E-09	.00	.22E-05
				TL 210	1590.0	.10E-09	.00	

				Al	28	1622.6	.52E-10	.00	
1630.6	135.5	141.5	15	AC	228	1630.4	.87E-10	.00	.19E-05
1729.7	167.3	145.7	13	Bi	214	1729.6	.72E-10	.00	.25E-05
1764.6	768.8	129.2	4	Bi	214	1764.0	.60E-10	.00	.12E-04
				Pa	234	1765.4	.17E-06	.00	
1847.1	107.7	138.3	18	BI	214	1847.4	.69E-10	.00	.18E-05
2103.1	275.6	131.4	8	TL	208	2103.5	.41E-10	.00	.58E-05
2118.5	113.2	107.8	16	BI	214	2118.5	.14E-09	.00	.24E-05
2204.0	235.4	131.6	9	Bi	214	2204.1	.72E-10	.00	.53E-05
2448.0	97.1	86.9	17	Bi	214	2447.7	.10E-09	.00	.26E-05
2614.6	1907.1	49.9	2	TL	208	2614.6	.33E-10	.00	.57E-04

SUM OF ESTIMATED EXTERNAL EXPOSURE RATE: .295E-03uR/Hr

Det#40279/Plus 3600s1cm B-1Pond Sed Sam007 325g 6-25-97

** Software Version: 122095/ 0/Q by R. T. Reiman •

Energy (keV)	Resolution FWHM (keV)	Live Time Seconds	Real Time Seconds	Quad Value	Gain (kev/ch)	OFFSET (keV)	HEIGHT (cm)
609.0	1.47	3600	3672	.347E-07	.375	-.450	1

Nuclide Summary

Isotope	Activity Ci	Error %
K- 40	.115E-08	1.0
U- 238	.533E-10	13.4
Ra 226	.294E-10	2.4
U- 235	.144E-11	24.6
Th 232	.255E-10	2.8
Cs 137	.364E-11	11.3
Am 241	.840E-10	1.7

ENERGY (keV)	NET COUNT	BACKGROUND COUNT	ERROR (%)	ISOTOPE	PHOTO-PEAK	ACTIVITY (Ci)		EXPOSURE (uR/Hr)
12.7	2214.6	2295.4	4	Pa 231	12.6	.10E-09	.00	.53E-07
				Th 231	13.3	.68E-11	.00	
				Th 234	13.3	.64E-10	.00	
				Pa 234	13.6	.16E-08	.00	
				Pu 238	13.6	.16E-09	.00	
15.8	597.5	4976.5	17	Pa 231	15.7	.21E-10	.00	.18E-07
				Y- 88	15.8	.19E-10	.00	
19.0	207.4	4591.6	47	Pa 231	18.5	.29E-10	.00	.73E-08
23.9	1250.8	4620.3	8	Sn 113	24.0	.16E-10	.00	.54E-07
				In 115	24.2	.34E-11	.00	
				Sn 113	24.2	.87E-11	.00	
				Cd 109	24.9	.24E-10	.00	
27.0	369.8	4617.3	27	AM 241	26.3	.40E-10	.00	.18E-07
				Th 231	26.6	.53E-11	.00	
				Sn 113	27.3	.90E-11	.00	
				Pa 231	27.4	.11E-10	.00	
				Sn 113	27.9	.47E-10	.00	
59.3	11993.6	14627.4	2	Th 231	58.6	.55E-08	.00	.12E-05
				U- 235	58.6	.31E-07	.00	
				Am 241	59.5	.85E-10	.00	
				Eu 155	60.0	.24E-08	.00	
63.3	689.2	14846.8	25	TH 234	63.2	.46E-10	.00	.75E-07
				U- 238	63.2	.46E-10	.00	
74.9	701.2	17867.8	27	Am 243	74.7	.28E-11	.00	.91E-07
				Pb 212	74.8	.19E-10	.00	
				U- 235	74.9	.18E-06	.00	
				Px 82	75.0	.18E-11	.00	

				Pu 241	77.0	.62E-05	.00	
				Pb 212	77.1	.85E-11	.00	
				Bi 209	77.1	.15E-11	.00	
				PU 239	77.6	.35E-06	.00	
92.6	959.5	17518.5	20	TH 234	92.6	.47E-10	.00	.16E-06
				U- 238	92.6	.47E-10	.00	
				U- 235	93.3	.10E-09	.00	
122.9	565.0	14059.0	30	Co 57	122.1	.18E-11	.00	.12E-06
				AM 241	123.0	.15E-06	.00	
185.6	558.2	9166.8	25	Un 235	185.7	.14E-11	.00	.22E-06
				Un 238	186.1	.30E-10	.00	
				U- 235	185.7	.33E-11	.00	
				U 238	186.1	.52E-10	.00	
209.2	343.6	7219.4	35	Ac 228	209.4	.25E-10	.00	.16E-06
238.4	2175.2	5947.8	5	Pb 212	238.6	.18E-10	.00	.12E-05
				Th 232	238.6	.17E-10	.00	
241.8	368.6	5768.4	30	U- 235	240.9	.19E-08	.00	.21E-06
				Pb 214	241.9	.18E-10	.00	
295.1	1012.5	3468.5	9	Pb 214	295.2	.21E-10	.00	.79E-06
				EU 152	296.0	.10E-08	.00	
300.3	256.4	3282.6	32	TH 227	299.9	.47E-10	.00	.21E-06
				U- 235	299.9	.52E-10	.00	
				Pb 212	300.1	.30E-10	.00	
				Pa 231	300.1	.45E-10	.00	
				AM 241	300.1	.18E-04	.00	
309.7	143.6	3041.4	55					.12E-06
338.2	639.2	2653.8	12	Ac 228	338.4	.27E-10	.00	.63E-06
				U- 235	338.6	.10E-09	.00	
351.7	1893.0	2721.0	5	Ra 226	351.9	.24E-10	.00	.20E-05
				Pb 214	352.0	.24E-10	.00	
				Co 57	352.2	.27E-06	.00	
409.8	244.5	2041.5	27	Ac 228	409.4	.54E-10	.00	.33E-06
				Pa 234	409.8	.30E-09	.00	
				Ra 224	410.0	.30E-07	.00	
				U- 235	410.3	.41E-07	.00	
				Pa 231	410.5	.79E-07	.00	
462.8	258.8	1675.2	23	Pa 228	463.0	.11E-10	.00	.43E-06
				Ac 228	463.0	.30E-10	.00	
				Sb 125	463.4	.13E-10	.00	
471.0	110.1	1603.9	52					.19E-06
477.7	206.0	1547.0	28	Pb 211	478.0	.89E-08	.00	.36E-06
510.7	1489.4	1634.6	5	I- 133	510.4	.57E-09	.00	.29E-05
				TL 208	510.8	.37E-10	.00	
				Na 22	511.0	.48E-11	.00	
				ZN 65	511.0	.30E-09	.00	
				Y 88	511.0	.21E-08	.00	
				Ru 106	511.8	.42E-10	.00	
582.8	1582.3	1349.7	4	Tl 208	583.1	.12E-10	.00	.39E-05
				Th 232	583.1	.33E-10	.00	
609.0	2102.3	1198.7	3	Xe 135	608.6	.52E-09	.00	.55E-05
				Bi 214	609.3	.29E-10	.00	
				Ra 226	609.3	.32E-10	.00	
				Ru 103	610.3	.25E-09	.00	
661.2	448.8	1060.2	11	Cs 137	661.6	.36E-11	.00	.14E-05
				AM 241	662.4	.89E-06	.00	
665.3	98.8	1046.2	47	BI 214	665.5	.44E-10	.00	.30E-06
727.2	412.6	1010.4	12	AC 228	727.0	.38E-08	.00	.15E-05
				Bi 212	727.2	.26E-10	.00	
				U- 239	727.5	.12E-06	.00	

				PU 239	727.9	.25E-02	.00	
768.1	294.3	1042.7	17	Rh 102	766.8	.66E-11	.00	.11E-05
				AM 241	766.9	.44E-04	.00	
				Bi 214	768.4	.46E-10	.00	
				PU 239	769.4	.20E-04	.00	
785.7	136.4	830.6	31	Bi 212	785.4	.52E-10	.00	.55E-06
				Pa 234	786.3	.30E-08	.00	
				Pu 238	786.3	.30E-04	.00	
794.7	253.3	825.7	17	Pa 228	794.7	.98E-10	.00	.10E-05
				Ac 228	794.8	.41E-10	.00	
				TL 210	795.0	.20E-11	.00	
				CS 134	795.8	.23E-11	.00	
847.6	111.6	764.4	36	I- 134	847.1	.94E-12	.00	.51E-06
860.3	296.5	875.5	15	Tl 208	860.4	.20E-10	.00	.14E-05
911.0	1356.8	828.2	4	Ac 228	911.1	.46E-10	.00	.70E-05
				Th 232	911.1	.46E-10	.00	
933.8	164.6	762.4	25	Bi 214	934.1	.45E-10	.00	.89E-06
964.2	163.7	1009.3	29	EU 152	964.0	.99E-11	.00	.93E-06
				Ac 228	964.6	.27E-10	.00	
				Pa 228	964.6	.14E-10	.00	
968.8	680.2	947.8	7	Ac 228	968.9	.40E-10	.00	.39E-05
1000.6	262.9	709.1	16	PA 234	1001.0	.28E-09	.00	.16E-05
				Pa 234	1001.0	.28E-09	.00	
				U- 238	1001.0	.28E-09	.00	
				Pu 238	1001.1	.18E-03	.00	
1120.0	738.8	689.2	6	Bi 214	1120.4	.42E-10	.00	.54E-05
				Ra 226	1120.4	.42E-10	.00	
1154.8	148.2	737.8	27	BI 214	1155.2	.87E-10	.00	.11E-05
1238.1	378.1	842.9	12	I- 133	1237.5	.25E-09	.00	.33E-05
				Bi 214	1238.1	.67E-10	.00	
1274.2	225.9	608.1	17	Al 29	1273.3	.27E-11	.00	.20E-05
				Na 22	1274.5	.24E-11	.00	
				Eu 154	1274.5	.72E-11	.00	
1280.6	130.9	609.1	28	BI 214	1281.0	.95E-10	.00	.12E-05
1377.3	214.1	360.9	14	Bi 214	1377.7	.60E-10	.00	.22E-05
1385.6	92.5	372.5	31	Ag 110	1384.3	.43E-11	.00	.96E-06
				Bi 214	1385.3	.13E-09	.00	
1401.3	90.6	360.4	31	Pa 234	1399.7	.45E-09	.00	.96E-06
				BI 214	1401.5	.74E-10	.00	
1407.7	161.8	370.2	19	Bi 214	1408.0	.74E-10	.00	.17E-05
				EU 152	1408.0	.89E-11	.00	
				Al 28	1408.8	.15E-09	.00	
1460.6	10891.3	368.7	1	K- 40	1460.8	.12E-08	.00	.12E-03
1509.0	136.1	177.9	16	Bi 214	1509.2	.74E-10	.00	.16E-05
				Pa 234	1510.5	.18E-07	.00	
1587.9	196.9	250.1	13					.26E-05
1620.5	121.6	139.4	16	Bi 212	1620.6	.55E-10	.00	.16E-05
1630.3	87.9	146.1	22	AC 228	1630.4	.57E-10	.00	.12E-05
1661.4	60.6	130.4	30	BI 214	1661.3	.67E-10	.00	.85E-06
1729.7	153.7	148.3	14	Bi 214	1729.6	.66E-10	.00	.23E-05
1764.6	657.4	151.6	5	Bi 214	1764.0	.51E-10	.00	.10E-04
				Pa 234	1765.4	.14E-06	.00	
1847.6	122.6	103.4	15	BI 214	1847.4	.79E-10	.00	.21E-05
2103.2	244.1	125.9	9	TL 208	2103.5	.36E-10	.00	.51E-05
2118.5	76.4	105.6	22	BI 214	2118.5	.95E-10	.00	.16E-05
2204.1	271.7	123.3	8	Bi 214	2204.1	.84E-10	.00	.61E-05
2447.0	109.1	101.9	16	Bi 214	2447.7	.12E-09	.00	.29E-05
2614.5	1813.5	45.5	2	TL 208	2614.6	.31E-10	.00	.54E-04

SUM OF ESTIMATED EXTERNAL EXPOSURE RATE: .279E-03uR/Hr

FAX

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The actinide particle size

Appendix 5.

Sample	Dates Counted	Weight (g)	Wet wt.-W (g)	Wet wt.-A (g)	Dry wt.-A (g)	θ [–]	$^{239,240}Pu$ (dpm/Kg)	Error	$^{239,240}Pu$ (Σdpm)	$\Sigma^{239,240}Pu$ (Σdpm/cm^2)
97-07-01										
25	08/18-08/20	1.0082	48.270	6.5872	4.7998	0.482	3.63E+03	220.4	127.68	7.69
29	08/18-08/20	1.0049	54.09	8.885	7.5427	0.308	4.72E+03	235.1	216.94	13.06
39	08/15-08/25	1.0086	83.837	12.9872	6.5808	0.709	2.77E+02	20.3	11.75	0.71
97-06-24-B1										
1	08/18-08/20	1.0053	107.79	14.0848	6.8038	0.728	2.44E+05	6653.5	12678.56	763.28
2	08/20-08/21	1.0043	131.95	15.162	10.5719	0.520	7.57E+04	2669.0	6967.52	419.46
4	08/18-08/20	1.0012	94.592	12.5494	5.7474	0.747	1.60E+05	4890.1	6912.35	416.14
5	08/20-08/21	1.0043	111.08	15.9793	7.4548	0.741	2.16E+05	8309.1	11210.71	674.91
6	08/18-08/20	1.0026	148.17	15.1248	8.7998	0.642	1.69E+05	2719.4	14565.87	876.90
7	08/18-08/20	1.0047	102.60	12.9456	5.5991	0.766	1.12E+05	2880.9	4975.54	299.54

Duplicate Sample