SUB-REPORT

SURVEY UNIT KAISER-FSS-016

TABLE OF CONTENTS

ATTACHMENTS

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-016
Survey Unit Kaiser-FSS-016
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-016, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the eastern portion of the Retention Pond area. Survey Unit Kaiser-FSS-016 is considered a Class 1 survey unit with an approximate surface area of 2,484 m^2. It is bounded to the south by Survey Unit Kaiser-FSS-020, to the east by Survey Unit Kaiser-FSS-014 and the Specific Systems property, to the north by Survey Unit Kaiser-FSS-017, and to the west by Survey Units Kaiser-FSS-018 and Kaiser-FSS-019 (**Figure 3**).

Survey Unit Kaiser-FSS-016 consists of an excavation bottom surface soil with two side walls (east wall and south wall). The excavation continued beyond (east and south) the Kaiser property line, beneath the Specific Systems concrete roadway. Two elevated areas (greater than net 3.0 pCi/g Th-232) were left in place beneath the concrete roadway due to structural integrity/safety concerns. These two elevated areas were evaluated using the elevated measurement comparison (EMC) as presented in the DP for the project. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the following physical features or elements of Survey Unit Kaiser-FSS-016:

- Excavation bottom surface soil including the east wall and south wall surface soil.
- Elevated soil areas located along the east wall and south wall of the survey unit.

2.1 Excavation Bottom/Side Wall Surface Soil

The final status survey of the excavation bottom and side walls surface soil consisted of a gross gamma scan of the exposed surface soil and systematic soil sampling.

2.1.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom and side walls) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 30 approximately equal distant locations within the survey unit. The statistics for the 30 background measurements are provided below in **Table 1.** Background measurements ranged from 19,431 counts per minute (cpm) along the southwestern survey unit boundary to 39,094 cpm along the northern survey unit boundary. The elevated background measurements identified along the northern boundary were the result of shine from radiologically-affected material (BCM) located immediately north of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 3,748 measurements of gross count rate were made at two second intervals across the survey unit's 2,484 m^2 surface area. The results ranged from 17,219 cpm to 67,100 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	2,484 m^2	
Number of Scan Measurements (2-Second Intervals)	3,748	
Scan Rate: (Swinging the detector a width of 1-meter side to side)	0.33 m/s (MARSSIM recommends 0.5m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	19,431	17,219
Maximum	39,094	67,100
Average	27,523	26,297
Standard Deviation	5,183	3,646
Median	26,197	25,899

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity on the excavation bottom (above the $DCGL_W$ for the site). As part of the gross gamma survey, 10 biased soil samples were collected at locations exhibiting the highest scan rates on the excavation bottom and side walls **(Figure A-2, Attachment A).** The biased soil samples were screened onsite in a lead cave. Results of the sample screening are presented below in **Table 2.** The sample screening levels were below the $DCGL_W$ for the site.

Table 2 – Biased Soil Sample Screening Results

Soil Sample ID	Cave Counter Screening Results (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)
$DCGL_W$	*3.0*		
Site Background	*1.1*	0.3	
K-751	0.320	0.807	1.50
K-752*	0.625	0.063	0.205
K-753	0.321	0.872	1.50
K-754	0.371	0.778	1.50
K-762	0.286	1.09	1.50
K-763	1.03	1.22	1.50
K-764	0.434	1.20	1.50
K-765	0.355	1.20	1.50
K-766	-0.358	0.982	1.50
K-767	1.54	0.979	1.50

*Sample K-752 was also analyzed by Outreach. The lab data are presented in the table.

Two confirmed areas of elevated activity were identified, one along the excavation's east wall and one along the excavation's south wall. These elevated areas are discussed in **Section 2.2.**

2.1.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 **(Attachment B)**. The default Class 1 Survey Unit area of 2,000 m^2 along with the N of 9 were used to calculate the Triangular Grid Node length (L) of 16.0 meters and the height of the equilateral triangle (h) of 13.9 meters. Since A was greater than 2,000 m^2, the number of samples (N_1) was recalculated (11) to correspond to the L of 16.0 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 **(Attachment B)**.

A layout of the soil sampling locations is provided on **Figure A-3** contained in **Attachment A.** The soil sample locations were demarcated in the field using a GPS unit. A total of 14 soil samples (identified as K-731 through K-744) were collected at the excavation bottom/side wall surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3.** Analytical data reports are contained in **Attachment C.**

Table 3 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-731	0.902	0.142	0.368	0	3.0
K-732	0.927	0.153	0.398	0	3.0
K-733	0.749	0.078	0.166	0	3.0
K-734	1.09	0.157	0.365	0	3.0
K-735	0.822	0.094	0.161	0	3.0
K-736	0.874	0.096	0.192	0	3.0
K-737	0.443	0.201	0.502	0	3.0
K-738	1.30	0.109	0.301	0.20	3.0
K-739	0.599	0.328	0.832	0	3.0
K-740	1.35	0.216	0.502	0.25	3.0
K-741	3.72	0.214	0.268	2.62	3.0
K-742	0.965	0.191	0.505	0	3.0
K-743	1.42	0.247	0.246	0.32	3.0
K-744	1.93	0.163	0.282	0.83	3.0
Average	*1.22*				
Standard Dev.	*0.812*				
Minimum	*0.443*				
Maximum	*3.72*				
Median	*0.946*				

All 14 systematic soil sample results (net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 3.72 pCi/g. The average gross Th-232 activity concentration was 1.22 pCi/g.

The standard deviation of the 14 equal-distant samples was 0.812, which fell above the estimated standard deviation of 0.42 used to calculate the minimum number of samples required. Since the estimated variance (standard deviation) is greater than the variance used to calculate the minimum number of samples required (N), N was recalculated using the measured variance of 0.812 to ensure enough samples were taken, as follows:

Paramount to determining the minimum number of samples is the determination of the relative shift, delta over sigma (Δ/σ). Delta is equal to the DCGL minus the lower-bound gray region (LBGR) value. The LBGR value is arbitrarily set at one-half the DCGL value to start the determination. Sigma is an estimate of the variability in a set of sample analysis results from a survey unit. In the DP, the estimate of sigma used was based on the standard deviations in Th-232 activity measured in survey units during the FSS sampling of the adjacent land remediation final survey (0.42). The net Th-232 activity concentration of 3.0 pCi/g was used as the DCGL and Δ was equal to 3.0 - 1.5, or 1.5. Delta divided by the sigma of 0.42 resulted in a relative shift of 3.57 which is rounded to 3.5 for the purpose of determining the required number of samples. The number of samples was then looked up in Table 5.3 of MARSSIM (9 for selected alpha and beta error rates of 0.05).

Using the original net DCGL value of 3.0 pCi/g, a recalculation of N results in a delta of (3 – 1.5) of 1.5 and a relative shift of (1.5 / 0.812) of 1.8 using the measured variance of 0.812. The resulting N for a standard Class 1 survey unit of 2,000 m^2 is 14 (MARSSIM Table 5.3) and for a 2,484 m^2 survey unit (FSS-016) the number is increased to 18. However, the number of sample values provided in MARSSIM Table 5.3 is increased 20% to account for unusable or lost data during surveys and achieve the desired power level for statistical tests (MARSSIM Section 5.5.2.2, Contaminant Present in Background – Determining Number of Data Points for Statistical Tests). Adjusting the value of 18 for the 20% buffer results in a minimum number of samples required of 14, the number taken in Survey Unit Kaiser-FSS-016.

2.1.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the criterion based on the first statistical test as described below.

If the difference (2.77 pCi/g) between the maximum survey unit soil sample activity concentration (3.72 pCi/g) and the minimum reference background area soil sample activity concentration (0.95 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	229	1.22	S1	K-731	0.902
R2	90	1.37	S2	K-732	0.927
R3	161	1.20	S3	K-733	0.749
R4	28	1.18	S4	K-734	1.09
R5	187	1.30	S5	K-735	0.822
R6	148	1.37	S6	K-736	0.874
R7	105	0.95	S7	K-737	0.443
R8	124	1.07	S8	K-738	1.30
R9	354	0.96	S9	K-739	0.599
R10	109	1.27	S10	K-740	1.35
R11	215	1.13	S11	K-741	3.72
R12	88	1.46	S12	K-742	0.965
R13	356	1.45	S13	K-743	1.42
R14	219	1.01	S14	K-744	1.93
	Average:	***1.21***		***Average:***	***1.22***
	Std. Dev.:	***0.17***		***Std. Dev.:***	***0.812***
	Minimum:	***0.95***		***Minimum:***	***0.443***
	Maximum:	***1.46***		***Maximum:***	***3.72***
	Median:	***1.21***		***Median:***	***0.946***

2.2 Elevated Areas

During the remediation of Survey Unit Kaiser-FSS-016, two areas adjacent to the Specific Systems property were encountered where the additional excavation of impacted material was not possible due to structural integrity/safety issues. These two areas were evaluated using the EMC criteria.

The first area, EMC-1, was located on the south wall of the survey unit at the northwest corner of the Specific Systems property **(Figure D-1, Attachment D)**. The total area of EMC-1 was less than 1 m^2. The following three soil samples were used to define the area:

- Sample K-730 – A biased soil sample taken at the highest gross gamma scan measurement location (approximately 62,000 cpm on contact). The sample was analyzed by Outreach and represents a conservative estimation of the Th-232 activity concentration within the 1 m^2 elevated area (EMC-1).
- Sample K-728 – A biased soil sample also taken within EMC-1 corresponding to a scan measurement of approximately 25,000 cpm on contact. The Outreach result for this sample was not used to estimate the activity concentration of the elevated area (conservative).
- Sample K-729 – A composite soil sample taken to bound the elevated area.

Figure D-2, Attachment D shows the soil sampling locations for this elevated area. The analytical results for the EMC-1 soil samples are presented below in **Table 5.**

Table 5 - EMC-1 Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-728	2.00	0.122	0.452	0.90	37.5
K-729	0.777	0.045	0.280	0	3.0
K-730	11.3	0.461	0.410	10.2	37.5

A conservative assessment of the elevated area was performed by assuming the area extends to 1 m^2 and that the result for Soil Sample K-730 represents the activity concentration of the entire 1 m^2 elevated area.

The second elevated area, EMC-2 was located on the east wall of the survey unit bordering the Specific Systems property **(Figure D-1, Attachment D).** The total area of EMC-2 was approximately 21 m^2. The following 7 soil samples were initially used to define the elevated area:

- Samples K-716, K-717 and K-718 – Biased soil samples taken in an approximate 0.3 meter by 7 meter area to initially define the elevated area.
- Samples K-719 and K-720 - Composite soil samples taken above and below the original 0.3 meter by 7 meter area to bound the elevated area.
- Samples K-721 and K-722 – Biased soil samples taken to the right and to the left of the original area to bound the elevated area.

Based on the results of the initial 7 soil samples and supporting scan measurements, the boundary of EMC-2 was extended to an area of approximately 1.2 meter by 17 meters (total area of 21 m^2). Subsequent biased soil samples (K-747 and K-749) were taken to confirm the adjacent areas were below the general $DCGL_W$ value of 3.0 pCi/g Th-232 net. The activity concentration within the 21 m^2 elevated area was estimated as the straight (versus weighted by area) average of the initial 7 samples (K-716 through K-722). The average of the 7 samples (5.20 pCi/g Th-232 gross) is conservative since the lower activity samples represent larger areas. The $DCGL_{EMC}$ value for 21 m^2 is 8.0 pCi/g Th-232 net.

Figure D-3, Attachment D shows the soil sampling locations for this elevated area. The analytical results for the EMC-2 soil samples are presented below in **Table 6.**

Table 6 – EMC-2 Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-716*	3.70	0.944	1.57	2.60	8.0
K-717	7.60	0.270	0.452	6.50	8.0
K-718*	5.47	1.04	1.57	4.37	8.0
K-719	1.75	0.153	0.378	0.65	8.0
K-720*	4.72	1.22	1.57	3.62	8.0
K-721*	4.70	1.21	1.57	3.60	8.0
K-722	8.46	0.345	0.590	7.36	8.0
K-747*	0.59	1.01	1.54	0.0	3.0
K-749*	-0.60	1.02	1.54	0.0	3.0

*Counted only in the onsite Cave Counter.

Both elevated areas, EMC-1 and EMC-2 exhibited Th-232 activity concentrations below the applicable $DCGL_{EMC}$ of 37.5 pCi/g (Th-232) for a 1 m^2 area and 8.0 pCi/g (Th-232) for a 21 m^2 area respectively. An elevated measurement comparison (sum of fractions) was completed for Survey Unit Kaiser-FSS-016 with a resulting sum of fractions of 0.79 compared to the Acceptance Criteria of 1.0. The elevated measurement comparison is presented in the Section 3.2 of this report and the Elevated Measurement Worksheet is contained in **Attachment D.**

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the Retention Pond area resulted in an open land area consisting of an excavation approximately 2,484 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-016 is considered a Class 1 survey unit. The survey unit is bounded to the south by Survey Unit Kaiser-FSS-020, to the east by Survey Unit Kaiser-FSS-014 and the Specific Systems property, to the north by Survey Unit Kaiser-FSS-017, and to the west by Survey Units Kaiser-FSS-018 and Kaiser-FSS-019 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings, an elevated measurement comparison, and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom/Side Wall Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the DCGLw of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-016 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom, eastern side wall, and southern side wall) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan indicated the presence of two elevated areas (one on the east side wall and one on the south side wall) which were left in-place due to structural integrity/safety issues associated with a neighboring property concrete drive. Elevated measurement comparisons were required for these two areas (presented in **Section 3.2**).
- All 14 systematic soil sample results (net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).

3.2 Elevated Measurement Comparisons

Consistent with the MARSSIM and the DP, elevated areas and the total dose from soil are evaluated as follows. Analytical results of soil samples are used to complete the elevated measurement comparison. If residual radioactivity is found in a localized area of elevated activity--in addition to the residual radioactivity distributed relatively uniformly across the survey unit--the Unity Rule is used to ensure that the release criterion has been met as follows:

$$\frac{\delta}{DCGL} + \sum_{x+1}^{n} \frac{(\delta_{EMC} - \delta)}{DCGL_{EMC}} \leq 1$$

where:

δ = is the average concentration of Th-232 over the entire survey unit,
δ_{EMC} = the average concentration of Th-232 over the elevated area (x) within the survey unit,
DCGL = the $DCGL_W$ for Th-232,
$DCGL_{EMC}$ = (area factor for elevated area x) X ($DCGL_W$),

x = refers to one of the elevated areas within the survey unit, and
n = the total number of elevated areas within the survey unit.

The calculation for Survey Unit Kaiser-FSS-016 including two elevated areas is summarized below in the **Table 7.**

Table 7 - Elevated Measurement Comparison and Fraction Summary

Sample Date	Unit / EMC unit	Unit Area (m^2)	Gross Th-232 (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)	Fraction (-)	Sample Number
6/21/2005	FSS-016	2,484	1.22	0.121	3.0	0.04	K-731 through K-744
5/24/2005	EMC-1	1	11.3	10.1	37.5	0.27	K-730
6/15/2005	EMC-2	21	5.20	3.98	8.0	0.48	K-716 through K-722

3.3 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-016 prior to backfill with below criteria material (BCM), as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 8.** As previously mentioned, no embedded structures were encountered within the survey unit.

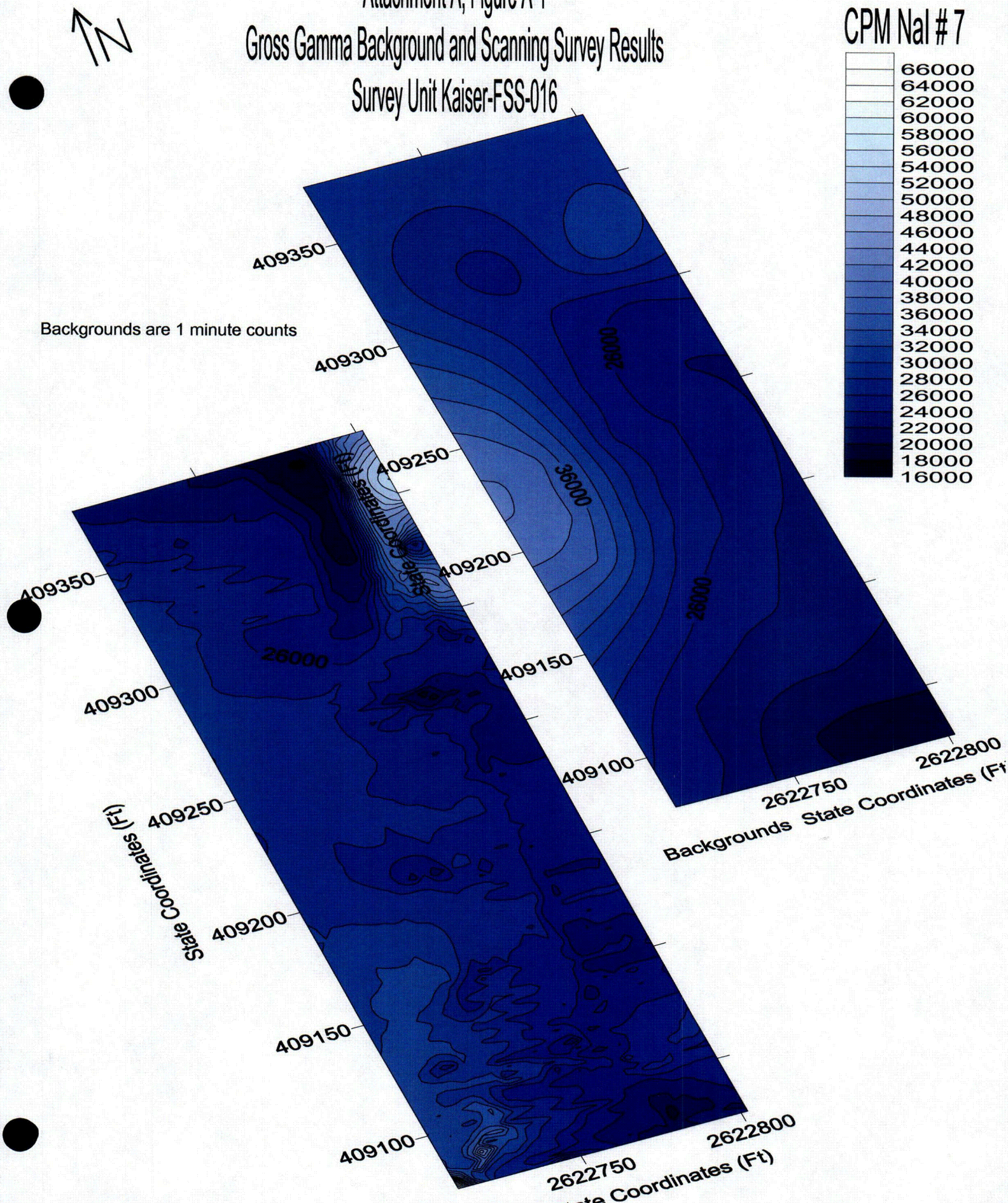
Table 8 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-016 Excavation Bottom Soil	pCi/g	0.121	3.0	0.04
-Elevated Area EMC-1 (Soil)	pCi/g	10.1	37.5	0.27
-Elevated Area EMC-2 (Soil)	pCi/g	3.98	8.0	0.48
-Embedded Structures (None Encountered)	$dpm/100cm^2$	0		0.00
TOTAL SUM OF FRACTIONS				***0.79***

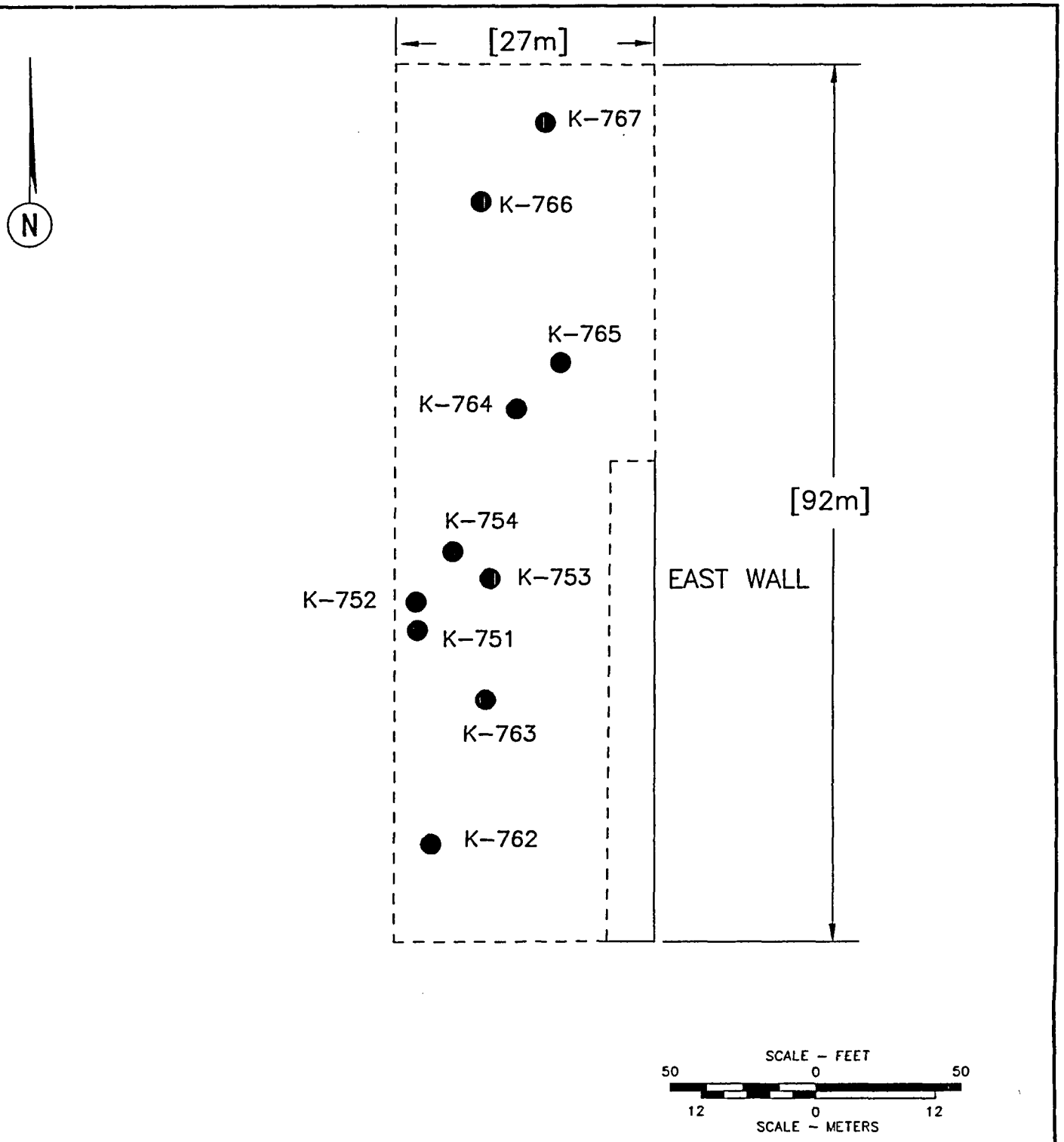
The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-016 meets the DP acceptance criteria.

ATTACHMENT A
TABLE OF CONTENTS

Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-016



Scanning readings are recorded at 2 second intervals.



K-766
● BIASED SOIL SAMPLING LOCATION BASED ON THE RESULTS OF THE GROSS GAMMA SCAN

FIGURE A-2
GROSS GAMMA SURVEY BIASED SOIL SAMPLE LOCATIONS
SURVEY UNIT KAISER - FSS-016
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

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DRAWN	DEB 11/23/05
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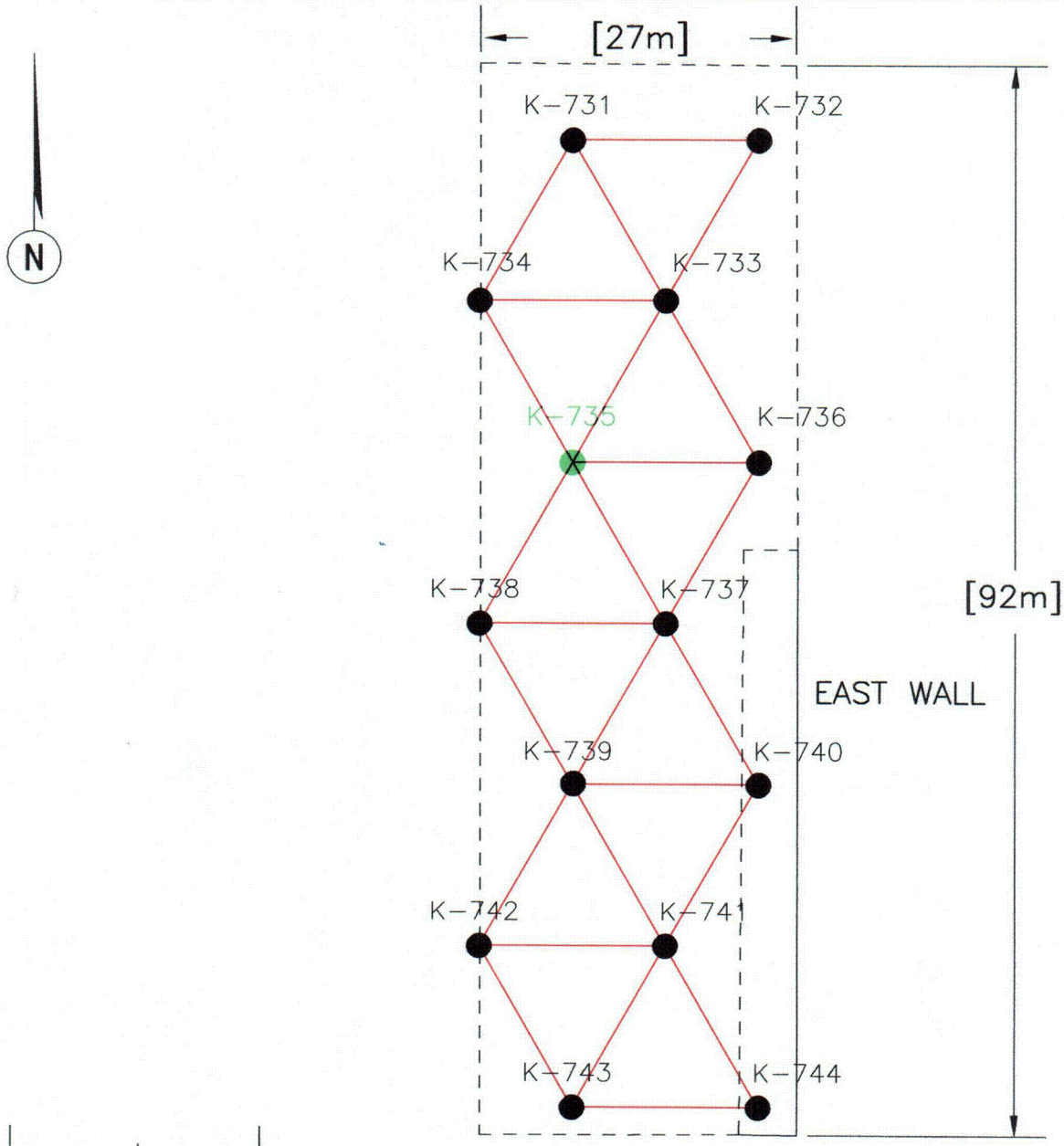
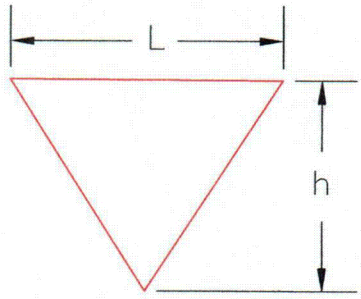
Penn E&R
Environmental & Remediation, Inc.





N = 11 (COLLECTED 14)
L = 16.0m
h = 13.9m
AREA = 2,484m^2

SCALE – FEET
50 0 50
12 0 12
SCALE – METERS

K-731
● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K-735
● RANDOM START POINT

FIGURE A-3
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS-016
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RFD 3-3-06
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Environmental & Remediation, Inc.

ATTACHMENT B
TABLE OF CONTENTS

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-016

2. Description: Retention Pond Area, North of the Flux Building Area

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – approximately 27 meters x 92 meters; Area, A (m^2): 2,484

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 16.0 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: 11

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 13.9 m.

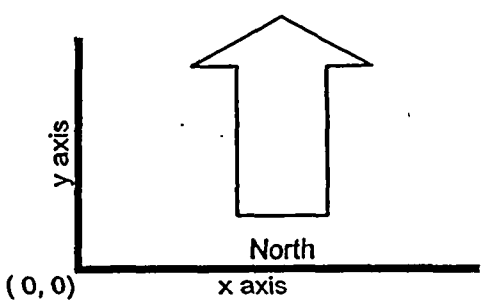
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum Chemical Corporation

SURVEY UNIT: KAISER-FSS-016

RANDOM START POINT

x axis (Meters)	y axis (Meters)
8	58

	x axis	y axis
lower bound	0	0
upper bound	27	92



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Lime # 11105
D/. 6/30/05

July 1, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050480

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on June 22, 2005, 2005. Fifteen soil samples were received in good condition and analyzed for Thorium-232 by Gamma Spectroscopy without drying and grinding and percent moisture with an expedited 5 work-day turn. In addition, at your request, we reported Th-232, the 911 KEV peak, on a separate report.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050480
Date Reported:	6/29/05
Date Received:	6/22/05
Page Number:	1 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050480-01**						
Client ID:	**K-731**						
Date Sampled:	**6/21/05 2:15:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.921 +/- 0.090	pCi/g	0.368		6/22/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	11.8	%		6/24/05	6/28/05	RT
Lab ID:	**20050480-02**						
Client ID:	**K-732**						
Date Sampled:	**6/21/05 1:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.03 +/- 0.116	pCi/g	0.398		6/22/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	10.6	%		6/24/05	6/28/05	RT
Lab ID:	**20050480-03**						
Client ID:	**K-733**						
Date Sampled:	**6/21/05 1:48:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.727 +/- 0.064	pCi/g	0.166		6/22/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.0	%		6/24/05	6/28/05	RT
Lab ID:	**20050480-04**						
Client ID:	**K-734**						
Date Sampled:	**6/21/05 1:55:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.05 +/- 0.115	pCi/g	0.365		6/22/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.3	%		6/24/05	6/28/05	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050480-05**						
Client ID:	**K-735**						
Date Sampled:	**6/21/05 2:23:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.712 +/- 0.076	pCi/g	0.161		6/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	22.3	%		6/24/05	6/28/05	RT
Lab ID:	**20050480-06**						
Client ID:	**K-736**						
Date Sampled:	**6/21/05 2:30:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.724 +/- 0.056	pCi/g	0.192		6/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	20.2	%		6/24/05	6/28/05	RT
Lab ID:	**20050480-07**						
Client ID:	**K-737**						
Date Sampled:	**6/21/05 11:42:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.555 +/- 0.131	pCi/g	0.502		6/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.6	%		6/24/05	6/28/05	RT
Lab ID:	**20050480-08**						
Client ID:	**K-738**						
Date Sampled:	**6/21/05 2:38:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.22 +/- 0.075	pCi/g	0.301		6/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	22.7	%		6/24/05	6/28/05	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
.oken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20050480
Date Reported: 6/29/05
Date Received: 6/22/05

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050480-09**						
Client ID:	**K-739**						
Date Sampled:	**6/21/05 11:36:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.838 +/- 0.142	pCi/g	0.423		6/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	12.3	%		6/24/05	6/28/05	RT
Lab ID:	**20050480-10**						
Client ID:	**K-740**						
Date Sampled:	**6/21/05 11:30:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.16 +/- 0.116	pCi/g	0.502		6/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	12.9	%		6/24/05	6/28/05	RT
Lab ID:	**20050480-11**						
Client ID:	**K-741**						
Date Sampled:	**6/21/05 11:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	3.55 +/- 0.132	pCi/g	0.268		6/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	22.9	%		6/24/05	6/28/05	RT
Lab ID:	**20050480-12**						
Client ID:	**K-742**						
Date Sampled:	**6/21/05 11:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.939 +/- 0.102	pCi/g	0.505		6/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	20.4	%		6/24/05	6/28/05	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20050480
Date Reported: 6/29/05
Date Received: 6/22/05

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050480-13**						
Client ID:	**K-743**						
Date Sampled:	**6/21/05 10:55:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.751 +/- 0.115	pCi/g	0.246		6/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	16.3	%		6/24/05	6/28/05	RT
Lab ID:	**20050480-14**						
Client ID:	**K-744**						
Date Sampled:	**6/21/05 11:05:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.66 +/- 0.092	pCi/g	0.282		6/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	20.0	%		6/24/05	6/28/05	RT
Lab ID:	**20050480-15**						
Client ID:	**K-746**						
Date Sampled:	**6/22/05 9:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	5.76 +/- 0.239	pCi/g	0.609		6/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	19.1	%		6/24/05	6/28/05	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20050480
Date Reported: 6/29/05
Date Received: 6/22/05

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					NC				6/23/05
Ac228					NC				6/23/05
Am-241		89.0	91.0	2.8					6/23/05
Am-241		99.0	89.0	11.5					6/23/05
Co-60		95.0	95.0	0.0					6/23/05
Co-60		99.0	93.0	6.6					6/23/05
Cs-137		95.0	96.0	1.0					6/23/05
Cs-137		107.0	98.0	8.9					6/23/05
Percent Moisture					6.0				6/28/05

Lab Approval: 

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

LOCAL: 364-0066
CELL: 724-749-0071

CHAIN OF CUSTODY

Results To:
Company Kaiser - Alum & Chem Inc.
Name DAVID B. WEAVER
Address 7311 E. 41st St.
City Tulsa State OK Zip 74145
Phone 774-934.3536 Fax # 918-364-3171

Bill To:
Company Kaiser/Ravenswood
Name DAVID B. WEAVER/AM WARD
Address 7311 E. 41st St.
City Tulsa State OK Zip 74145

PO # Kaiser 4672
PROJECT # PA-400-4672
PROJECT NAME Kaiser-Gramercy Rema
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 5 DAY T.A.T
SAMPLER David B. Weaver
Signature DAVID B. WEAVER

ANALYSIS REQUESTED

LAB SAMPLE #	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec (HL-232)	Ra-226 & Ra-228 filtrate for Archive	mDC 40 CFR pCi/g	Asbestos 6216.02 Modified Content	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
1	K-731	6-21-05	14:15	Soil	1	500ml Plastic	None	X	X	X	X	Grab
2	K-732	6-21-05	13:40		1			X	X	X	X	
3	K-733	6-21-05	13:48		1			X	X	X	X	
4	K-734	6-21-05	13:55		1			X	X	X	X	
5	K-735	6-21-05	14:27		1			X	X	X	X	
6	K-736	6-21-05	14:30		1			X	X	X	X	
7	K-737	6-21-05	11:42		1			X	X	X	X	
8	K-738	6-21-05	14:35		1			X	X	X	X	
9	K-739	6-21-05	11:36		1			X	X	X	X	
10	K-740	6-21-05	11:20		1			X	X	X	X	
11	K-741	6-21-05	11:20		1			X	X	X	X	
12	K-742	6-21-05	11:10		1			X	X	X	X	
13	K-743	6-21-05	10:55		1			X	X	X	X	
14	K-744	6-21-05	11:05		1			X	X	X	X	

RELINQUISHED BY: David B. Weaver DATE 6-22-05 TIME 1500 RECEIVED BY: Michelle Austin DATE 6/22/05 TIME 1500
RELINQUISHED BY: DAVID B. WEAVER DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

...shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: Received on Ice: Y / N
Cooler Temperature: 4°C

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company: Kaiser-Alum & Chem. Inc.
Name: David G. Weyand
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3332 Fax #: 918-364-3171
LOCAL: 918-364-0566
CELL: 724-799-0071

Bill To:
Company: Kaiser / Penn E&R
Name: David G. Weyand / Paul Davis
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: Kaiser 4072
PROJECT #: PO-4000-4072
PROJECT NAME: Kaiser-Hazen REMED.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): N / A
SAMPLER: David Weyand
Signature: David Weyand

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GAMMA SPEC (Ra-226)	PITZER CLEAR for Arsenic	RAD (20 yr) pCi/L	ASTRO 2711 Rad Multi Cuvette	SDMT A.S	TDMT A.S	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
15	K-746	6-22-05	9:10	Soil	1	Plastic	none	X	X	X	X	X	X	Grab
16	K-750	"	10:10	"	1	Sand	"	X	X	X	X	Quart	X	"

RELINQUISHED BY: David G. Weyand DATE 6-22-05 TIME 1500 RECEIVED BY: Michelle Barton DATE 6/22/05 TIME 15:00
RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to [illegible]h Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY

SAMPLE LOGIN

Date Received: *6/22/05 3:48:25 P* **Lab Number:** 20050480 **Due:** 6/23/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050480-01 A	K-731	Soil	06/21/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050480-02 A	K-732	Soil	06/21/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050480-03 A	K-733	Soil	06/21/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050480-04 A	K-734	Soil	06/21/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050480-05 A	K-735	Soil	06/21/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050480-06 A	K-736	Soil	06/21/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050480-07 A	K-737	Soil	06/21/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050480-08 A	K-738	Soil	06/21/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050480-09 A	K-739	Soil	06/21/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050480-10 A	K-740	Soil	06/21/05	Plastic	16 oz	None	No	No

Percent ure (LOD) Th-232 Gamma Spec								
20050480-11 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-741	Soil	06/21/05	Plastic	16 oz	None	No	No
20050480-12 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-742	Soil	06/21/05	Plastic	16 oz	None	No	No
20050480-13 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-743	Soil	06/21/05	Plastic	16 oz	None	No	No
20050480-14 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-744	Soil	06/21/05	Plastic	16 oz	None	No	No
20050480-15 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-746	Soil	06/22/05	Plastic	16 oz	None	No	No
20050480-16 A Percent Moisture (LOD) Th-232 by Gamma Spec	K-750	Soil	06/22/05	Plastic	16 oz	None	No	No

CONTA . INSPECTION

Coolers 1 Custody Seals Broken - Y/N N/A Temperature AMB Blue Ice / Wet Ice Radiation Survey 300 fixed _____ removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N N/A Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies: _____

Inspected By: Michael J DATE 6-22-05

QA or Designee Review: Raymond Thomas DATE 06/22-05

Sample Custodian Review: Desiree Gregory DATE 6/22/05

Project Notes:

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050480
Date Reported:	6/29/05
Date Received:	6/22/05
Page Number:	1 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050480-01**						
Client ID:	**K-731**						
Date Sampled:	**6/21/05 2:15:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	0.902 +/- 0.142	pCi/g	0.368		6/22/05	
Lab ID:	**20050480-02**						
Client ID:	**K-732**						
Date Sampled:	**6/21/05 1:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	0.927 +/- 0.153	pCi/g	0.398		6/22/05	SD
Lab ID:	**20050480-03**						
Client ID:	**K-733**						
Date Sampled:	**6/21/05 1:48:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	0.749 +/- 0.078	pCi/g	0.166		6/22/05	SD
Lab ID:	**20050480-04**						
Client ID:	**K-734**						
Date Sampled:	**6/21/05 1:55:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	1.09 +/- 0.157	pCi/g	0.365		6/22/05	SD
Lab ID:	**20050480-05**						
Client ID:	**K-735**						
Date Sampled:	**6/21/05 2:23:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	0.822 +/- 0.094	pCi/g	0.161		6/23/05	SD

BDL = Below Detection Limit

Outreach Laboratory
11 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20050480
Date Reported: 6/29/05
Date Received: 6/22/05

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050480-06**						
Client ID:	**K-736**						
Date Sampled:	**6/21/05 2:30:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	0.874 +/- 0.096	pCi/g	0.192		6/23/05	SD
Lab ID:	**20050480-07**						
Client ID:	**K-737**						
Date Sampled:	**6/21/05 11:42:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	0.443 +/- 0.201	pCi/g	0.502		6/23/05	SD
Lab ID:	**20050480-08**						
Client ID:	**K-738**						
Date Sampled:	**6/21/05 2:38:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	1.30 +/- 0.109	pCi/g	0.301		6/23/05	SD
Lab ID:	**20050480-09**						
Client ID:	**K-739**						
Date Sampled:	**6/21/05 11:36:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	0.599 +/- 0.328	pCi/g	0.832		6/23/05	SD
Lab ID:	**20050480-10**						
Client ID:	**K-740**						
Date Sampled:	**6/21/05 11:30:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	1.35 +/- 0.216	pCi/g	0.502		6/23/05	SD

BDL = Below Detection Limit

Outreach
Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050480
Date Reported:	6/29/05
Date Received:	6/22/05
Page Number:	3 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050480-11**						
Client ID:	**K-741**						
Date Sampled:	**6/21/05 11:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	3.72 +/- 0.214	pCi/g	0.268		6/23/05	SD
Lab ID:	**20050480-12**						
Client ID:	**K-742**						
Date Sampled:	**6/21/05 11:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	0.965 +/- 0.191	pCi/g	0.505		6/23/05	SD
Lab ID:	**20050480-13**						
Client ID:	**K-743**						
Date Sampled:	**6/21/05 10:55:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	1.42 +/- 0.247	pCi/g	0.246		6/23/05	SD
Lab ID:	**20050480-14**						
Client ID:	**K-744**						
Date Sampled:	**6/21/05 11:05:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	1.93 +/- 0.163	pCi/g	0.282		6/23/05	SD
Lab ID:	**20050480-15**						
Client ID:	**K-746**						
Date Sampled:	**6/22/05 9:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232 (911KEV)	HASL 300	6.04 +/- 0.388	pCi/g	0.609		6/23/05	SD

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050480
Date Reported:	6/29/05
Date Received:	6/22/05
Page Number:	4 of 4

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					NC				6/23/05
Ac228					NC				6/23/05
Am-241		89.0	91.0	2.8					6/23/05
Am-241		99.0	89.0	11.5					6/23/05
Co-60		95.0	95.0	0.0					6/23/05
Co-60		99.0	93.0	6.6					6/23/05
Cs-137		95.0	96.0	1.0					6/23/05
Cs-137		107.0	98.0	8.9					6/23/05
Percent Moisture					6.0				6/28/05

Lab Approval: _____

BDL = Below Detection Limit

Outreach
Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

11076
Invoice # 6/19/2005

June 17, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050453

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on June 16, 2005. One soil sample was received in good condition and analyzed for Thorium-232 by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5 work-day turn. Results were faxed early on 6/17/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050453
Date Reported:	6/17/05
Date Received:	6/16/05
Page Number:	1 of 2

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050453-01**						
Client ID:	**K-717**						
Date Sampled:	**6/15/05 11:30:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	7.60 +/- 0.270	pCi/g	0.452		6/16/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	22.6	%		6/16/05	6/17/05	RT
Lab ID:	**20050453-02**						
Client ID:	**K-719**						
Date Sampled:	**6/15/05 11:40:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.75 +/- 0.153	pCi/g	0.378		6/16/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	12.3	%		6/16/05	6/17/05	RT
Lab ID:	**20050453-03**						
Client ID:	**K-722**						
Date Sampled:	**6/15/05 11:55:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	8.46 +/- 0.345	pCi/g	0.590		6/16/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	20.8	%		6/16/05	6/17/05	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050453
Date Reported:	6/17/05
Date Received:	6/16/05
Page Number:	2 of

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					10.5				6/16/05
Am-241		94.0	101.0	6.8					6/16/05
Co-60		100.0	100.0	0.3					6/16/05
Cs-137		99.0	100.0	1.3					6/16/05
Percent Moisture					2.5				6/17/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
LOCAL: 918-364-0056
Cell: 724-799-0071

Company: Kaiser-Alum & Chem Corp.
Name: David R. Wright
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3230 Fax #: 918-364-0071

Bill To:
Company: Kaiser Alum & Chem
Name: David R. Wright / Paul Hano
Address: 7311 E. 41st Street
City: Tulsa State: OK Zip: 74145

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser Alum Remed.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 5 DAY.
SAMPLER: David R. Wright
Signature: David R. Wright

ANALYSIS REQUESTED

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec (Th-232)	Beta on Chem Lac Analysis	MDC Co.55 pCi/gm	Asmd 2216.92 moist Content	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-717	6-15-05	11:30	Soil	1	500ml Plastic	None	X	X	X	X	Grab
	K-719	6-15-05	11:40		1			X	X	X	X	Comp
	K-722	6-15-05	11:55		1			X	X	X	X	Grab

RELINQUISHED BY: David R. Wright DATE 6-16-05 TIME 0745 RECEIVED BY: Ron Grason DATE 6/16/05 TIME 0745
David R. Wright

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: 0605045
Sample Condition upon Receipt: Good
Custody Seal: Yes
Cooler Temperature: 5.4 (4.3)

SAMPLE I ,IN

Date Received: *6/16/05 7:52:17 A* Lab Number: 20050453 Due: 6/23/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050453-01 A	K-717	Soil	06/15/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050453-02 A	K-719	Soil	06/15/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050453-03 A	K-722	Soil	06/15/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								

CONTAINER INSPECTION

Coolers N/A Custody Seals Broken - Y/N N/A Temperature N/A Blue Ice / Wet Ice Radiation Survey _____fixed_____removable

SAMPLE INSPECTION

Custody Seals Broken Y/N N/A Chain of Custody Record (Y)N Labels in Tact (Y)N Radiation Survey Complete (Y)N

Anomalies: _____

Inspected By: Michelle Sutton DATE 6-16-05

QA or Designee Review: Raymond Thomas DATE 06/16/05

Sample Custodian Review: Desiree Gregory DATE 06/16/05

Project Notes:

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Invoice # 11021
D/- 6/7/05

June 7, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050390

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on May 25, 2005. Three soil samples were received in good condition and analyzed for Thorium-232 by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5 work-day turn. Preliminary results were faxed May 27, 2005.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050390
Date Reported:	6/6/05
Date Received:	5/25/05
Page Number:	1 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050390-01**						
Client ID:	**K-728**						
Date Sampled:	**5/24/05 3:20:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	2.00 +/- 0.122	pCi/g	0.452		5/25/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	18.9	%		5/25/05	5/26/05	MD
Lab ID:	**20050390-02**						
Client ID:	**K-729**						
Date Sampled:	**5/24/05 3:35:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.777 +/- 0.045	pCi/g	0.280		5/25/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	19.5	%		5/25/05	5/26/05	MD
Lab ID:	**20050390-03**						
Client ID:	**K-730**						
Date Sampled:	**5/24/05 3:45:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	11.3 +/- 0.461	pCi/g	0.410		5/25/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	34.1	%		5/25/05	5/26/05	MD

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
oken Arrow, OK 74012
918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050390
Date Reported:	6/6/05
Date Received:	5/25/05
Page Number:	2 of 2

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					14.8				5/25/05
Am-241		96.0	91.0	5.3					5/25/05
Co-60		94.0	95.0	0.3					5/25/05
Cs-137		97.0	94.0	3.0					5/25/05
Percent Moisture					0.9				5/26/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
LOCAL: 918-384-0561
CELL: 724-749-0071

Company KAISER-ALUM & CHEM CORP.
Name DAVID G. WEYANT
Address 7311 E. 41ST ST.
City TULSA State OK Zip 74145
Phone 724-934-3570 Fax # 918-384-7171

Bill To:
Company KAISER / PAUL HANSA
Name PAUL HANSA / DAVID G. WEYANT
Address 7311 E. 41ST ST.
City TULSA State OK Zip 74145

PO # KAISR-4072
PROJECT # PA-4000-4.72
PROJECT NAME KAISER-TH.R PLANT
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 5 DAYS
SAMPLER [signature] DAVID G. WEYANT

ANALYSIS REQUESTED

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec (AL-722)	Partial Uranium for Archive	MDC <0.5 pCi/g ASTM D 2216-92 mod 3772	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-728	5-24-05	15:20	SOIL	1	500ml PLASTIC	NONE	X	X	X	GRAB
	K-729		15:35		1			X	X	X	
	K-730		15:45		1			X	X	X	

RELINQUISHED BY: D. Weyant DATE 5-25-05 TIME 0830 RECEIVED BY: Michelle Dutton DATE 5/25/05 TIME 08:30
DAVID G. WEYANT

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: K005-030

SAMPLE IN

Date Received: *5/25/05 8:47:03 A* Lab Number: 20050390 Due: 6/1/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050390-01 A	K-728	Soil	05/24/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050390-02 A	K-729	Soil	05/24/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050390-03 A	K-730	Soil	05/24/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								

CONTAINER INSPECTIO

Coolers 0 Custody Seals Broken - Y/N N/A Temperature N/A Blue Ice / Wet Ice N/A Radiation Survey <300 fixed _____ removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N N/A Chain of Custody Record (Y)N Labels in Tact (Y)N Radiation Survey Complete (Y)

Anomalies: _____

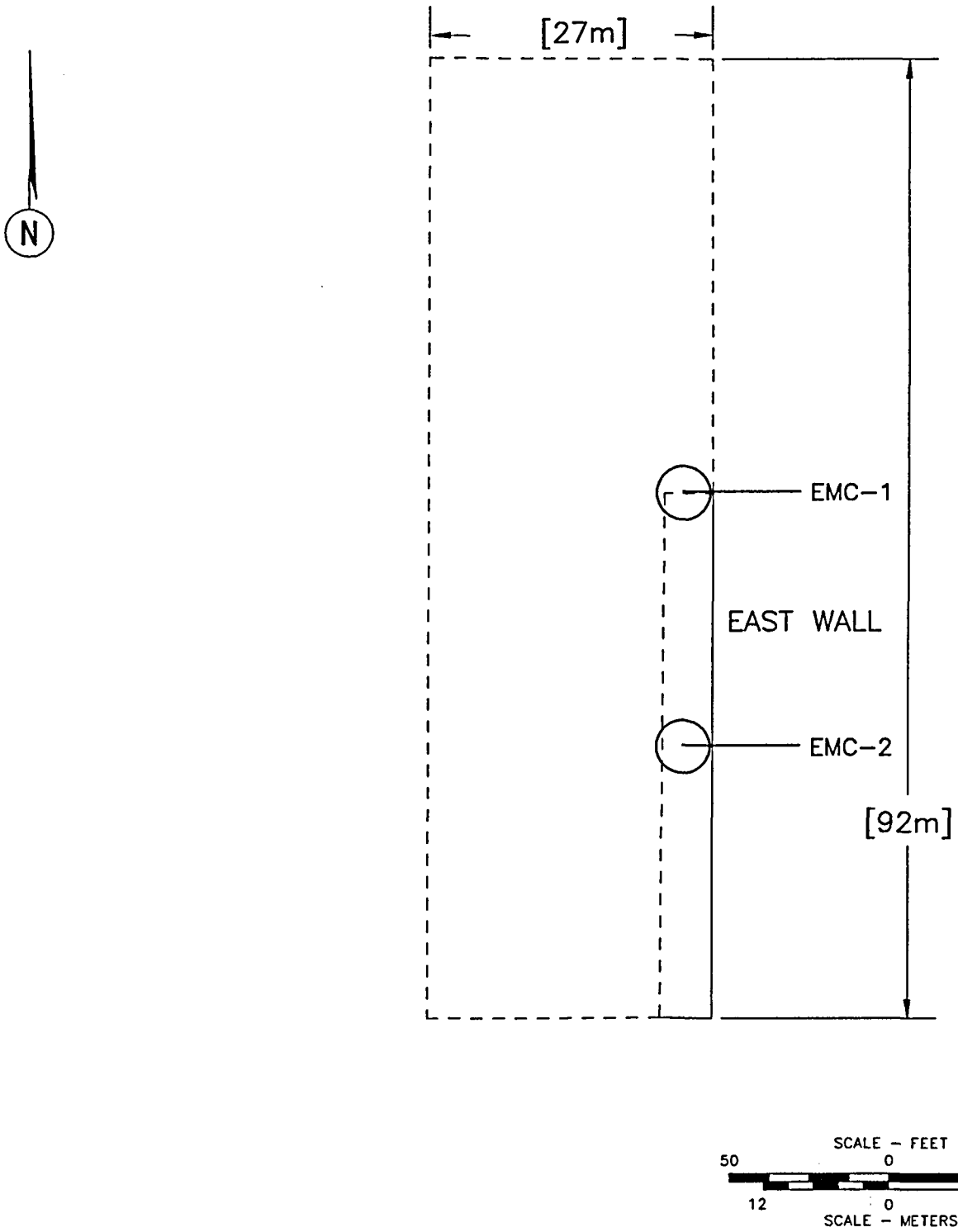
Inspected By: Michelle Sutton DATE 05/25/05

QA or Designee Review: _____ DATE 5/25/05

Sample Custodian Review: _____ DATE 05/25/05

Project Notes:

ATTACHMENT D
TABLE OF CONTENTS



SCALE – FEET

50 0 50

12 0 12

SCALE – METERS

EMC–1

LOCATION OF ELEVATED AREA

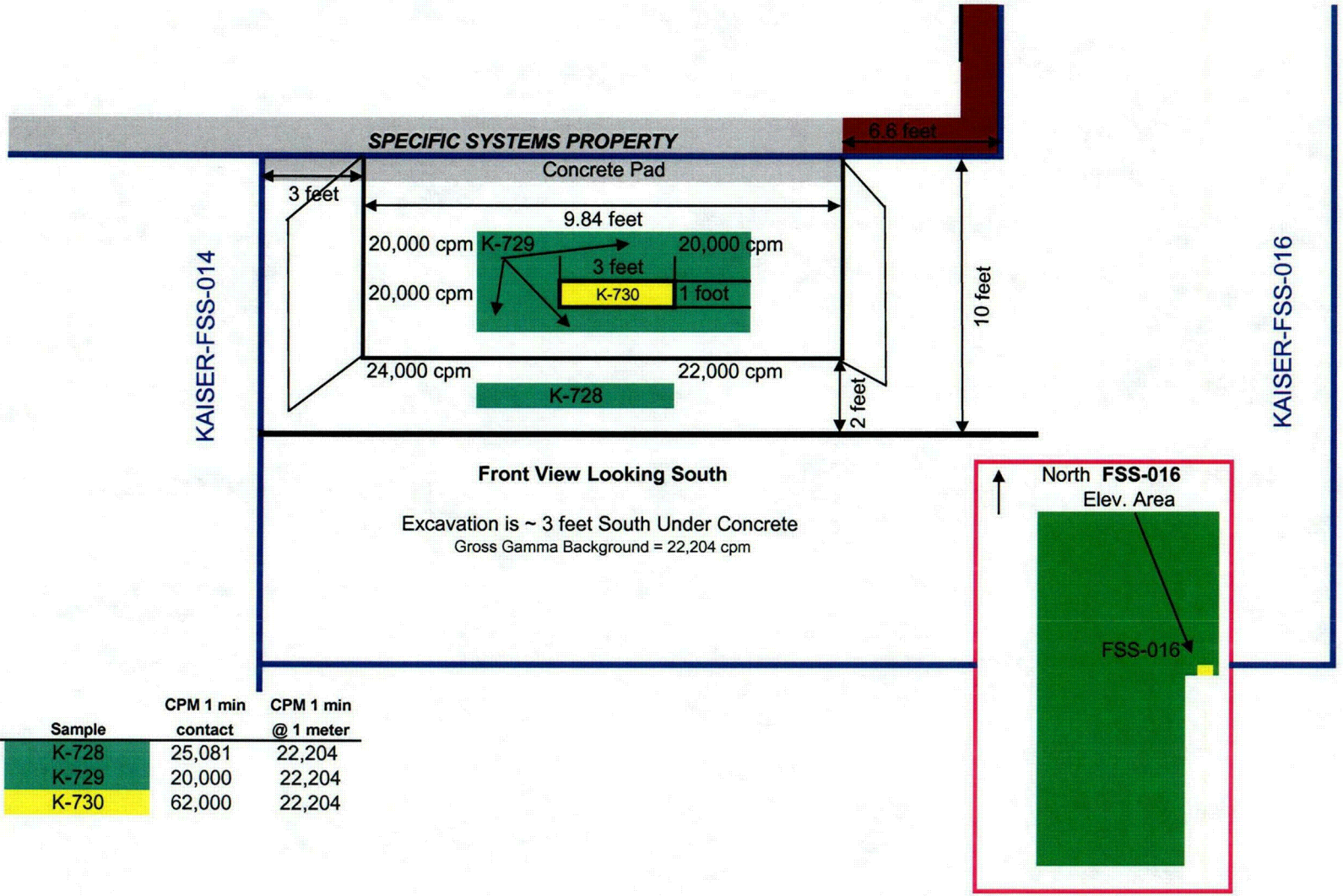
FIGURE D–1
ELEVATED AREAS
SURVEY UNIT KAISER – FSS–016
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RD 3-3-06
CHECKED	RD 3-3-06
DRAWN	DEB 12/12/05
DRAWING NUMBER	PA4072047B

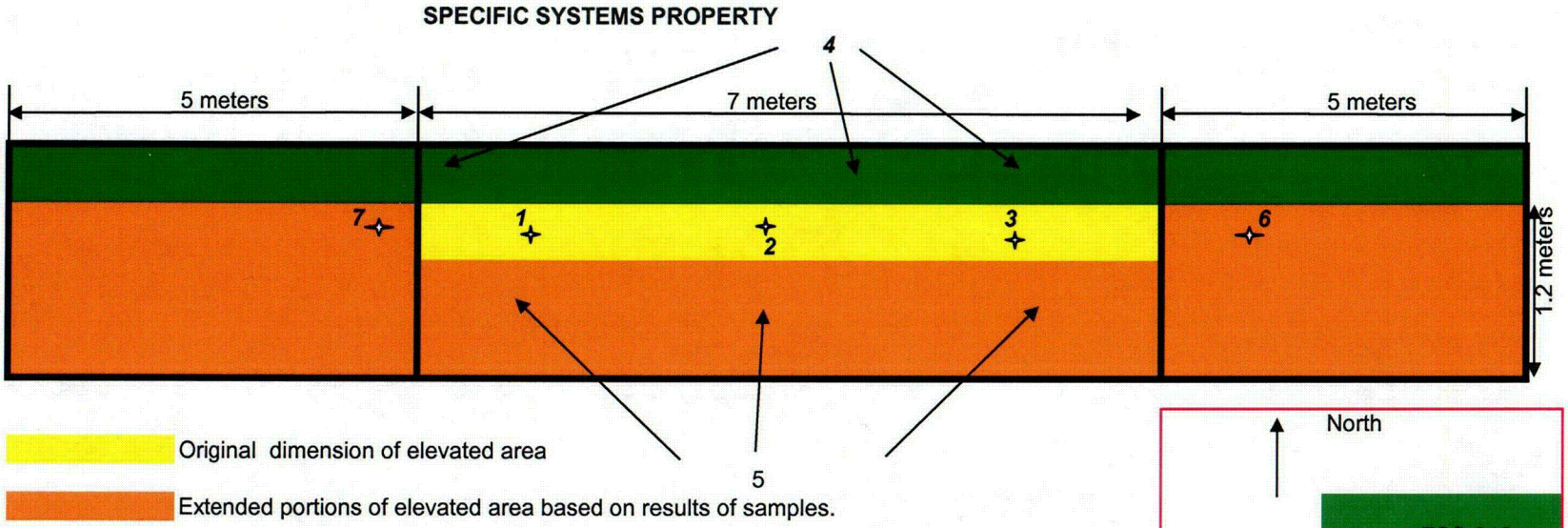
Penn E&R
Environmental & Remediation, Inc.

Attachment D, Figure D-2
Elevated Area EMC-1
Survey Unit Kaiser-FSS-016
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Company

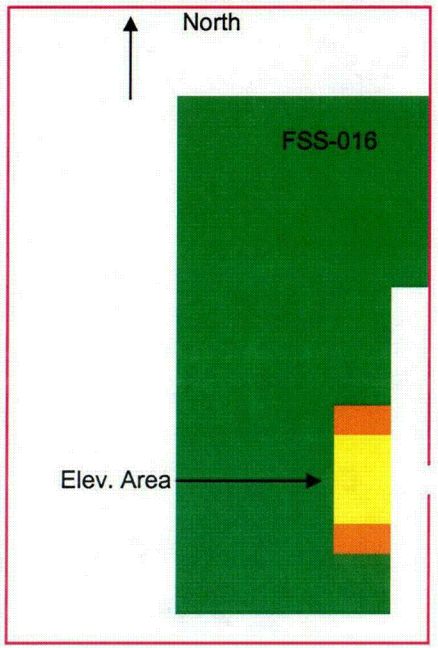


Material	Sample	CPM 1 min contact	CPM 1 min @ 1 meter
Soil	K-728	25,081	22,204
Soil	K-729	20,000	22,204
Soil	K-730	62,000	22,204

Attachement D, Figure D-3
Elevated Area EMC-2
Survey Unit Kaiser-FSS-016
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation



Front View Looking East



Location	Sample	CPM 1 min contact	CPM 1 min @ 1 meter
1	K-716	36345	24438
2	K-717	49490	24237
3	K-718	35530	24552
4	K-719	23K to 28K	-
5	K-720	23K to 29K	-
6	K-721	30541	21835
7	K-722	49490	24237

Attachment D
Elevated Measurement Comparison Worksheet
Survey Unit Kaiser-FSS-016
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum and Chemical Corporation

$DCGL_{EMC}$ = Area Factor * $DCGL_W$

Table 2-2 - Area Factors

Area Factors									
Radio-nuclide	1 m2 (11 ft2)	3 m2 (32 ft2)	10 m2 (108 ft2)	30 m2 (323 ft2)	100 m2 (1,076 ft2)	300 m2 (3,229 ft2)	1,000 m2 (10,764 ft2)	3,000 m2 (32,292 ft2)	10,000 m2 (107,639 ft2)
Th-232	12.5	6.2	3.2	2.3	1.8	1.5	1.1	1	1

Table 2-3 - $DCGL_{EMC}$ Values for Open Land Areas

$DCGL_{EMC}$ (pCi/g)									
Radio-nuclide	1 m2 (11 ft2)	3 m2 (32 ft2)	10 m2 (108 ft2)	30 m2 (323 ft2)	100 m2 (1,076 ft2)	300 m2 (3,229 ft2)	1,000 m2 (10,764 ft2)	3,000 m2 (32,292 ft2)	10,000 m2 (107,639 ft2)
Th-232	37.5	18.6	9.6	6.9	5.4	4.5	3.3	3	3

$$\frac{\delta}{DCGL} + \sum_{x+1}^{n} \frac{(\delta_{EMC} - \delta)}{DCGL_{EMC}} \leq 1$$

where:
δ = is the average concentration of Th-232 over the entire survey unit,
δ_{EMC} = the average concentration of Th-232 over the elevated area x within the survey unit,
$DCGL_{EMC}$ = (area factor for elevated area x) X (DCGL or DCCL),
x = refers to one of the elevated areas within the survey unit, and
n = the total number of elevated areas within the survey unit.

Elevated Measurement Comparisons

Date	Unit / EMC unit	Unit Area (m^2)	Gross Th-232 (pCi/g)	Net Th-232 (pCi/g)	DCGL (pCi/g)	Fraction (-)	Notes Samples
6/21/2005	FSS-016	2,484	1.22	0.12	3.0	0.04	K-731 through K-744
5/24/2005	EMC-1	1	11.3	10.1	37.5	0.27	K- 730
6/15/2005	EMC-2	21	5.20	3.98	8.0	0.48	K-716 through K-722
					Sum of Fractions:	**0.79**	

SUB-REPORT

SURVEY UNIT KAISER-FSS-017

TABLE OF CONTENTS

ATTACHMENTS

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-017
Survey Unit Kaiser-FSS-017
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-017, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the northwestern corner of the former Reserve Pond area. Survey Unit Kaiser-FSS-017 is considered a Class 1 survey unit with an approximate surface area of 2,230 m^2. It is bounded to the south by Survey Units Kaiser-FSS-016 and Kaiser-FSS-018, to the east by Survey Units Kaiser-FSS-014 and Kaiser-FSS-015, to the north by Fulton Creek, and to the west by Survey Unit Kaiser-FSS-021 (**Figure 3**).

Survey Unit Kaiser-FSS-017 consists of an excavation bottom surface soil with one side wall (north wall). No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom and northern side wall surface soil of Survey Unit Kaiser-FSS-017. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom and northern side wall) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 24 approximately equal-distant locations in the survey unit. The statistics for the 24 background measurements are provided below in **Table 1.** Background measurements ranged from 17,974 counts per minute (cpm) to 28,163 cpm moving east to west within the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the west/southwest of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 8,230 measurements of gross count rate were made at one second intervals across the survey unit's 2,230 m^2 surface area. The results ranged from 13,441 cpm to 54,641 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	2,230 m^2	
Number of Scan Measurements (1-Second Intervals)	8,230	
Scan Rate: (Swinging the detector a width of 1-meter side to side)	0.27 m/s (MARSSIM recommends 0.5m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	17,974	13,441
Maximum	28,163	54,641
Average	22,075	21,134
Standard Deviation	2,948	4,107
Median	21,331	20,388

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site). As part of the gross gamma survey, 3 biased soil samples were collected at

locations exhibiting the highest scan rates on the excavation bottom (**Figure A-2, Attachment A**). The biased soil samples were screened on-site in a lead cave. Results of the sample screening are presented below in **Table 2.** The sample screening levels were below the $DCGL_W$ for the site.

Table 2 – Biased Soil Sample Screening Results

Soil Sample ID	Cave Counter Screening Results (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)
$DCGL_W$	*3.0*		
Background	*1.1*	*0.3*	
K-799	0.56	0.39	0.61
K-800	0.24	0.38	0.61
K-801	0.70	0.41	0.61

2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 (**Attachment B**). The default Class 1 Survey Unit Area (A) of 2,000 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 16.0 meters and the Height of the Equilateral Triangle (h) of 13.9 meters. Since A was greater than 2,000 m^2, the number of samples (N_1) was recalculated (10) to correspond to the L of 16.0 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 (**Attachment B**).

A layout of the soil sampling locations is provided on **Figure A-3** contained in **Attachment A.** The soil sampling locations were demarcated in the field using a GPS unit. It should be noted that the sampling locations as marked in the field were based on a L of 12.0 meters and a h of 10.0 meters thereby allowing for a total of 17 soil sampling locations. The soil samples (identified as K-774 through K-790) were collected at the excavation bottom/side wall surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3.** Analytical data reports are contained in **Attachment C.**

Table 3 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-774	0.819	0.224	0.518	0	3.0
K-775	0.824	0.115	0.479	0	3.0
K-776	1.19	0.100	0.350	0.09	3.0
K-777	0.977	0.111	0.409	0	3.0
K-778	0.952	0.101	0.343	0	3.0
K-779	0.890	0.056	0.351	0	3.0
K-780	1.29	0.110	0.410	0.19	3.0
K-781	0.993	0.109	0.408	0	3.0
K-782	1.37	0.304	0.887	0.27	3.0
K-783	0.895	0.100	0.402	0	3.0
K-784	0.774	0.091	0.325	0	3.0
K-785	0.944	0.059	0.328	0	3.0
K-786	0.747	0.174	0.548	0	3.0
K-787	0.873	0.171	0.567	0	3.0
K-788	0.837	0.105	0.370	0	3.0
K-789	0.948	0.162	0.472	0	3.0
K-790	1.73	0.086	0.452	0.63	3.0
Average	***1.00***				
Standard Dev.	***0.255***				
Minimum	***0.747***				
Maximum	***1.73***				
Median	***0.944***				

All 17 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.73 pCi/g, which fell slightly above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 1.00 pCi/g. The standard deviation of the 17 equal-distant samples was 0.255, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3. Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (1.16 pCi/g) between the maximum survey unit soil sample activity concentration (1.73 pCi/g) and the minimum reference background area soil sample activity

concentration (0.57 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	84	0.79	S1	K-774	0.819
R2	300	0.67	S2	K-775	0.824
R3	234	0.57	S3	K-776	1.19
R4	4	0.61	S4	K-777	0.977
R5	76	0.97	S5	K-778	0.952
R6	364	1.31	S6	K-779	0.890
R7	37	0.86	S7	K-780	1.29
R8	89	0.87	S8	K-781	0.993
R9	246	1.46	S9	K-782	1.37
R10	197	1.52	S10	K-783	0.895
R11	335	1.11	S11	K-784	0.774
R12	152	1.27	S12	K-785	0.944
R13	50	0.97	S13	K-786	0.747
R14	232	1.25	S14	K-787	0.873
R15	5	0.90	S15	K-788	0.837
R16	302	1.16	S16	K-789	0.948
R17	52	1.63	S17	K-790	1.73
	Average	***1.05***		***Average***	***1.00***
	Std. Dev.	***0.32***		***Std. Dev.***	***0.255***
	Minimum	***0.57***		***Minimum***	***0.747***
	Maximum	***1.63***		***Maximum***	***1.73***
	Median	***0.97***		***Median***	***0.944***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the northwestern corner of the former Reserve Pond area resulted in an open land area consisting of an excavation approximately 2,230 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-017 is considered a Class 1 survey unit. The survey unit is bounded to the south by Survey Units Kaiser-FSS-016 and Kaiser-FSS-018, to the east by Survey Units Kaiser-FSS-014 and Kaiser-FSS-015, to the north by Fulton Creek, and to the west by Survey Unit Kaiser-FSS-021 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom/Side Wall Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-017 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom and north wall) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 17 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-017 prior to backfill with below criteria material (BCM), as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 5.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

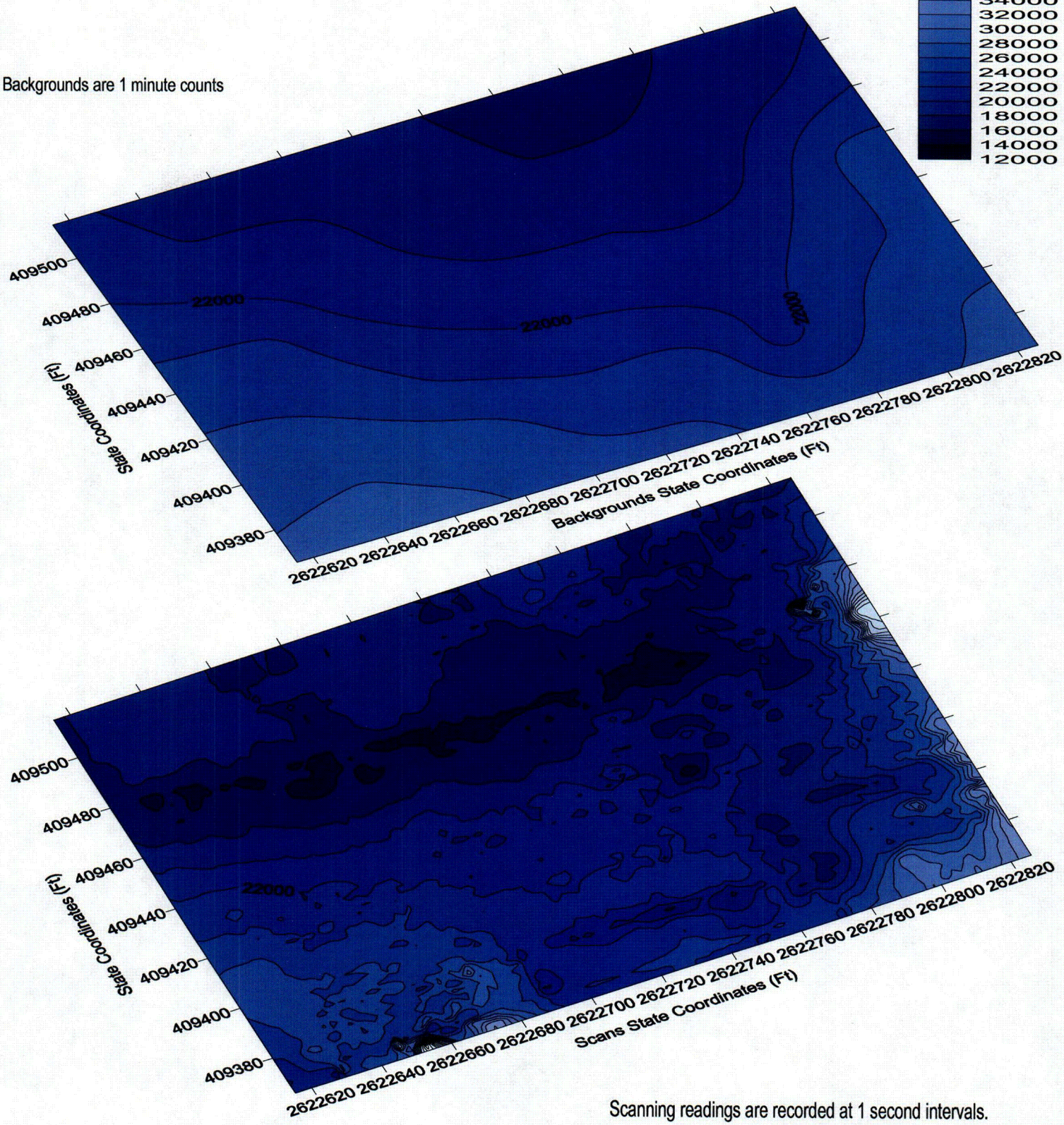
Table 5 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-017 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	dpm/100cm^2	0		0.00
TOTAL SUM OF FRACTIONS				***0.00***

The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-017 meets the DP acceptance criteria.

ATTACHMENT A
TABLE OF CONTENTS

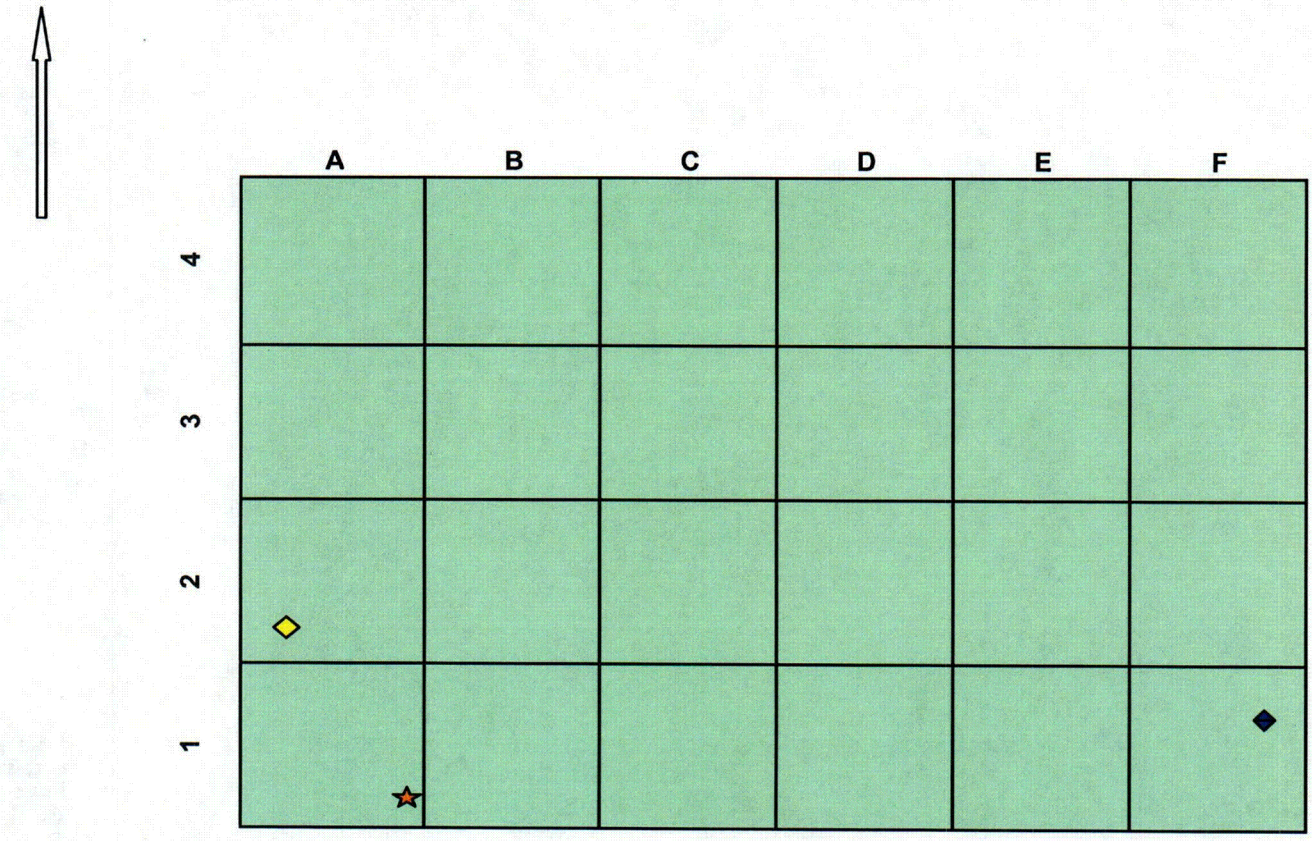
Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit KAISER-FSS-017



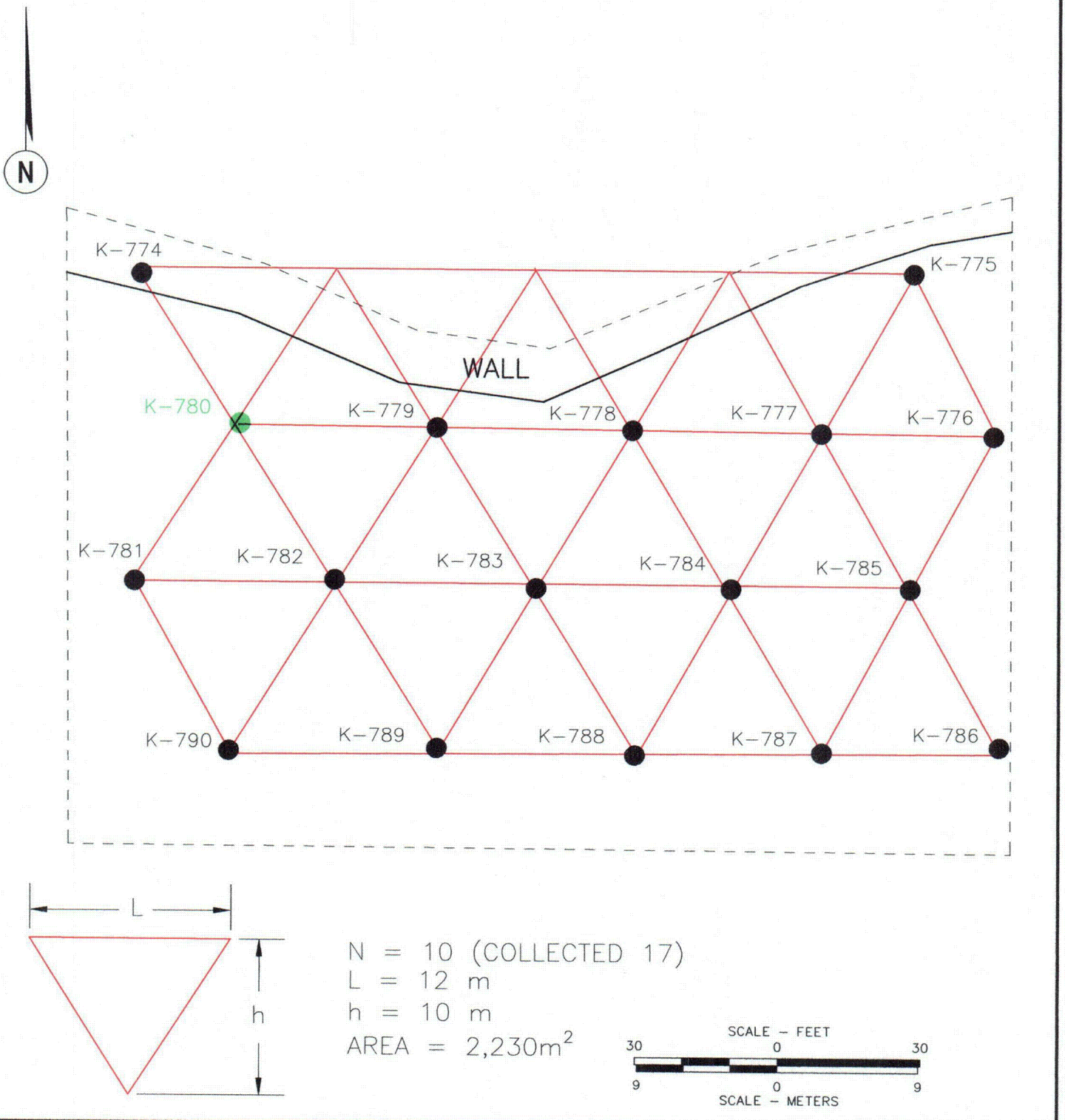
Scanning readings are recorded at 1 second intervals.

Attachment A, Figure A-2
Gross Gamma Survey - Biased Soil Sample Locations
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Survey Unit: Kaiser-FSS-017
Area: 2,230 m^2
Grid: 10m x 10m



K-799 - Biased soil sampling location based on the results of the gross gamma scan.
K-800 - Biased soil sampling location based on the results of the gross gamma scan.
K-801 - Biased soil sampling location based on the results of the gross gamma scan.



N = 10 (COLLECTED 17)
L = 12 m
h = 10 m
AREA = 2,230m^2

SCALE – FEET
30 0 30
9 0 9
SCALE – METERS

K-774 ● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K-780 ● RANDOM START POINT

FIGURE A-3
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS-017
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RD 3-3-06
CHECKED	RD 3-3-06
DRAWN	DEB 10/6/05
DRAWING NUMBER	PA4072030

Penn E&R
Environmental & Remediation, Inc.

ATTACHMENT B
TABLE OF CONTENTS

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum and Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-017

2. Description: Reserve Pond Area, West of Survey Unit Kaiser-FSS-015

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – Approx. 60 meters x 37 meters; Area, A (m^2): 2,230

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: N/A

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: 10

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or (L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 13.9 m.

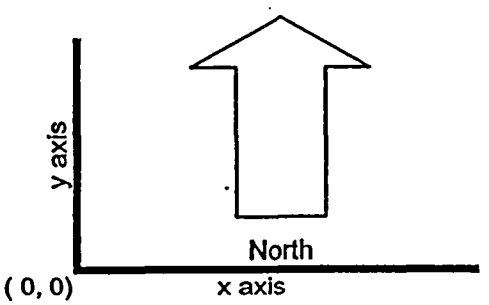
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-017

RANDOM START POINT

x axis (Meters)	y axis (Meters)
13	34

	x axis	y axis
lower bound	0	0
upper bound	60	40



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
1 North Aspen
ken Arrow, OK 74012
(8) 251-2515
AX (918) 251-0008

Lims # 11181

01- 7/21/2005

July 21, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050539

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on July 12, 2005. One soil sample was received in good condition and analyzed for Thorium-232 by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5 work-day turn. Results were faxed early on 7/18/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
.1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050539
Date Reported:	7/18/05
Date Received:	7/12/05
Page Number:	1 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050539-01**						
Client ID:	**K-777**						
Date Sampled:	**7/8/05 1:45:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.977 +/- 0.111	pCi/g	0.409		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	18.4	%		7/13/05	7/15/05	RT
Lab ID:	**20050539-02**						
Client ID:	**K-788**						
Date Sampled:	**7/8/05 2:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.837 +/- 0.105	pCi/g	0.370		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	7.5	%		7/13/05	7/15/05	RT
Lab ID:	**20050539-03**						
Client ID:	**K-780**						
Date Sampled:	**7/8/05 2:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.29 +/- 0.110	pCi/g	0.410		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	7.5	%		7/13/05	7/15/05	RT
Lab ID:	**20050539-04**						
Client ID:	**K-778**						
Date Sampled:	**7/8/05 1:50:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.952 +/- 0.101	pCi/g	0.343		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	8.5	%		7/13/05	7/15/05	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050539
Date Reported:	7/18/05
Date Received:	7/12/05
Page Number:	2 of 4

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050539-05**						
Client ID:	**K-781**						
Date Sampled:	**7/8/05 2:05:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.993 +/- 0.109	pCi/g	0.408		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	10.2	%		7/13/05	7/15/05	RT
Lab ID:	**20050539-06**						
Client ID:	**K-779**						
Date Sampled:	**7/8/05 1:55:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.890 +/- 0.056	pCi/g	0.351		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	12.1	%		7/13/05	7/15/05	RT
Lab ID:	**20050539-07**						
Client ID:	**K-776**						
Date Sampled:	**7/8/05 1:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.19 +/- 0.100	pCi/g	0.350		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.2	%		7/13/05	7/15/05	RT
Lab ID:	**20050539-08**						
Client ID:	**K-775**						
Date Sampled:	**7/8/05 1:35:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.824 +/- 0.115	pCi/g	0.479		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	8.2	%		7/13/05	7/15/05	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050539
Date Reported:	7/18/05
Date Received:	7/12/05
Page Number:	3 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050539-09**						
Client ID:	**K-790**						
Date Sampled:	**7/8/05 2:50:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.73 +/- 0.086	pCi/g	0.452		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	10.3	%		7/13/05	7/15/05	RT
Lab ID:	**20050539-10**						
Client ID:	**K-784**						
Date Sampled:	**7/8/05 2:20:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.774 +/- 0.091	pCi/g	0.325		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.0	%		7/13/05	7/15/05	RT
Lab ID:	**20050539-11**						
Client ID:	**K-785**						
Date Sampled:	**7/8/05 2:25:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.944 +/- 0.059	pCi/g	0.328		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	1.3	%		7/13/05	7/15/05	RT
Lab ID:	**20050539-12**						
Client ID:	**K-783**						
Date Sampled:	**7/8/05 2:15:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.895 +/- 0.100	pCi/g	0.402		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	11.3	%		7/13/05	7/15/05	RT

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050539
Date Reported:	7/18/05
Date Received:	7/12/05
Page Number:	4 of 4

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050539-13**						
Client ID:	**K-792**						
Date Sampled:	**7/8/05 4:45:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	19.3 +/- 0.428	pCi/g	0.699		7/14/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	9.8	%		7/13/05	7/15/05	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					24.1				7/14/05
Am-241		93.0	99.0	6.9					7/14/05
Co-60		93.0	101.0	9.0					7/14/05
Cs-137		91.0	98.0	7.3					7/14/05
Percent Moisture					4.2				7/15/05

Lab Approval:

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company: KAISER Alum & Chem Corp.
Name: DAVID G. WEYAND
Address: 7311 E. 41ST ST.
City: TULSA State: OK Zip: 74145
Phone: 794-5054-3551 Fax #: 918-384-7171
LOCAL: 918-384-0566
CELL: 794-0071

Bill To:
Company: KAISER / PENN E&R
Name: DAVID G. WEYAND / PAT HADA
Address: 7311 E. 41ST ST.
City: TULSA State: OK Zip: 74145

PO #: KAISER-4072
PROJECT #: PA - 4000 - 4072
PROJECT NAME: KAISER - THORIUM REMOVAL
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 5 DAY T.A.T.
SAMPLER: DAVID G. WEYAND
Signature

ANALYSIS REQUESTED

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GAMMA SPEC (Th-232)	Th-232 + U-238 (Total) for Activity	RAD C Ra-226 pCi/gm	ASTM 2216, #2 Moist Content	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-777	7-6-05	13:45	Soil	1	Plastic	None	X	X	X	X	GRAB
	K-788		14:40		1			X	X	X	X	
	K-780		14:00		1			X	X	X	X	
	K-778		13:50		1			X	X	X	X	
	K-781		14:05		1			X	X	X	X	
	K-779		13:55		1			X	X	X	X	
	K-776		13:40		1			X	X	X	X	
	K-775		13:35		1			X	X	X	X	
	K-790		14:50		1			X	X	X	X	
	K-784		14:20		1			X	X	X	X	
	K-785		14:25		1			X	X	X	X	
	K-787		14:15		1			X	X	X	X	
	K-792	7-6-05	16:45		1			X	X	X	X	
	"	"	"		1			X	X	X	X	

RELINQUISHED BY: D. Weyand DATE 7/12/05 TIME 955 RECEIVED BY: Donna Edson DATE 7/12/05 TIME 955
DAVID G. WEYAND
RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN: SAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY
Sample Condition:
Custody Seal Intact:
Temperature:

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Limit = 11606
DL. 12/15/05

December 14, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050995

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on December 09, 2005 for the above captioned project. Ten soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5-work day turn. Results were faxed early on 12/14/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH
CERT. ID #OK001

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050995
Date Reported:	12/14/05
Date Received:	12/9
Page Number:	1 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050995-01**						
Client ID:	**K-506**						
Date Sampled:	**2/14/05 9:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.760 +/- 0.172	pCi/g	0.294		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	20.3	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-02**						
Client ID:	**K-552**						
Date Sampled:	**3/8/05 2:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.811 +/- 0.141	pCi/g	0.641		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	8.1	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-03**						
Client ID:	**K-619**						
Date Sampled:	**4/25/05 2:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.932 +/- 0.188	pCi/g	0.509		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	11.9	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-04**						
Client ID:	**K-774**						
Date Sampled:	**7/8/05 1:30:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.819 +/- 0.224	pCi/g	0.318		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	10.9	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-05**						
Client ID:	**K-782**						
Date Sampled:	**7/8/05 2:10:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050995
Date Reported:	12/14/05
Date Received:	12/9/05
Page Number:	2 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	1.37 +/- 0.304	pCi/g	0.887		12/9/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	7.8	%		12/9/05	12/14/05	RT
Lab ID:	20050995-06						
Client ID:	K-786						
Date Sampled:	7/8/05 2:30:00 PM						
Matrix:	Soil						
Radiochemical Analyses							
Thorium 232	HASL 300	0.747 +/- 0.174	pCi/g	0.548		12/9/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	4.2	%		12/9/05	12/14/05	RT
Lab ID:	20050995-07						
Client ID:	K-787						
Date Sampled:	7/8/05 2:35:00 PM						
Matrix:	Soil						
Radiochemical Analyses							
Thorium 232	HASL 300	0.873 +/- 0.171	pCi/g	0.567		12/12/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	7.2	%		12/9/05	12/14/05	RT
Lab ID:	20050995-08						
Client ID:	K-789						
Date Sampled:	7/8/05 2:45:00 PM						
Matrix:	Soil						
Radiochemical Analyses							
Thorium 232	HASL 300	0.948 +/- 0.162	pCi/g	0.472		12/12/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	9.3	%		12/9/05	12/14/05	RT
Lab ID:	20050995-09						
Client ID:	K-965						
Date Sampled:	8/19/05 9:35:00 AM						
Matrix:	Soil						
Radiochemical Analyses							
Thorium 232	HASL 300	1.07 +/- 0.234	pCi/g	0.594		12/12/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	18.4	%		12/9/05	12/14/05	RT

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050995
Date Reported:	12/14/05
Date Received:	12/9/
Page Number:	3 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20050995-10						
Client ID:	K-969						
Date Sampled:	8/19/05 9:40:00 AM						
Matrix:	Soil						
	Radiochemical Analyses						
Thorium 232	HASL 300	0.286 +/- 0.051	pCi/g	0.133		12/12/05	SD
	Inorganics Analyses						
Percent Moisture	ASTM D2216-92	17.6	%		12/9/05	12/14/05	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					NC				12/9/05
Am-241		94.0	94.0	0.0					12/9/05
Co-60		93.0	95.0	2.2					12/9/05
Cs-137		94.0	94.0	0.7					12/9/05
Percent Moisture					1.1				12/14/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN CUSTODY

Results To:
Company KAISER Alum & Chem Inc.
Local: Name DAVID R. WEYAND
918-384-0066 Address 7311 E. 41st ST.
City TULSA State OK Zip 74145
Cell: 724-799-0071 Phone 724-934-3530 Fax # 918-384-3171

Bill To:
Company KAISER/PAUL EAR
Name DAVID R. WEYAND/PAUL HANNA
Address 7311 E. 41st ST.
City TULSA State OK Zip 74145

ANALYSIS REQUESTED

PO # KAISER-4572
PROJECT # PA-4000-4072
PROJECT NAME KAISER-ALUM & CHEM FEM.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 5 DAY
SAMPLER: Signature DAVID R. WEYAND

CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GAMMA SPEC (Th-232)	RADIUM-226 (CLIENT TO ADVISE)	VOC (SW-8260)	PCB (SW-8082)	ASTM D2216-92 (MOISTURE)	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
K-506	12-14-05	Soil	9:50	1	Plastic	None						Grab
K-552	12-9-05		14:00	1								
K-619	12-15-05		14:40	1								
K-774	12-9-05		13:30	1								
K-782	12-9-05		14:10	1								
K-786	12-9-05		14:30	1								
K-787	12-9-05		14:35	1								
K-789	12-9-05		14:45	1								
K-965	12-19-05		9:35	1								
K-969	12-19-05		9:45	1								

RELINQUISHED BY: DAVID R. WEYAND DATE 12/20 TIME 8:00 RECEIVED BY: DATE 12/20/05 TIME

RELINQUISHED BY: DATE TIME RECEIVED BY: DATE TIME

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

For Laboratory Use Only: Work Order # 0512375

Sample Condition Upon Receipt: OK

Custody Seals Intact: (Y) N

Cooler Temperature: 4.3°C

SAMPLE LOG

Date Received: *12/9/05 8:44:38 A* Lab Number: 20050995 Due: 12/16/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050995-01 A	K-506	Soil	02/14/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-02 A	K-552	Soil	03/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-03 A	K-619	Soil	04/25/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-04 A	K-774	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-05 A	K-782	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-06 A	K-786	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-07 A	K-787	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-08 A	K-789	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-09 A	K-965	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-10	K-969	Soil	08/19/05	[illegible]c	16 oz	None	Yes	Yes

Gamma Thorium 232
Percent Moisture (LOD)

CONTAINER INSPECTION

 # Coolers 1 **Custody Seals Broken** ☐ **Temperature** **Ice** **Radiation Survey:** <300 cpm

SAMPLE INSPECTION

Sample Seal Broken NA **Chain of Custody Record** ☑ **Labels in Tact** ☑ **Radiation Survey Complete** ☑

Anomalies

Inspected By: Michelle Scott **DATE** 12/09/05

QA or Designee Review: [illegible] **DATE** 12/09/05

Sample Custodian Review: [illegible] **DATE** 12/9/05

Project Notes:

SUB-REPORT

SURVEY UNIT KAISER-FSS-018

TABLE OF CONTENTS

ATTACHMENTS

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report EB-018
Survey Unit Kaiser-FSS-018
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility **(Figure 1)**. Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-018, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the eastern-central portion of the Retention Pond area. Survey Unit Kaiser-FSS-018 is considered a Class 1 survey unit with an approximate surface area of 1,582 m^2. It is bounded to the south by Survey Unit Kaiser-FSS-019, to the east by Survey Unit Kaiser-FSS-016, to the north by Survey Unit Kaiser-FSS-017, and to the west by Survey Units Kaiser-FSS-023 and Kaiser-FSS-028 **(Figure 3)**.

Survey Unit Kaiser-FSS-018 consists of an excavation bottom surface soil with no side walls. No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom surface soil of Survey Unit Kaiser-FSS-018. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 12 approximately equal-distant locations in the survey unit. The statistics for the 12 background measurements are provided below in **Table 1.** Background measurements ranged from 19,724 counts per minute (cpm) to 24,651 cpm moving southeast to northwest within the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the west /northwest of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 2,017 measurements of gross count rate were made at two second intervals across the survey unit's 1,582 m^2 surface area. The results ranged from 15,000 cpm to 31,940 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	1,582 m^2	
Number of Scan Measurements (2-Second Intervals)	2,017	
Detector Swing Rate: (Swinging the detector a width of 1-meter side to side)	0.39 m/s (MARSSIM recommends 0.5 m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	19,724	15,000
Maximum	24,651	31,940
Average	21,742	22,571
Stand Deviation	1,645	2,496
Median	21,427	22,509

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site). As part of the gross gamma survey, 2 biased soil samples were collected at locations exhibiting the highest scan rates on the excavation bottom **(Figure A-2, Attachment A).** The biased soil samples were screened on-site in a lead cave. Results of the sample

screening are presented below in **Table 2.** The sample screening levels were below the $DCGL_W$ for the site.

Table 2 – Biased Soil Sample Screening Results

Soil Sample ID	Cave Counter Screening Results (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)
$DCGL_W$	*3.0*		
Background	*1.1*	*0.3*	
K-945	0.204	0.368	0.614
K-946	0.616	0.366	0.614

2.2 Systematic Soil Sampling – Excavation Bottom Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 **(Attachment B).** Once N was determined, the Survey Unit Area (A) of 1,582 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 14.2 meters and the Height of the Equilateral Triangle (h) of 12.3 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 **(Attachment B).**

A layout of the soil sampling locations is provided on **Figure A-3** contained in **Attachment A.** The soil sample locations were demarcated in the field using a GPS unit. A total of 10 soil samples (identified as K-959 through K-968) were collected at the excavation bottom surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3.** Analytical data reports are contained in **Attachment C.**

Table 3 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-959	0.491	0.043	0.142	0	3.0
K-960	1.32	0.106	0.441	0.22	3.0
K-961	0.491	0.055	0.175	0	3.0
K-962	0.703	0.085	0.471	0	3.0
K-963	0.536	0.044	0.121	0	3.0
K-964	0.980	0.137	0.525	0	3.0
K-965	1.07	0.234	0.594	0	3.0
K-966	0.872	0.059	0.235	0	3.0
K-967	0.445	0.053	0.206	0	3.0
K-968	0.423	0.050	0.167	0	3.0
Average	***0.733***				
Standard Dev.	***0.312***				
Minimum	***0.423***				
Maximum	***1.32***				
Median	***0.620***				

All 10 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.32 pCi/g, which fell slightly above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 0.733 pCi/g. The standard deviation of the 10 equal-distant samples was 0.312, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (0.40 pCi/g) between the maximum survey unit soil sample activity concentration (1.32 pCi/g) and the minimum reference background area soil sample activity concentration (0.92 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	33	0.92	S1	K-959	0.491
R2	306	1.41	S2	K-960	1.32
R3	311	1.42	S3	K-961	0.491
R4	340	1.10	S4	K-962	0.703
R5	73	1.09	S5	K-963	0.536
R6	124	1.07	S6	K-964	0.980
R7	172	1.07	S7	K-965	1.07
R8	310	1.42	S8	K-966	0.872
R9	205	1.05	S9	K-967	0.445
R10	15	1.11	S10	K-968	0.423
	Average	***1.17***		***Average***	***0.733***
	Standard Dev.	***0.18***		***Standard Dev.***	***0.312***
	Minimum	***0.92***		***Minimum***	***0.423***
	Maximum	***1.42***		***Maximum***	***1.32***
	Median	***1.10***		***Median***	***0.620***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the eastern-central portion of the Retention Pond resulted in an open land area consisting of an excavation approximately 1,582 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-018 is considered a Class 1 survey unit. The survey unit is bounded to the south by the Survey Unit Kaiser-FSS-019, to the east by Survey Unit Kaiser-FSS-016, to the north by Survey Unit Kaiser-FSS-017, and to the west by Survey Units Kaiser-FSS-023 and Kaiser-FSS-028 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-018 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 10 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-018 prior to backfill with below criteria material (BCM), as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 5.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

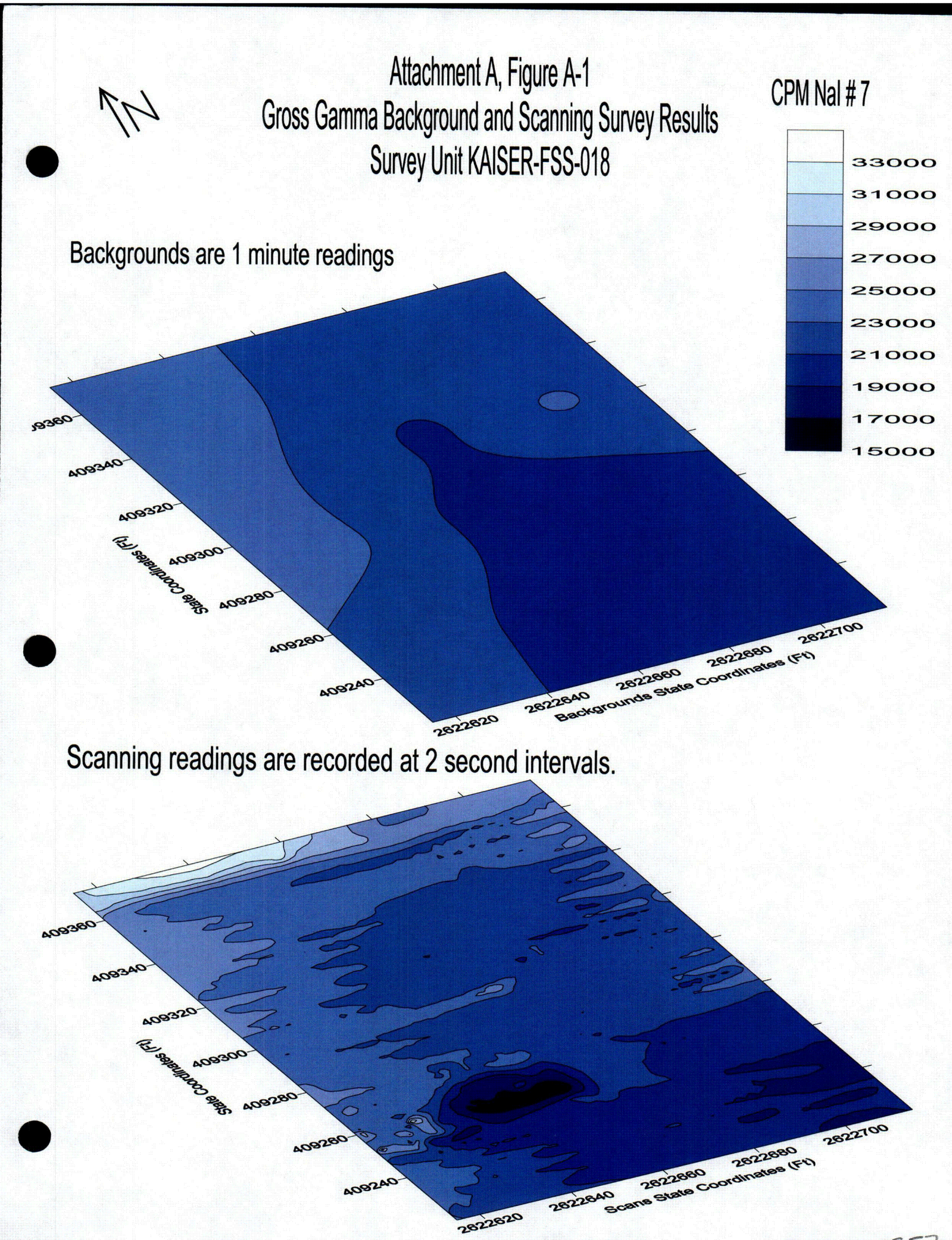
Table 5 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-018 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	$dpm/100cm^2$	0		0.00
TOTAL SUM OF FRACTIONS				***0.00***

The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-018 meets the DP acceptance criteria.

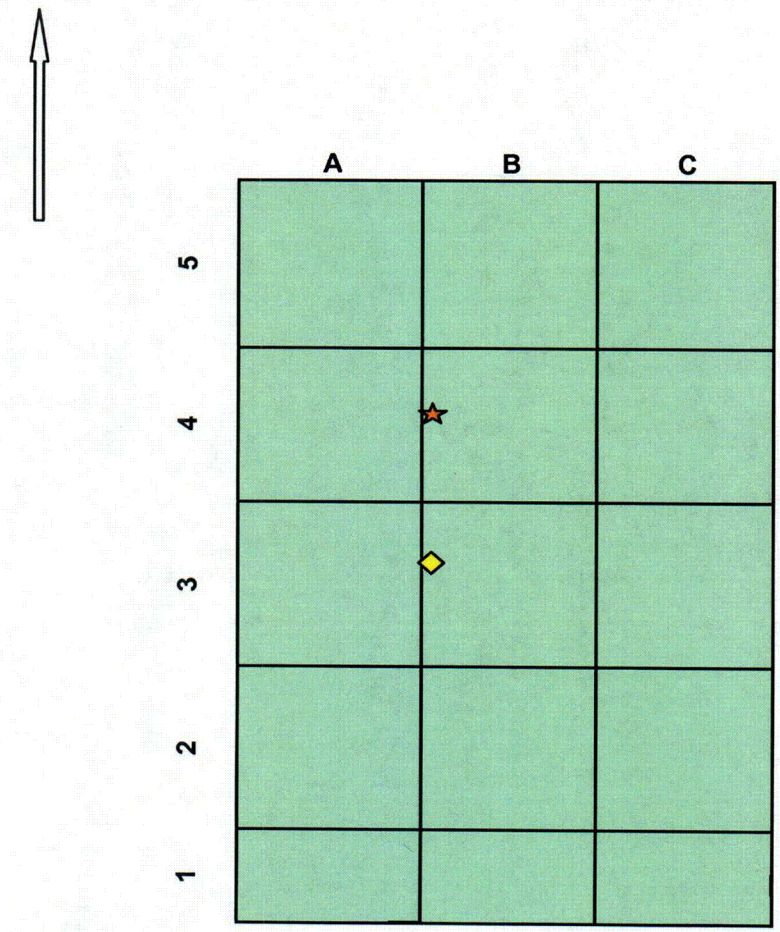
ATTACHMENT A
TABLE OF CONTENTS

Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit KAISER-FSS-018

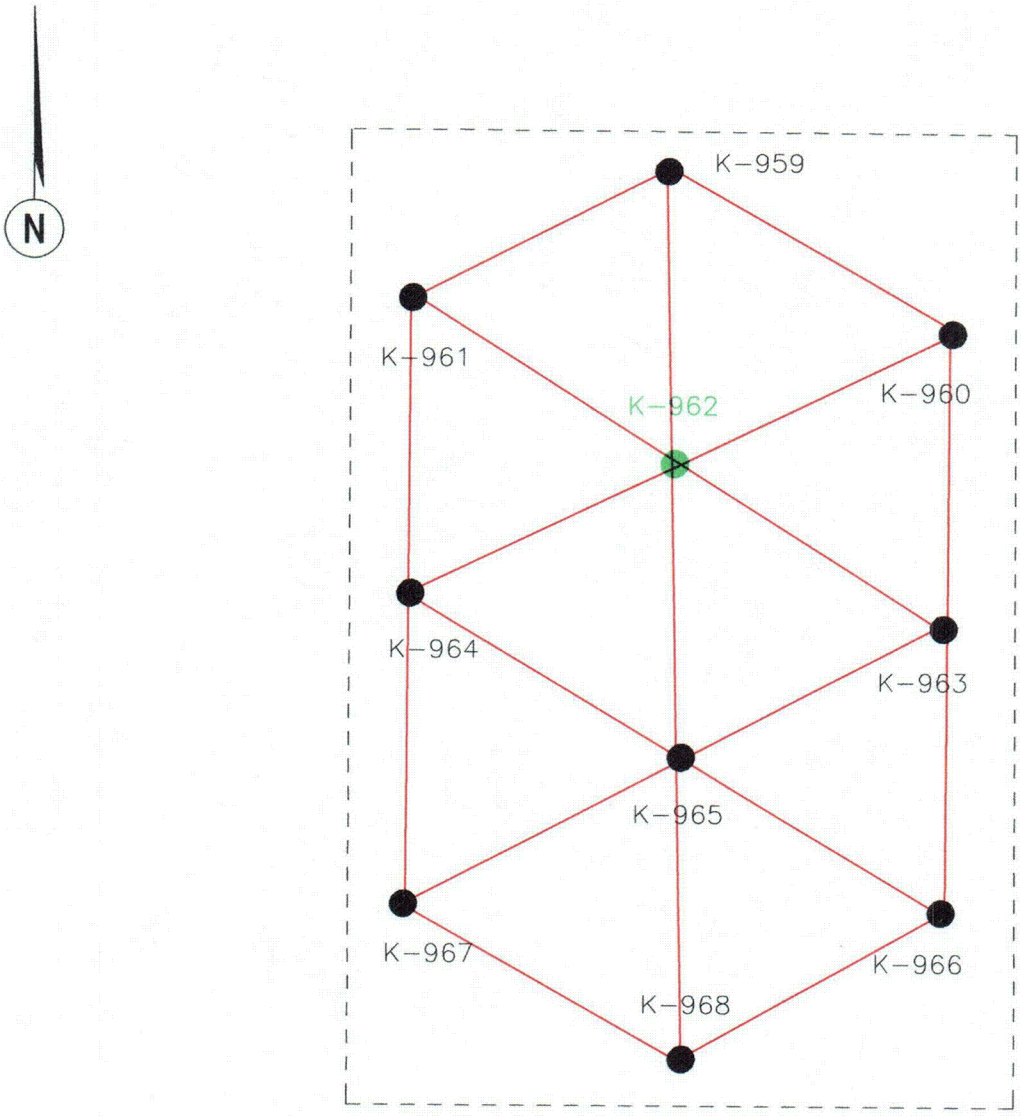


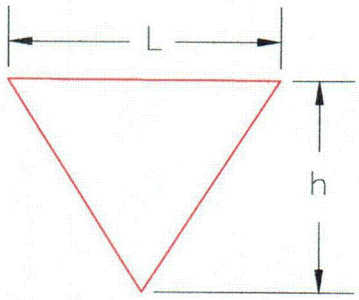
Attachment A, Figure A-2
Gross Gamma Survey - Biased Soil Sample Locations
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Survey Unit: Kaiser-FSS-018
Area: 1,582 m^2
Grid: 10m x 10m



★ K-945 - Biased soil sampling location based on the results of the gross gamma scan.
◇ K-946 - Biased soil sampling location based on the results of the gross gamma scan.





N = 9 (COLLECTED 10)
L = 14.2 m
h = 12.3 m
AREA = 1,582m^2

SCALE – FEET
30 0 30
9 0 9
SCALE – METERS

K-960
● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K-962
● RANDOM START POINT

FIGURE A-3
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS-018
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RD 3.3.06
CHECKED	RD 3.3.06
DRAWN	DEB 10/7/05
DRAWING NUMBER	PA4072031

Penn E&R
Environmental & Remediation, Inc.

ATTACHMENT B
TABLE OF CONTENTS

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-018

2. Description: Retention Pond Area, West of Survey Unit Kaiser-FSS-016

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – 33.5 meters x 47.2 meters; Area, A (m^2): 1,582

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 14.2 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 12.3 m.

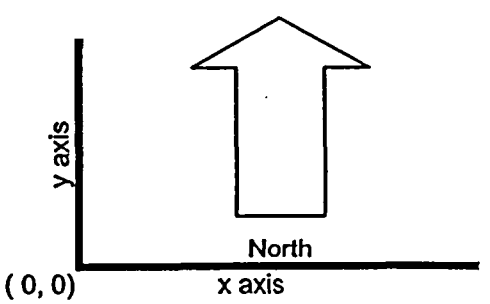
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-018

RANDOM START POINT

x axis (Meters)	y axis (Meters)
16	30

	x axis	y axis
lower bound	0	0
upper bound	33	47



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

August 26, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050664

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on August 19, 2005 for the above captioned project. Seven soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5-work day turn. Results were faxed on 8/26/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20050664
Date Reported: 8/26/05
Date Received: 8/19/05

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050664-01**						
Client ID:	**K-959**						
Date Sampled:	**8/18/05 9:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.491 +/- 0.043	pCi/g	0.142		8/22/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	22.1	%		8/23/05	8/24/05	RT
Lab ID:	**20050664-02**						
Client ID:	**K-960**						
Date Sampled:	**8/18/05 9:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.32 +/- 0.106	pCi/g	0.441		8/22/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	19.6	%		8/23/05	8/24/05	RT
Lab ID:	**20050664-03**						
Client ID:	**K-961**						
Date Sampled:	**8/18/05 9:30:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.491 +/- 0.055	pCi/g	0.175		8/22/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.6	%		8/23/05	8/24/05	RT
Lab ID:	**20050664-04**						
Client ID:	**K-962**						
Date Sampled:	**8/18/05 9:40:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.703 +/- 0.085	pCi/g	0.471		8/22/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.9	%		8/23/05	8/24/05	RT

BDL = Below Detection Limit

Outreach
Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client Project: Thorium Remediation
Lab Number: 20050664
Date Reported: 8/26/05
Date Received: 8/19/05

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050664-05**						
Client ID:	**K-963**						
Date Sampled:	**8/18/05 9:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.536 +/- 0.044	pCi/g	0.121		8/22/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	23.8	%		8/23/05	8/24/05	RT
Lab ID:	**20050664-06**						
Client ID:	**K-964**						
Date Sampled:	**8/18/05 10:00:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.980 +/- 0.137	pCi/g	0.525		8/22/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.0	%		8/23/05	8/24/05	RT
Lab ID:	**20050664-07**						
Client ID:	**K-967**						
Date Sampled:	**8/18/05 10:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.445 +/- 0.053	pCi/g	0.206		8/22/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.0	%		8/23/05	8/24/05	RT

BDL = Below Detection Limit

Outreach
Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum

Client Project: Thorium Remediation
Lab Number: 20050664
Date Reported: 8/26/05
Date Received: 8/19/05

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					NC				8/22/05
Am-241		93.0	93.0	0.0					8/22/05
Co-60		93.0	94.0	0.3					8/22/05
Cs-137		96.0	96.0	0.0					8/22/05
Percent Moisture					4.7				8/24/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company Kaiser Alum & Chem Corp.
Local: 918-384-0566 Cell: 724-799-0071
Name David B. Weyant
Address 7311 E. 41st Street
City Tulsa State Ok Zip 74145
Phone 724-934-3530 Fax # 918-384-3171

Bill To:
Company KAISER / PEAN & ERC
Name PAUL HAMM / David Weyant
Address 7311 E. 41st St.
City Tulsa State Ok Zip 74145

ANALYSIS REQUESTED

PO # Kaiser - 4072
PROJECT # PA - 4000 - 4072
PROJECT NAME Kaiser - Thorium Photo.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 5 DAY
SAMPLER David B. Weyant (Signature)
David B. Weyant

LAB USE ONLY	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec (U-232)	Radon + Daughters (Filtered para Activity)	MDC 20 pCi/l Op.	ASTM D2460 (Radium Content)	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-959	8-18-05	0910	Soil	1	500ml plastic	None	X	X	X	X	Grab
	K-960		0920		1			X	X	X	X	
	K-961		0930		1			X	X	X	X	
	K-962		0940		1			X	X	X	X	
	K-963		0950		1			X	X	X	X	
	K-964		1000		1			X	X	X	X	
	K-967		1010		1			X	X	X	X	

" = same as above

RELINQUISHED BY: David B. Weyant DATE 8/19/05 TIME 9:15 RECEIVED BY: Donna Edson DATE 8/19/05 TIME 945

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: 20050604
Sample Condition Upon Receipt: Good
Custody Seals Intact: Yes
Temperature: 4°C

SAMPLE LOGIN

Date Received: *8/19/05 11:18:32* Lab Number: 20050664 Due: 8/26/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050664-01 A	K-959	Soil	08/18/05	Plastic	Lg Zip Bag	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050664-02 A	K-960	Soil	08/18/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050664-03 A	K-961	Soil	08/18/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050664-04 A	K-962	Soil	08/18/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050664-05 A	K-963	Soil	08/18/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050664-06 A	K-964	Soil	08/18/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050664-07 A	K-967	Soil	08/18/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								

CONTAINER INSPECTION

Coolers 1 Custody Seals Broken - Y/N N/A Temperature _____ Blue Ice / Wet Ice Radiation Survey 800 fixed _____ removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N N/A Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies: _____

Inspected By: Michelle Sutton DATE 08/19/05

QA or Designee Review: [signature] DATE 8/19/05

Sample Custodian Review: [signature] DATE 8/19/05

Project Notes:

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Limit # 11606
DL. 12/15/05

December 14, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050995

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on December 09, 2005 for the above captioned project. Ten soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5-work day turn. Results were faxed early on 12/14/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH
CERT. ID #OK001

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050995
Date Reported:	12/14/05
Date Received:	12/9/05
Page Number:	1 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050995-01**						
Client ID:	**K-506**						
Date Sampled:	**2/14/05 9:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.760 +/- 0.172	pCi/g	0.294		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	20.3	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-02**						
Client ID:	**K-552**						
Date Sampled:	**3/8/05 2:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.811 +/- 0.141	pCi/g	0.641		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	8.1	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-03**						
Client ID:	**K-619**						
Date Sampled:	**4/25/05 2:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.932 +/- 0.188	pCi/g	0.509		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	11.9	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-04**						
Client ID:	**K-774**						
Date Sampled:	**7/8/05 1:30:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.819 +/- 0.224	pCi/g	0.318		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	10.9	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-05**						
Client ID:	**K-782**						
Date Sampled:	**7/8/05 2:10:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050995
Date Reported:	12/14/05
Date Received:	12/9/05
Page Number:	2 of 4

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	1.37 +/- 0.304	pCi/g	0.887		12/9/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	7.8	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-06**						
Client ID:	**K-786**						
Date Sampled:	**7/8/05 2:30:00 PM**						
Matrix:	**Soil**						
Radiochemical Analyses							
Thorium 232	HASL 300	0.747 +/- 0.174	pCi/g	0.548		12/9/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	4.2	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-07**						
Client ID:	**K-787**						
Date Sampled:	**7/8/05 2:35:00 PM**						
Matrix:	**Soil**						
Radiochemical Analyses							
Thorium 232	HASL 300	0.873 +/- 0.171	pCi/g	0.567		12/12/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	7.2	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-08**						
Client ID:	**K-789**						
Date Sampled:	**7/8/05 2:45:00 PM**						
Matrix:	**Soil**						
Radiochemical Analyses							
Thorium 232	HASL 300	0.948 +/- 0.162	pCi/g	0.472		12/12/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	9.3	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-09**						
Client ID:	**K-965**						
Date Sampled:	**8/19/05 9:35:00 AM**						
Matrix:	**Soil**						
Radiochemical Analyses							
Thorium 232	HASL 300	1.07 +/- 0.234	pCi/g	0.594		12/12/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	18.4	%		12/9/05	12/14/05	RT

BDL = Below Detection Limit

Outreach Laboratory
511 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050995
Date Reported:	12/14/05
Date Received:	12/9/05
Page Number:	3 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20050995-10						
Client ID:	K-969						
Date Sampled:	8/19/05 9:40:00 AM						
Matrix:	Soil						
	Radiochemical Analyses						
Thorium 232	HASL 300	0.286 +/- 0.051	pCi/g	0.133		12/12/05	SD
	Inorganics Analyses						
Percent Moisture	ASTM D2216-92	17.6	%		12/9/05	12/14/05	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					NC				12/9/05
Am-241		94.0	94.0	0.0					12/9/05
Co-60		93.0	95.0	2.2					12/9/05
Cs-137		94.0	94.0	0.7					12/9/05
Percent Moisture					1.1				12/14/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

CHAIN CUSTODY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

Cell: 724-799-0471

Results To:
Company KAISER Alum & Chem Jdc.
Local: 918-384-0466
Name DAVID R. WEYANT
Address 7311 E. 41st ST.
City TULSA State OK Zip 74145
Phone 724-934-3530 Fax # 918-384-3171

Bill To:
Company Kaiser/Penn EAR
Name DAVID R. WEYANT/Paul Hanna
Address 7311 E. 41st St.
City TULSA State OK Zip 74145

ANALYSIS REQUESTED

PO # KAISER-4572
PROJECT # PA-4000-4572
PROJECT NAME KAISER-ALUM & CHEM ESM.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 5 DAY
SAMPLER Signature
DAVID R. WEYANT

PRESERVATIVE #: 1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11

LAB #	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE #	GAMMA SPEC (Th-232)	RADIUM 226 + RADON EMANATION	URANIUM by ICP/MS	ALPHA SPEC RADIUM 226/228	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-506	7-14-05	5:11	9:50	1	Plastic	None					Grab
	K-552	7-8-05		14:00	1							
	K-619	7-7-05		14:40	1							
	K-774	7-8-05		13:30	1							
	K-782	7-8-05		14:10	1							
	K-786	7-8-05		14:30	1							
	K-787	7-8-05		14:35	1							
	K-789	~~7-8-05~~ 7-7-05		14:45	1							
	K-961	8-19-05		9:35	1							
	K-963	8-19-05		9:45	1							

RELINQUISHED BY: DAVID R. WEYANT DATE 12/6/05 TIME 8:00 RECEIVED BY: DATE 12/6/05 TIME 9:10

RELINQUISHED BY: DATE TIME RECEIVED BY: DATE TIME

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN: TRIAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

Turnaround Time Due Date: 12/13/05

Sample Condition Upon Receipt: Good

Custody Seals Intact: (Y) N

Cooler Temperature: 4.3°C

SAMPLE LOG

Date Received: *12/9/05 8:44:38 A* Lab Number: 20050995 Due: 12/16/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050995-01 A	K-506	Soil	02/14/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-02 A	K-552	Soil	03/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-03 A	K-619	Soil	04/25/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-04 A	K-774	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-05 A	K-782	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-06 A	K-786	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-07 A	K-787	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-08 A	K-789	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-09 A	K-965	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-10 A	K-969	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes

Gamma S Thorium 232

Percent Moisture (LOD)

CONTAINER INSPECTION

Coolers 1 Custody Seals Broken ☐ Temperature Ice Radiation Survey: <300 cpm

SAMPLE INSPECTION

Sample Seal Broken NA Chain of Custody Record ☑ Labels in Tact ☑ Radiation Survey Complete ☑

Anomalies

Inspected By: Michelle Scott DATE 12/09/05

QA or Designee Review: Lawrence Thomas DATE 12/09/05

Sample Custodian Review: R. Gregory DATE 12/9/05

Project Notes:

SUB-REPORT

SURVEY UNIT KAISER-FSS-019

TABLE OF CONTENTS

ATTACHMENTS

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-019
Survey Unit Kaiser-FSS-019
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-019, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the eastern-central portion of the Retention Pond area. Survey Unit Kaiser-FSS-019 is considered a Class 1 survey unit with an approximate surface area of 1,582 m^2. It is bounded to the south by Survey Unit Kaiser-FSS-029, to the east by Survey Unit Kaiser-FSS-016, to the north by Survey Unit Kaiser-FSS-018, and to the west by Survey Unit Kaiser-FSS-028 (**Figure 3**).

Survey Unit Kaiser-FSS-019 consists of an excavation bottom surface soil with no side walls. No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom surface soil of Survey Unit Kaiser-FSS-019. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1. Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 12 approximately equal-distant locations in the survey unit. The statistics for the 12 background measurements are provided below in **Table 1.** Background measurements ranged from 16,016 counts per minute (cpm) to 20,057 cpm moving east to west within the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the west and south of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 2,162 measurements of gross count rate were made at two second intervals across the survey unit's 1,582 m^2 surface area. The results ranged from 15,596 cpm to 29,375 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	1,582 m^2	
Number of Scan Measurements (2-Second Intervals):	2,162	
Detector Swing Rate: (Swinging the detector a width of 1-meter side to side)	0.37 m/s (MARSSIM recommends 0.5 m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	16,016	15,596
Maximum	20,057	29,375
Average	17,776	19,299
Stand Deviation	1,102	1,840
Median	17,523	18,963

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site). As part of the gross gamma survey, 4 biased soil samples were collected at locations exhibiting the highest scan rates on the excavation bottom **(Figure A-2, Attachment A).** The biased soil samples were screened on-site in a lead cave. Results of the sample

screening are presented below in **Table 2.** The sample screening levels were below the $DCGL_W$ for the site.

Table 2 – Biased Soil Sample Screening Results

Soil Sample ID	Cave Counter Screening Results (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)
$DCGL_W$	*3.0*		
Site Background	*1.1*	*0.3*	
K-941	0.972	1.10	1.56
K-942	1.71	0.809	1.56
K-943	0.454	0.966	1.56
K-944	0.081	1.08	1.56

2.2 Systematic Soil Sampling – Excavation Bottom Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 **(Attachment B).** Once N was determined, the Survey Unit Area (A) of 1,582 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 14.2 meters and the Height of the Equilateral Triangle (h) of 12.3 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 **(Attachment B).**

A layout of the soil sampling locations is provided on **Figure A-3** contained in **Attachment A.** The soil sample locations were demarcated in the field using a GPS unit. A total of 10 soil samples (identified as K-969 through K-978) were collected at the excavation bottom surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3.** Analytical data reports are contained in **Attachment C.**

Table 3 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-969	0.286	0.051	0.133	0	3.0
K-970	0.591	0.050	0.191	0	3.0
K-971	0.563	0.077	0.227	0	3.0
K-972	0.574	0.062	0.194	0	3.0
K-973	0.547	0.041	0.248	0	3.0
K-974	0.509	0.034	0.216	0	3.0
K-975	0.856	0.074	0.224	0	3.0
K-976	1.10	0.087	0.238	0	3.0
K-977	0.796	0.047	0.241	0	3.0
K-978	0.784	0.097	0.327	0	3.0
Average	***0.661***				
Standard Dev.	***0.227***				
Minimum	***0.286***				
Maximum	***1.10***				
Median	***0.583***				

All 10 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.10 pCi/g, which is equal to the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 0.661 pCi/g. The standard deviation of the 10 equal-distant samples was 0.227, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (0.40 pCi/g) between the maximum survey unit soil sample activity concentration (1.10 pCi/g) and the minimum reference background area soil sample activity concentration (0.70 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	126	1.29	S1	K-969	0.286
R2	139	0.70	S2	K-970	0.591
R3	74	0.87	S3	K-971	0.563
R4	231	1.38	S4	K-972	0.574
R5	131	1.26	S5	K-973	0.547
R6	162	1.00	S6	K-974	0.509
R7	59	0.96	S7	K-975	0.856
R8	273	0.84	S8	K-976	1.10
R9	164	1.88	S9	K-977	0.796
R10	27	1.24	S10	K-978	0.784
	Average	***1.14***		***Average***	***0.661***
	Standard Dev.	***0.34***		***Standard Dev.***	***0.227***
	Minimum	***0.70***		***Minimum***	***0.286***
	Maximum	***1.88***		***Maximum***	***1.10***
	Median	***1.12***		***Median***	***0.583***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the eastern-central portion of the Retention Pond resulted in an open land area consisting of an excavation approximately 1,582 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-019 is considered a Class 1 survey unit. The survey unit is bounded to the south by the Survey Unit Kaiser-FSS-029, to the east by Survey Unit Kaiser-FSS-016, to the north by Survey Unit Kaiser-FSS-018, and to the west by Survey Unit Kaiser-FSS-028 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-019 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 10 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-019 prior to backfill with below criteria material (BCM), as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 5.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

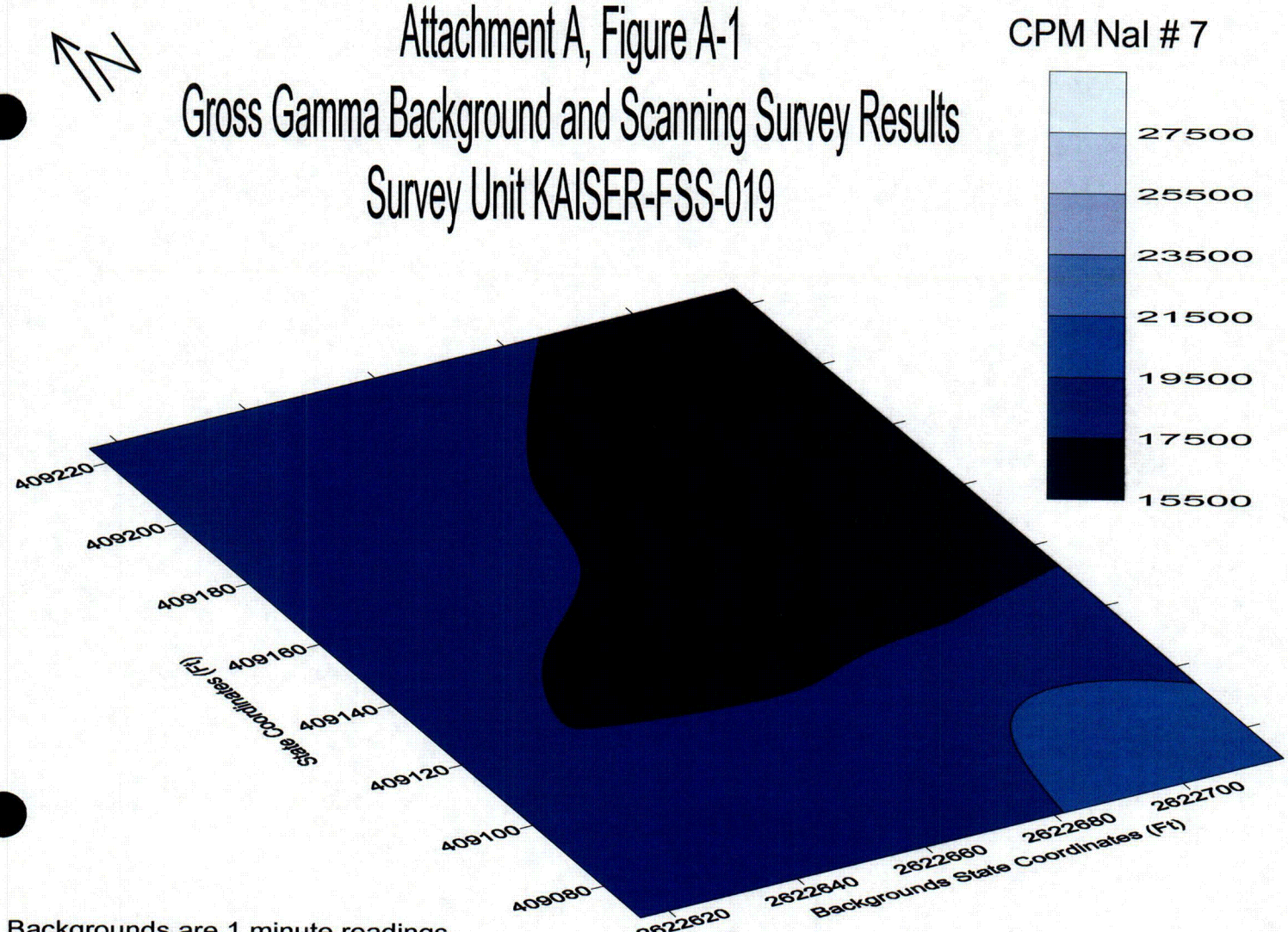
Table 5 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-019 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	dpm/100cm^2	0		0.00
TOTAL SUM OF FRACTIONS				***0.00***

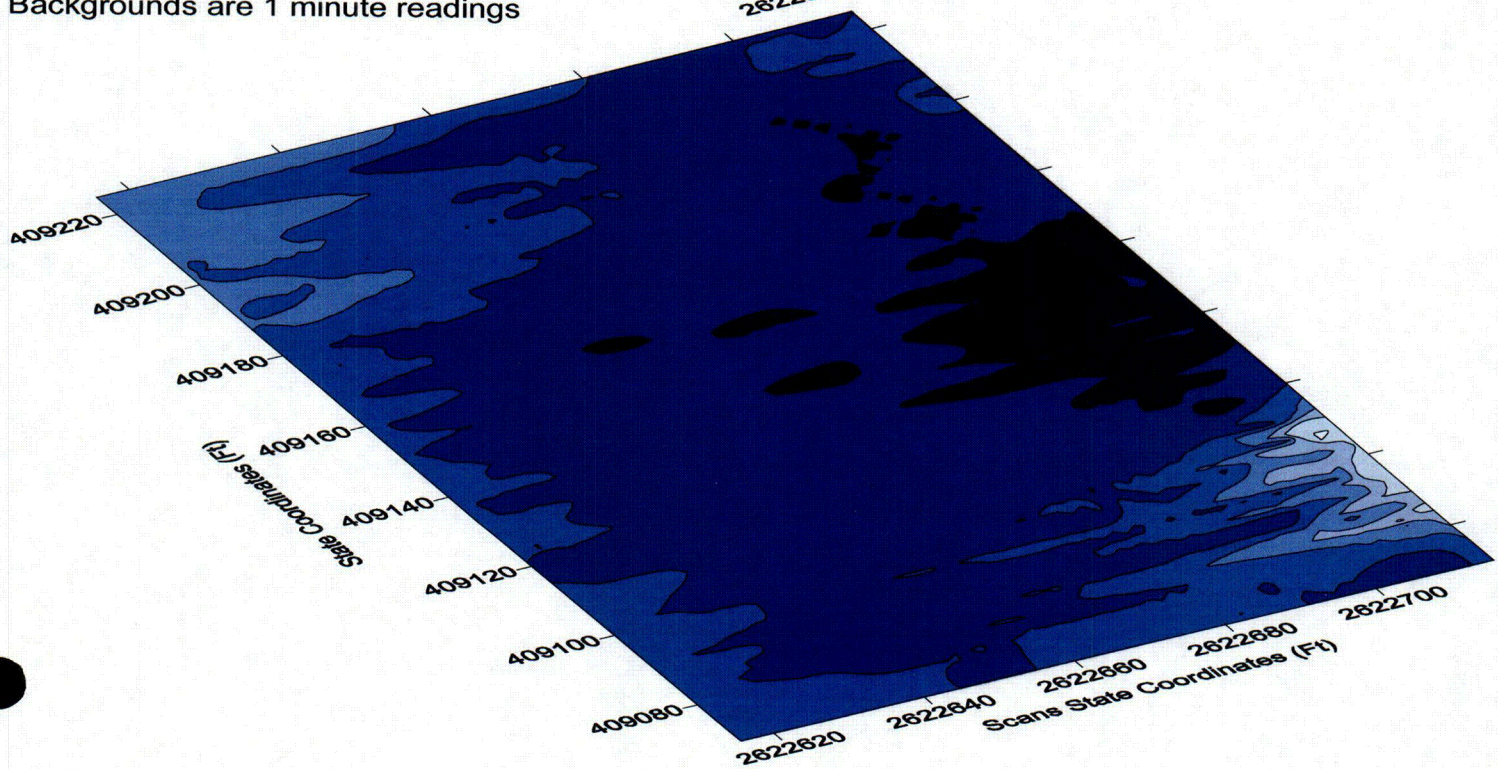
The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-019 meets the DP acceptance criteria.

ATTACHMENT A
TABLE OF CONTENTS

Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit KAISER-FSS-019



Backgrounds are 1 minute readings



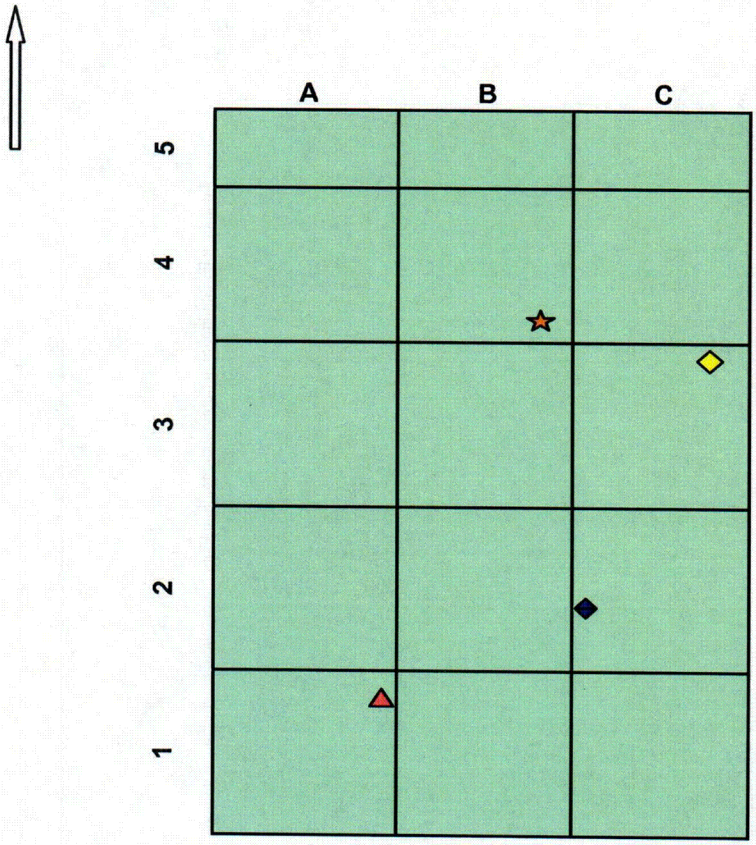
Scanning readings are recorded at 2 second intervals.

C56

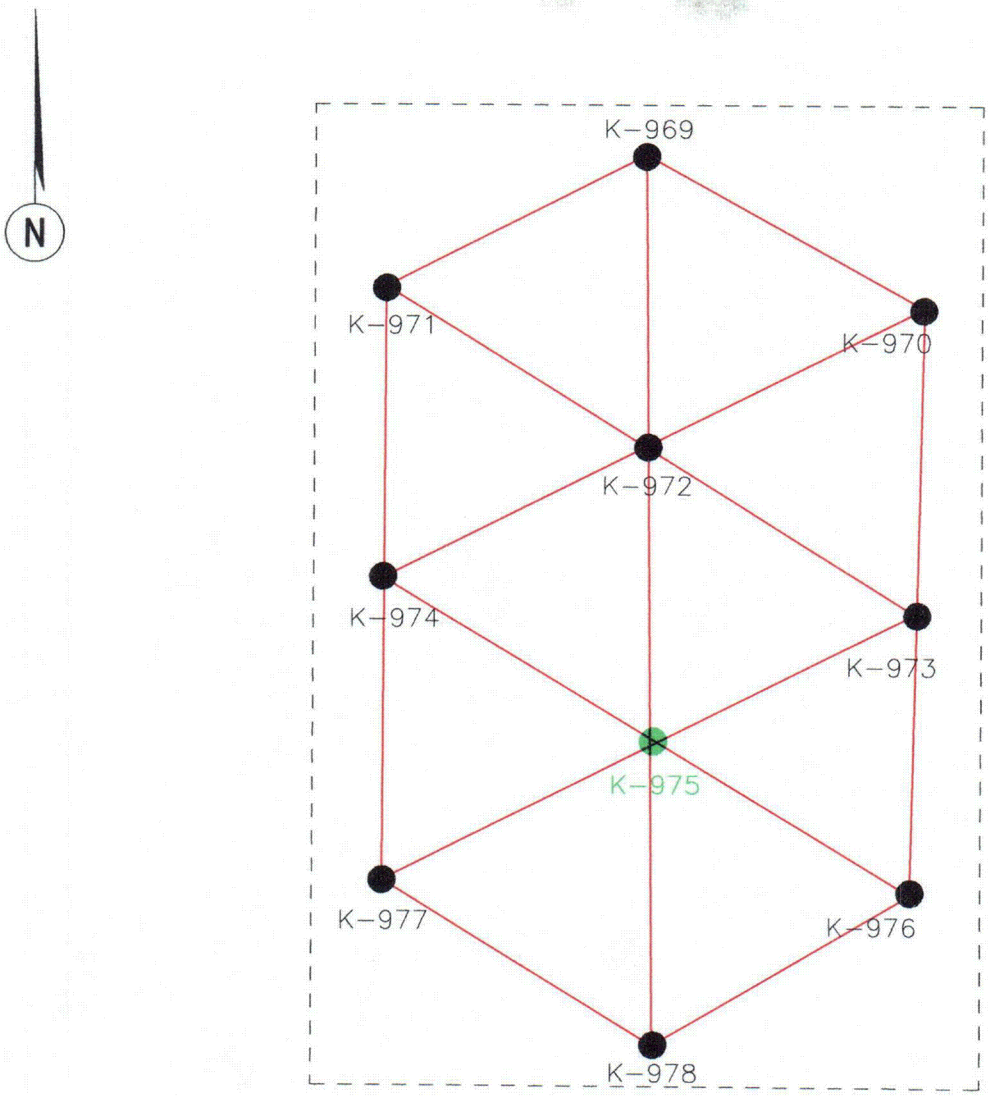
Attachment A, Figure A-2
Gross Gamma Survey - Biased Soil Sample Locations
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

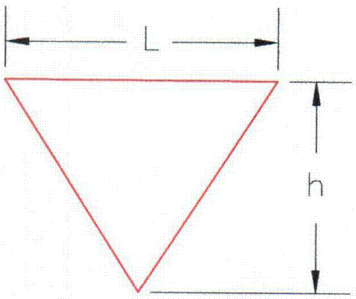
Survey Unit: Kaiser-FSS-019
Area: 1,582 m^2
Grid: 10m x 10m

North



K-941 - Biased soil sampling location based on the results of the gross gamma scan
K-942 - Biased soil sampling location based on the results of the gross gamma scan
K-943 - Biased soil sampling location based on the results of the gross gamma scan
K-944 - Biased soil sampling location based on the results of the gross gamma scan





N = 9 (COLLECTED 10)
L = 14.2 m
h = 12.3 m
AREA = 1,582m^2

SCALE – FEET
30 0 30
9 0 9
SCALE – METERS

K-969
● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K-975
● RANDOM START POINT

FIGURE A-3
SYSTEMATIC SOIL SAMPLING LOCATIONS SURVEY UNIT KAISER – FSS-019 FINAL STATUS SURVEY THORIUM REMEDIATION PROJECT TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RD 3·3·06
CHECKED	RD 3·3·06
DRAWN	DEB 10/10/05
DRAWING NUMBER	PA4072032

Penn E&R
Environmental & Remediation, Inc.

ATTACHMENT B
TABLE OF CONTENTS

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-019

2. Description: Retention Pond Area, West of Survey Unit Kaiser-FSS-016

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – 33.5 meters x 47.2 meters; Area, A (m^2): 1,582

5. Estimated Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 14.2 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 12.3 m.

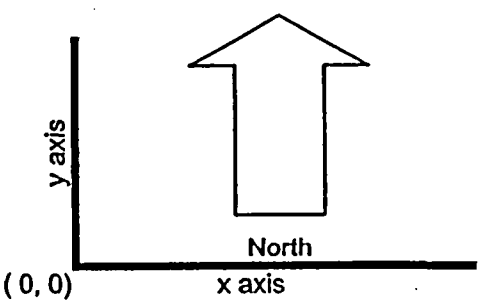
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-019

RANDOM START POINT

x axis (Meters)	y axis (Meters)
16	16

	x axis	y axis
lower bound	0	0
upper bound	33	47



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach
Laboratory
rth Aspen
Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

August 26, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050669

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on August 19, 2005 for the above captioned project. Eleven soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5-work day turn. Results were faxed on 8/26/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach
Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050669
Date Reported:	8/26/05
Date Received:	8/22/05
Page Number:	1 of 4

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050669-01**						
Client ID:	**K-966**						
Date Sampled:	**8/19/05 9:25:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.872 +/- 0.059	pCi/g	0.235		8/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	37.4	%		8/22/05	8/23/05	RT
Lab ID:	**20050669-02**						
Client ID:	**K-968**						
Date Sampled:	**8/19/05 9:30:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.423 +/- 0.050	pCi/g	0.167		8/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.1	%		8/22/05	8/23/05	RT
Lab ID:	**20050669-03**						
Client ID:	**K-970**						
Date Sampled:	**8/19/05 9:45:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.591 +/- 0.050	pCi/g	0.191		8/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	20.8	%		8/22/05	8/23/05	RT
Lab ID:	**20050669-04**						
Client ID:	**K-971**						
Date Sampled:	**8/19/05 9:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.563 +/- 0.077	pCi/g	0.227		8/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.2	%		8/22/05	8/23/05	RT

BDL = Below Detection Limit

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20050669
Date Reported: 8/26/05
Date Received: 8/22/05

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050669-05**						
Client ID:	**K-972**						
Date Sampled:	**8/19/05 9:55:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.574 +/- 0.062	pCi/g	0.194		8/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	29.3	%		8/22/05	8/23/05	RT
Lab ID:	**20050669-06**						
Client ID:	**K-973**						
Date Sampled:	**8/19/05 9:59:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.547 +/- 0.041	pCi/g	0.248		8/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.1	%		8/22/05	8/23/05	RT
Lab ID:	**20050669-07**						
Client ID:	**K-974**						
Date Sampled:	**8/19/05 10:05:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.509 +/- 0.034	pCi/g	0.216		8/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	20.3	%		8/22/05	8/23/05	RT
Lab ID:	**20050669-08**						
Client ID:	**K-975**						
Date Sampled:	**8/19/05 10:09:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.856 +/- 0.074	pCi/g	0.224		8/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	21.6	%		8/22/05	8/23/05	RT

BDL = Below Detection Limit

Outreach
Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:
Client Project: Thorium Remediation
Lab Number: 20050669
Date Reported: 8/26/05
Date Received: 8/22/05

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050669-09**						
Client ID:	**K-976**						
Date Sampled:	**8/19/05 10:15:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.10 +/- 0.087	pCi/g	0.238		8/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	24.5	%		8/22/05	8/23/05	RT
Lab ID:	**20050669-10**						
Client ID:	**K-977**						
Date Sampled:	**8/19/05 10:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.796 +/- 0.047	pCi/g	0.241		8/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	11.3	%		8/22/05	8/23/05	RT
Lab ID:	**20050669-11**						
Client ID:	**K-978**						
Date Sampled:	**8/19/05 10:25:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.784 +/- 0.097	pCi/g	0.327		8/23/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	22.2	%		8/22/05	8/23/05	RT

BDL = Below Detection Limit

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20050669
Date Reported: 8/26/05
Date Received: 8/22/05

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					NC				8/22/05
Ac228					NC				8/23/05
Am-241		93.0	93.0	0.0					8/22/05
Am-241		89.0	94.0	5.4					8/23/05
Co-60		93.0	94.0	0.3					8/22/05
Co-60		91.0	93.0	2.0					8/23/05
Cs-137		96.0	96.0	0.0					8/22/05
Cs-137		93.0	95.0	2.3					8/23/05
Percent Moisture					4.8				8/23/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Local: 918-384-0500

Company: Kaiser Alum & Chem Corp.
Name: DAVID B. WEYANT
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3570 Fax #: 918-384-3171

Bill To:
Company: KAISER/PEAK E&C
Name: PAUL HANDA / DAVID WEYA
Address: 7311 E. 41st St.
City: TULSA State: OK Zip: 7414

ANALYSIS REQUESTED

PO #: Kaiser-4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser-Thorium Remo Pod 1
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 5 DAY
SAMPLER: Signature
DAVID B. WEYANT

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2, 2. Ice <4°C, 3. HCl pH<2, 4. H_2SO_4 pH<2, 5. NaOH pH>11)	Gamma Spec (Th-232)	Radium-226 (Rn Emanation)	MDC 20.5 pCi/g	ASTM D3649 Gamma Spec	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-966	8-19-04	0925	Soil	1	50ml Plastic	None	X	X	X	X	Grab
	K-968	"	0930	"	1	"	"		X	X	X	
	K-970	"	0945	"	1	"	"		X	X	X	
	K-971	"	0950	"	1	"	"		X	X	X	
	K-972	"	0955	"	1	"	"		X	X	X	
	K-973	"	0959	"	1	"	"		X	X	X	
	K-974	"	10:05	"	1	"	"		X	X	X	
	K-975	"	10:09	"	1	"	"		X	X	X	
	K-976	"	10:15	"	1	"	"		X	X	X	
	K-977	"	10:20	"	1	"	"		X	X	X	
	K-978	"	10:25	"	1	"	"		X	X	X	
	"	"	"	"	"	"	"	"	"	"	"	
	"	"	"	"	"	"	"	"	"	"	"	
	"	"	"	"	"	"	"	"	"	"	"	

RELINQUISHED BY: DAVID B. WEYANT DATE 8-22-04 TIME 930 RECEIVED BY: Katrina Eidson DATE 8/22/04 TIME 930

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE R[illegible] DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others [illegible] returned at client's expense.

FOR LABORATORY USE ONLY: 20050866
Sample Condition Upon Receipt: Good
Custody Seal Intact:
Cooler Temperature:

SAMPLE LOGIN

Date Received: *8/22/05 10:18:56* Lab Number: 20050669 Due: 8/26/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050669-01 A	K-966	Soil	08/19/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050669-02 A	K-968	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050669-03 A	K-970	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050669-04 A	K-971	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050669-05 A	K-972	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050669-06 A	K-973	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050669-07 A	K-974	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050669-08 A	K-975	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050669-09 A	K-976	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050669-10 A	K-977	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes

Tr v Gamma Spec

20050669-11 A	K-978	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Percent Moisture (LOD)									
Th-232 by Gamma Spec									

CONTAINER INSPECTION

Coolers Both Custody Seals Broken - Y/N Temperature _____ Blue Ice / Wet Ice Radiation Survey 4300 fixed _____ removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies: _____

Inspected By: Michelle Sutton DATE 08/22/05

QA or Designee Review: Raymond Thomas DATE 08/22/05

Sample Custodian Review: Debbie Gregory DATE 8/22/05

Project Notes:

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Limit # 71606
DL. 12/15/05

December 14, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050995

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on December 09, 2005 for the above captioned project. Ten soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5-work day turn. Results were faxed early on 12/14/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH
CERT. ID #OK001

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050995
Date Reported:	12/14/05
Date Received:	12/9/
Page Number:	1 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050995-01**						
Client ID:	**K-506**						
Date Sampled:	**2/14/05 9:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.760 +/- 0.172	pCi/g	0.294		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	20.3	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-02**						
Client ID:	**K-552**						
Date Sampled:	**3/8/05 2:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.811 +/- 0.141	pCi/g	0.641		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	8.1	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-03**						
Client ID:	**K-619**						
Date Sampled:	**4/25/05 2:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.932 +/- 0.188	pCi/g	0.509		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	11.9	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-04**						
Client ID:	**K-774**						
Date Sampled:	**7/8/05 1:30:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.819 +/- 0.224	pCi/g	0.318		12/9/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	10.9	%		12/9/05	12/14/05	RT
Lab ID:	**20050995-05**						
Client ID:	**K-782**						
Date Sampled:	**7/8/05 2:10:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050995
Date Reported:	12/14/05
Date Received:	12/9/05
Page Number:	2 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	1.37 +/- 0.304	pCi/g	0.887		12/9/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	7.8	%		12/9/05	12/14/05	RT

Lab ID: 20050995-06
Client ID: K-786
Date Sampled: 7/8/05 2:30:00 PM
Matrix: Soil

Radiochemical Analyses							
Thorium 232	HASL 300	0.747 +/- 0.174	pCi/g	0.548		12/9/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	4.2	%		12/9/05	12/14/05	RT

Lab ID: 20050995-07
Client ID: K-787
Date Sampled: 7/8/05 2:35:00 PM
Matrix: Soil

Radiochemical Analyses							
Thorium 232	HASL 300	0.873 +/- 0.171	pCi/g	0.567		12/12/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	7.2	%		12/9/05	12/14/05	RT

Lab ID: 20050995-08
Client ID: K-789
Date Sampled: 7/8/05 2:45:00 PM
Matrix: Soil

Radiochemical Analyses							
Thorium 232	HASL 300	0.948 +/- 0.162	pCi/g	0.472		12/12/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	9.3	%		12/9/05	12/14/05	RT

Lab ID: 20050995-09
Client ID: K-965
Date Sampled: 8/19/05 9:35:00 AM
Matrix: Soil

Radiochemical Analyses							
Thorium 232	HASL 300	1.07 +/- 0.234	pCi/g	0.594		12/12/05	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	18.4	%		12/9/05	12/14/05	RT

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20050995
Date Reported: 12/14/05
Date Received: 12/9/
Page Number: 3 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20050995-10						
Client ID:	K-969						
Date Sampled:	8/19/05 9:40:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.286 +/- 0.051	pCi/g	0.133		12/12/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.6	%		12/9/05	12/14/05	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac-228					NC				12/9/05
Am-241		94.0	94.0	0.0					12/9/05
Co-60		93.0	95.0	2.2					12/9/05
Cs-137		94.0	94.0	0.7					12/9/05
Percent Moisture					1.1				12/14/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN CUSTODY

Results To:
Company KAISER Alum & Chem Jtv.
Local: Name DAVID R. WEYAND
918-384- Address 7311 E. 41st St.
0x66 City TULSA State OK Zip 74145
Cell: 724-799-0071 Phone 724-934-3530 Fax # 918-384-7171

Bill To:
Company KAISER/Paul EAR
Name DAVID R WEYAND / PAUL HANDA
Address 7311 E. 41st St.
City TULSA State OK Zip 74145

ANALYSIS REQUESTED

PO # KAISER-4572
PROJECT # PA-4000-4572
PROJECT NAME KAISER - Alumg chem EEM.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 5 DAY
SAMPLER: Signature
DAVID R WEYAND

LAB #	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GAMMA SPEC (Th-232)	RADON + progeny	ASC <0.5 pCi/g	AS+Pb+Ra226+Ra228	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-506	7-14-05	5:11	9:50	1	Plastic	Acid					Grab
	K-552	7-8-05		14:00	1							
	K-619	7-7-05		14:40	1							
	K-774	7-8-05		13:30	1							
	K-782	7-8-05		14:10	1							
	K-786	7-8-05		14:30	1							
	K-787	7-8-05		14:35	1							
	K-789	~~7-8-05~~ 7-7-05		14:45	1							
	K-962	7-19-05		9:35	1							
	K-963	7-19-05		9:45	1							

RELINQUISHED BY: DAVID R WEYAND DATE 7/19/05 TIME 8:00 RECEIVED BY: DATE 7/19/05 TIME

RELINQUISHED BY: DATE TIME RECEIVED BY: DATE TIME

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

For Laboratory Use Only: Received on Ice: Y / N
Sample Condition Upon Receipt: Good
Custody Seals Intact: (Y) N
Cooler Temperature: 4°C

SAMPLE LOG

Date Received: *12/9/05 8:44:38 A* Lab Number: 20050995 Due: 12/16/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050995-01 A	K-506	Soil	02/14/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-02 A	K-552	Soil	03/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-03 A	K-619	Soil	04/25/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-04 A	K-774	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-05 A	K-782	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-06 A	K-786	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-07 A	K-787	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-08 A	K-789	Soil	07/08/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-09 A	K-965	Soil	08/19/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050995-10	K-969	Soil	08/19/05		16 oz	None	Yes	Yes

Gamma [illegible]horium 232
Percent Moisture (LOD)

CONTAINER INSPECTION

 # Coolers 1 **Custody Seals Broken** ☐ **Temperature** **Ice** **Radiation Survey:** <300 cpm

SAMPLE INSPECTION

Sample Seal Broken NA **Chain of Custody Record** ☑ **Labels in Tact** ☑ **Radiation Survey Complete** ☑

Anomalies

Inspected By: Michelle Boatright **DATE** 12/09/05

QA or Designee Review: Samuel Thomas **DATE** 12/09/05

Sample Custodian Review: D Gregory **DATE** 12/9/05

Project Notes:

SUB-REPORT

SURVEY UNIT KAISER-FSS-020

TABLE OF CONTENTS

ATTACHMENTS

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-020
Survey Unit Kaiser-FSS-020
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-020, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the former Flux Building area. Survey Unit Kaiser-FSS-020 is considered a Class 1 survey unit with an approximate surface area of 1,570 m^2. It is bounded to the south by the Union Pacific Railroad right-of-way, to the east by the Specific Systems property, to the north by Survey Unit Kaiser-FSS-016, and to the west by Survey Unit Kaiser-FSS-029 (**Figure 3**).

Survey Unit Kaiser-FSS-020 consists of an excavation bottom surface soil with one side wall (east wall). The excavation continued beyond (east) the Kaiser property line, beneath the Specific Systems concrete roadway. One elevated area (greater than net 3.0 pCi/g Th-232) was left in-place beneath the concrete roadway due to structural integrity/safety concerns. The elevated area was evaluated using the elevated measurement comparison (EMC) as presented in the DP for the project. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the following physical features or elements of Survey Unit Kaiser-FSS-020:

- Excavation bottom surface soil including the east wall surface soil.
- Elevated soil area located along the east wall of the survey unit.

2.1 Excavation Bottom/Side Wall Surface Soil

The final status survey of the excavation bottom and side wall surface soil consisted of a gross gamma scan of the exposed surface soil and systematic soil sampling.

2.1.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom and side wall) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 9 approximately equal-distant locations within the survey unit. The statistics for the 9 background measurements are provided below in **Table 1.** Background measurements ranged from 11,450 counts per minute (cpm) along the southwestern survey unit boundary to 14,670 cpm along the northern survey unit boundary. The elevated background measurements identified along the northern boundary were the result of shine from radiologically-affected material (BCM) located immediately north of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 4,321 measurements of gross count rate were made at two second intervals across the survey unit's 1,570 m^2 surface area. The results ranged from 9,082 cpm to 29,000 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	1,570 m^2	
Number of Scan Measurements (2-Second Intervals)	4,321	
Scan Rate: (Swinging the detector a width of 1-meter side to side)	0.18 m/s (MARSSIM recommends 0.5m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	11,450	9,082
Maximum	14,670	29,000
Average	12,843	14,515
Standard Deviation	931	2,073
Median	12,986	14,111

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity on the excavation bottom (above the $DCGL_W$ for the site). As part of the gross gamma survey, 12 biased soil samples were collected at locations exhibiting the highest scan rates on the excavation bottom and eastern side wall **(Figure A-2, Attachment A).** The biased soil samples were screened onsite in a lead cave. Results of the sample screening are presented below in **Table 2.** The sample screening levels were below the $DCGL_W$ for the site.

Table 2 – Biased Soil Sample Screening Results

Soil Sample ID	Cave Counter Screening Results (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)
$DCGL_W$	*3.0*		
Site Background	*1.1*	*0.3*	
K-1058	2.78	0.855	1.56
K-1059	1.88	0.898	1.56
K-1163	0.826	1.06	1.53
K-1164	0.037	1.15	1.53
K-1203	1.87	1.20	1.56
K-1204	1.66	1.21	1.56
K-1205	0.320	1.06	1.55
K-1206	1.13	1.16	1.54
K-1207	0.256	1.15	1.54
K-1208	0.826	0.782	1.54
K-1209	1.13	1.00	1.54
K-1210	1.71	1.04	1.54

One area of elevated activity was identified along the excavation's east wall. This elevated area is discussed in **Section 2.2.**

2.1.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 **(Attachment B).** Once N was determined, the Survey Unit Area (A) of 1,570 m^2 was used to calculate the Triangular Grid Node Length (L) of 14.2 meters and the Height of the Equilateral Triangle (h) of 12.3 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 **(Attachment B).**

A layout of the soil sampling locations is provided on **Figure A-3** contained in **Attachment A.** The soil sample locations were demarcated in the field using a GPS unit. A total of 9 soil samples (identified as K-1165 through K-1173) were collected at the excavation bottom/side wall surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity

concentration. Analytical results are provided below in **Table 3**. Analytical data reports are contained in **Attachment C.**

Table 3 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-1165	0.774	0.089	0.217	0	3.0
K-1166	0.622	0.167	0.237	0	3.0
K-1167	1.12	0.208	0.250	0.02	3.0
K-1168	0.680	0.131	0.176	0	3.0
K-1169	0.941	0.178	0.286	0	3.0
K-1170	0.943	0.190	0.204	0	3.0
K-1171	0.606	0.098	0.214	0	3.0
K-1172	0.475	0.138	0.265	0	3.0
K-1173	0.838	0.156	0.237	0	3.0
Average	***0.778***				
Standard Dev.	***0.203***				
Minimum	***0.475***				
Maximum	***1.12***				
Median	***0.774***				

All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.12 pCi/g. The average gross Th-232 activity concentration was 0.778 pCi/g. The standard deviation of the 9 equal-distant samples was 0.203, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.1.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the criterion based on the first statistical test as described below.

If the difference (0.31 pCi/g) between the maximum survey unit soil sample activity concentration (1.12 pCi/g) and the minimum reference background area soil sample activity concentration (0.81 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	338	1.04	S1	K-1165	0.774
R2	224	1.59	S2	K-1166	0.622
R3	182	1.16	S3	K-1167	1.12
R4	209	0.90	S4	K-1168	0.680
R5	205	1.05	S5	K-1169	0.941
R6	233	1.20	S6	K-1170	0.943
R7	183	0.81	S7	K-1171	0.606
R8	27	1.24	S8	K-1172	0.475
R9	323	0.87	S9	K-1173	0.838
	Average	***1.10***		***Average***	***0.778***
	Standard Dev.	***0.24***		***Standard Dev.***	***0.203***
	Minimum	***0.81***		***Minimum***	***0.475***
	Maximum	***1.59***		***Maximum***	***1.12***
	Median	***1.05***		***Median***	***0.774***

2.2 Elevated Area

During the remediation of Survey Unit Kaiser-FSS-020, one area adjacent to the Specific Systems property was encountered where the additional excavation of impacted material was not possible due to structural integrity/safety issues. This area was evaluated using the EMC criteria. The elevated area was located just east of the former Flux Building footer bordering the Specific Systems property. The total area of the elevated area was conservatively estimated as 2 m^2. The following 7 soil samples were used to define the area:

- Sample K-1050 – A biased soil sample taken at the highest gross gamma scan measurement location (29,008 cpm on contact) within the elevated area. The sample was analyzed by Outreach and represents a conservative estimation of the Th-232 activity concentration within the 2 m^2 elevated area (EMC-1).
- Sample K-1051 – A composite soil sample taken right of EMC-1 to bound the elevated area (19,000 cpm on contact).
- Sample K-1052 – A biased soil sample taken below EMC-1 to bound the elevated area (20,354 cpm on contact).
- Sample K-1053 – A biased soil sample taken left of EMC-1 to bound the elevated area (19,878 cpm on contact).
- Sample K-1054 – A biased soil sample taken above EMC-1 to bound the elevated area (24,026 cpm on contact).
- Sample K-1055 – A biased soil sample taken below Sample K-1052 (19,246 cpm on contact).
- Sample K-1056 – A biased sample taken left of Sample K-1053 (15,420 cpm on contact).

Figure D-1, Attachment D shows the soil sampling locations for this elevated area. The analytical results for the EMC-1 soil samples are presented below in **Table 5.**

Table 5 – EMC-1 Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-1050	5.90	0.439	0.460	4.80	26.4
K-1051	1.26	0.138	0.254	0.16	3.0
K-1052	1.85	0.122	0.217	0.75	3.0
K-1053	1.05	0.146	0.257	0	3.0
K-1054	1.80	0.271	0.315	0.70	3.0
K-1055	0.662	0.184	0.332	0	3.0
K-1056	0.796	0.196	0.386	0	3.0

A conservative assessment of the elevated area was performed by assuming the area extends to 2 m^2 and that the result for Soil Sample K-1050 represents the activity concentration of the entire 2 m^2 elevated area.

The elevated area (EMC-1) exhibited Th-232 activity concentration below the applicable $DCGL_{EMC}$ of 26.4 pCi/g (Th-232) for a 2 m^2 area. An elevated measurement comparison (sum of fractions) was completed for Survey Unit Kaiser-FSS-020 with a resulting Sum of Fractions of 0.19 compared to the Acceptance Criteria of 1.0. The elevated measurement comparison is presented in the **Section 3.2** of this report and the Elevated Measurement Worksheet is contained in **Attachment D.**

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the area of the Flux Building resulted in an open land area consisting of an excavation approximately 1,570 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-020 is considered a Class 1 survey unit. The survey unit is bounded to the south by the Union Pacific Railroad right-of-way, to the east by the Specific Systems property, to the north by Survey Unit Kaiser-FSS-016, and to the west by Survey Unit Kaiser-FSS-029 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings, an elevated measurement comparison, and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom/Side Wall Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the DCGLw of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-020 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom and eastern side wall) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) indicated the presence of an elevated area on the east wall which was left in-place due to structural integrity/safety issues associated with a neighboring property concrete drive. An elevated measurement comparison was required for this area (presented in **Section 3.2**).
- All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).

3.2 Elevated Measurement Comparison

Consistent with the MARSSIM and the DP, elevated areas and the total dose from soil are evaluated as follows. Analytical results of soil samples are used to complete the elevated measurement comparison. If residual radioactivity is found in a localized area of elevated activity--in addition to the residual radioactivity distributed relatively uniformly across the survey unit--the Unity Rule is used to ensure that the release criterion has been met as follows:

$$\frac{\delta}{DCGL} + \sum_{x+1}^{n} \frac{(\delta_{EMC} - \delta)}{DCGL_{EMC}} \leq 1$$

where:

δ = is the average concentration of Th-232 over the entire survey unit,
δ_{EMC} = the average concentration of Th-232 over the elevated area (x) within the survey unit,
DCGL = the $DCGL_w$ for Th-232,
$DCGL_{EMC}$ = (area factor for elevated area x) X ($DCGL_W$),

x = refers to one of the elevated areas within the survey unit, and
n = the total number of elevated areas within the survey unit.

The calculation for Survey Unit Kaiser-FSS-020 is summarized below in the **Table 6.**

Table 6 - Elevated Measurement Comparison and Fraction Summary

Sample Date	Unit / EMC unit	Unit Area (m^2)	Gross Th-232 (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)	Fraction (-)	Sample Number
10/3/2005	FSS-020	1,570	0.778	0.0	3.0	0.0	K-1165 through K-1173
9/28/2005	EMC-1	2	5.90	5.12	26.4	0.19	K-1050

3.3 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-020 prior to backfill with clean import borrow material, as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 7.** As previously mentioned, no embedded structures were encountered within the survey unit.

Table 7 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

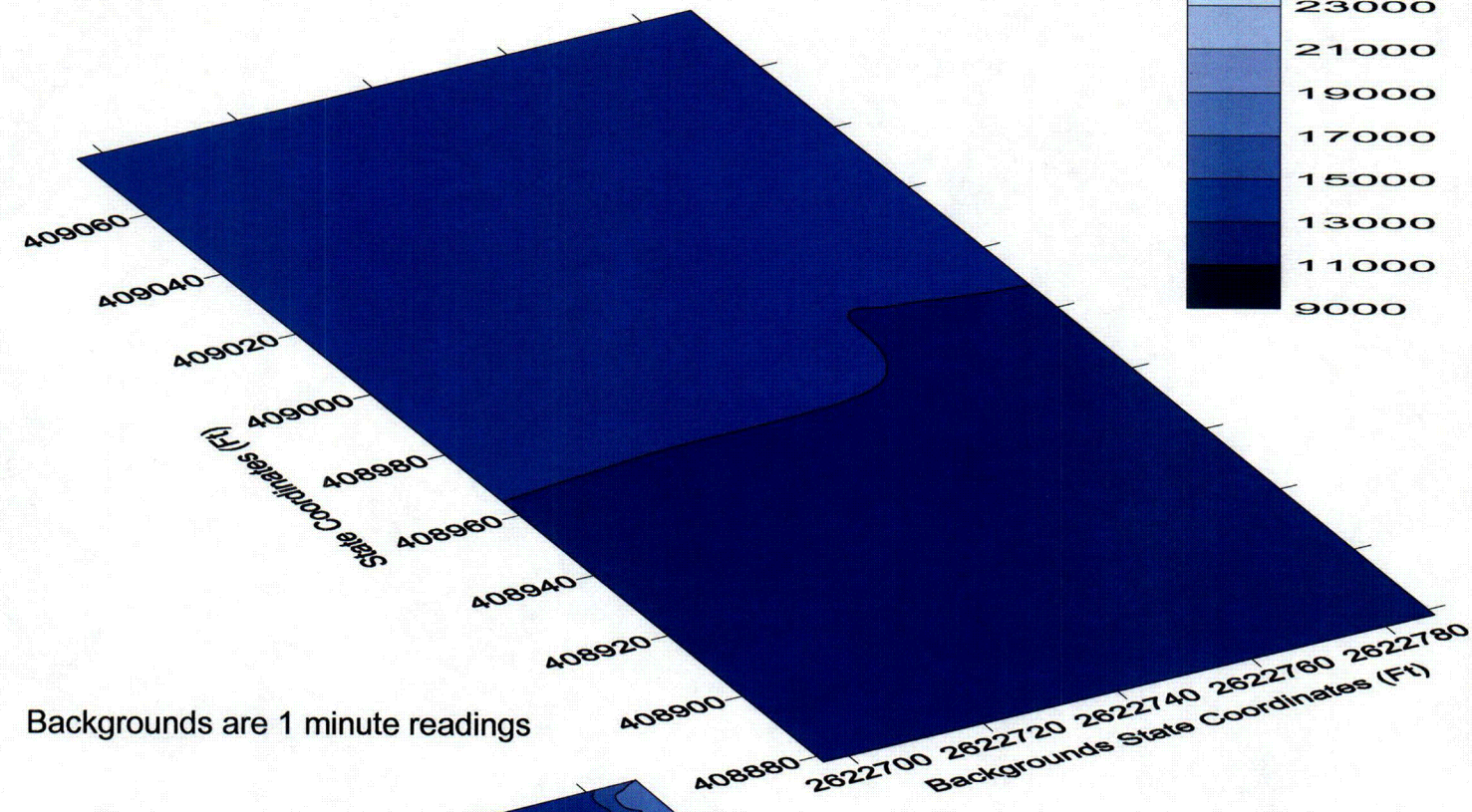
Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-020 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Area EMC-1 (Soil)	pCi/g	5.12	26.4	0.19
-Embedded Structures (None Encountered)	dpm/100cm^2	0		0.00
TOTAL SUM OF FRACTIONS				***0.19***

The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-020 meets the DP acceptance criteria.

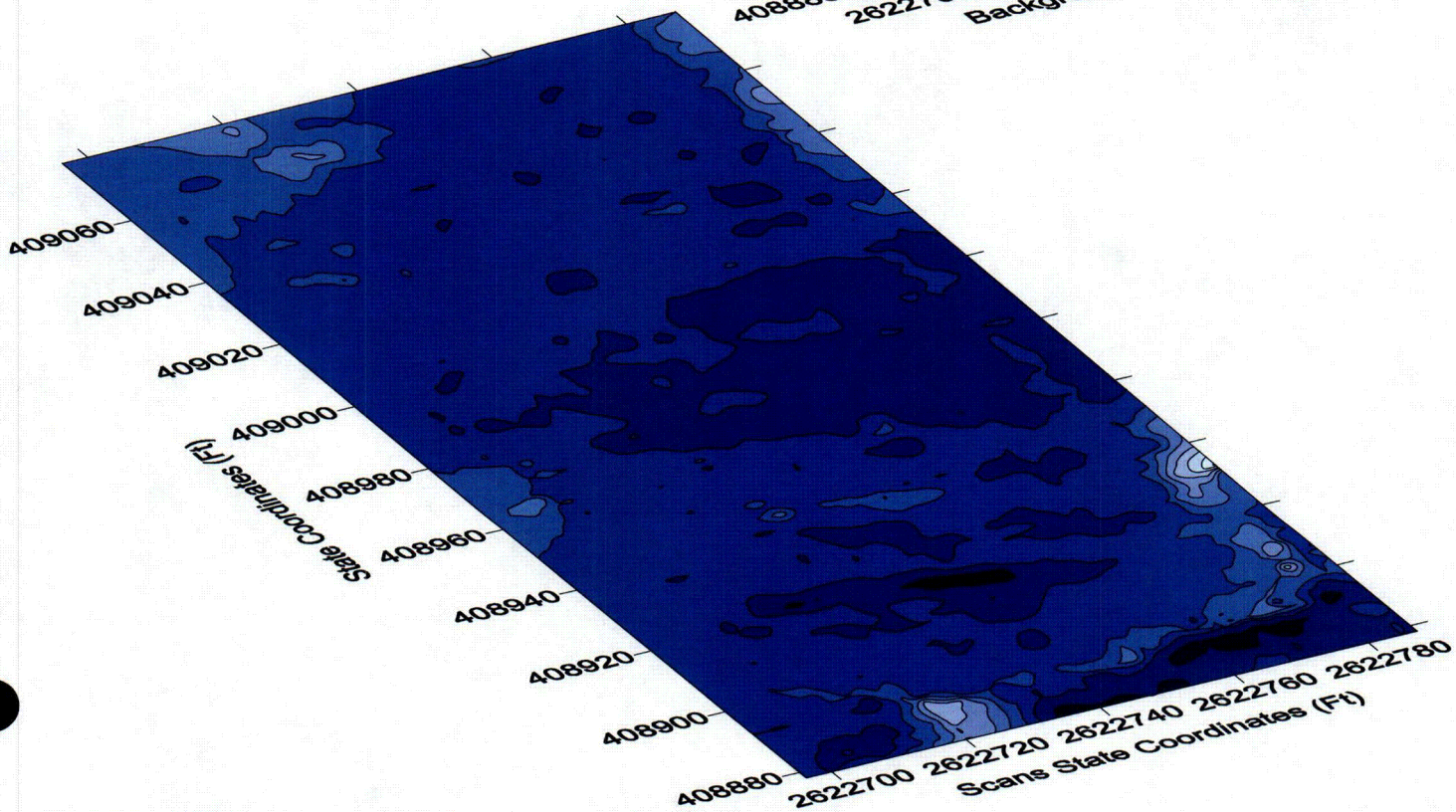
Q:\P4000\PA4072\FSS Reports\Survey Unit Kaiser-FSS-020\Text\FSS Technical Report IFSSR 020R.doc

ATTACHMENT A
TABLE OF CONTENTS

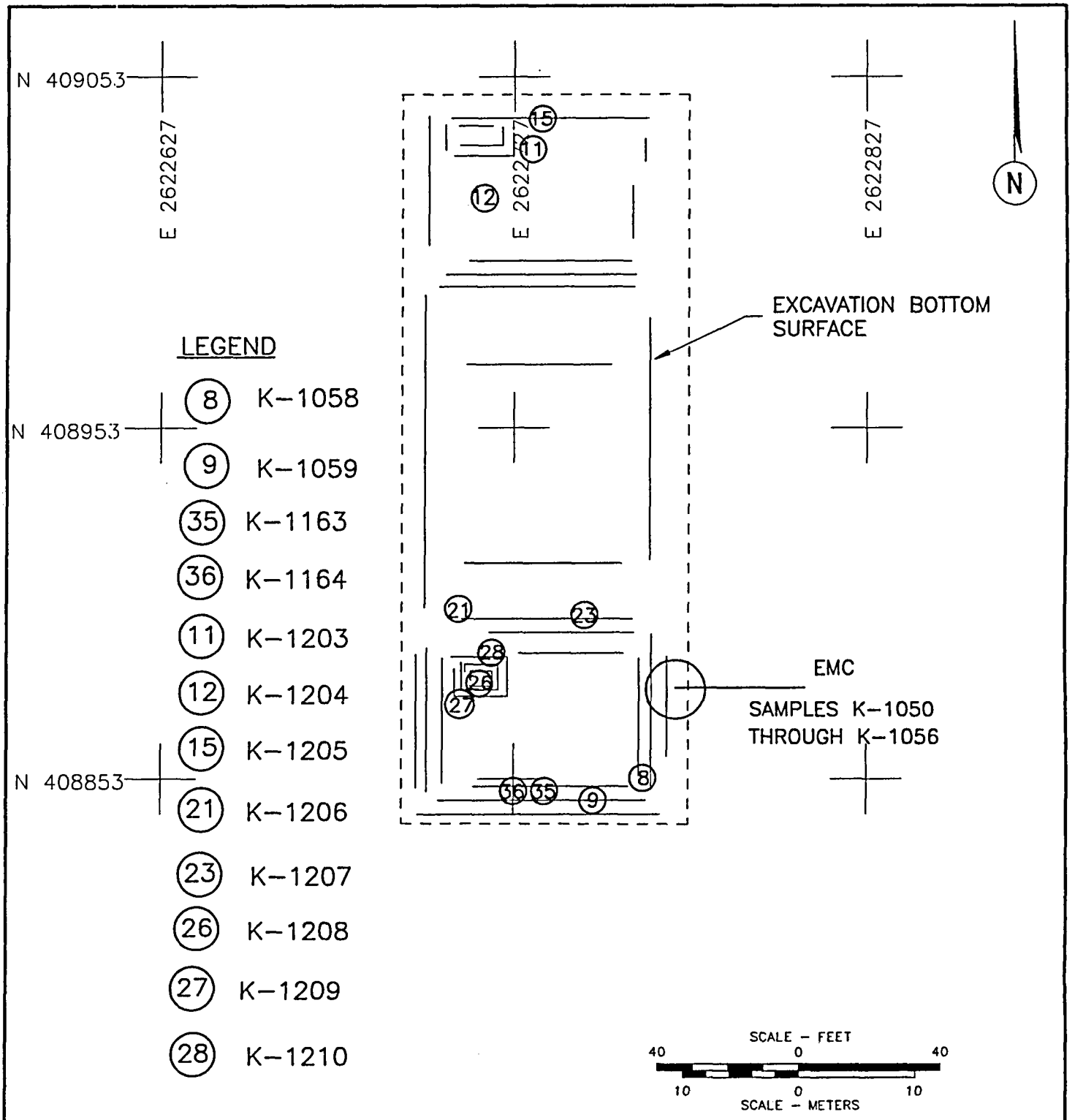
Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-020



Backgrounds are 1 minute readings



Scanning readings are recorded at 2-second intervals



(8) K-1058

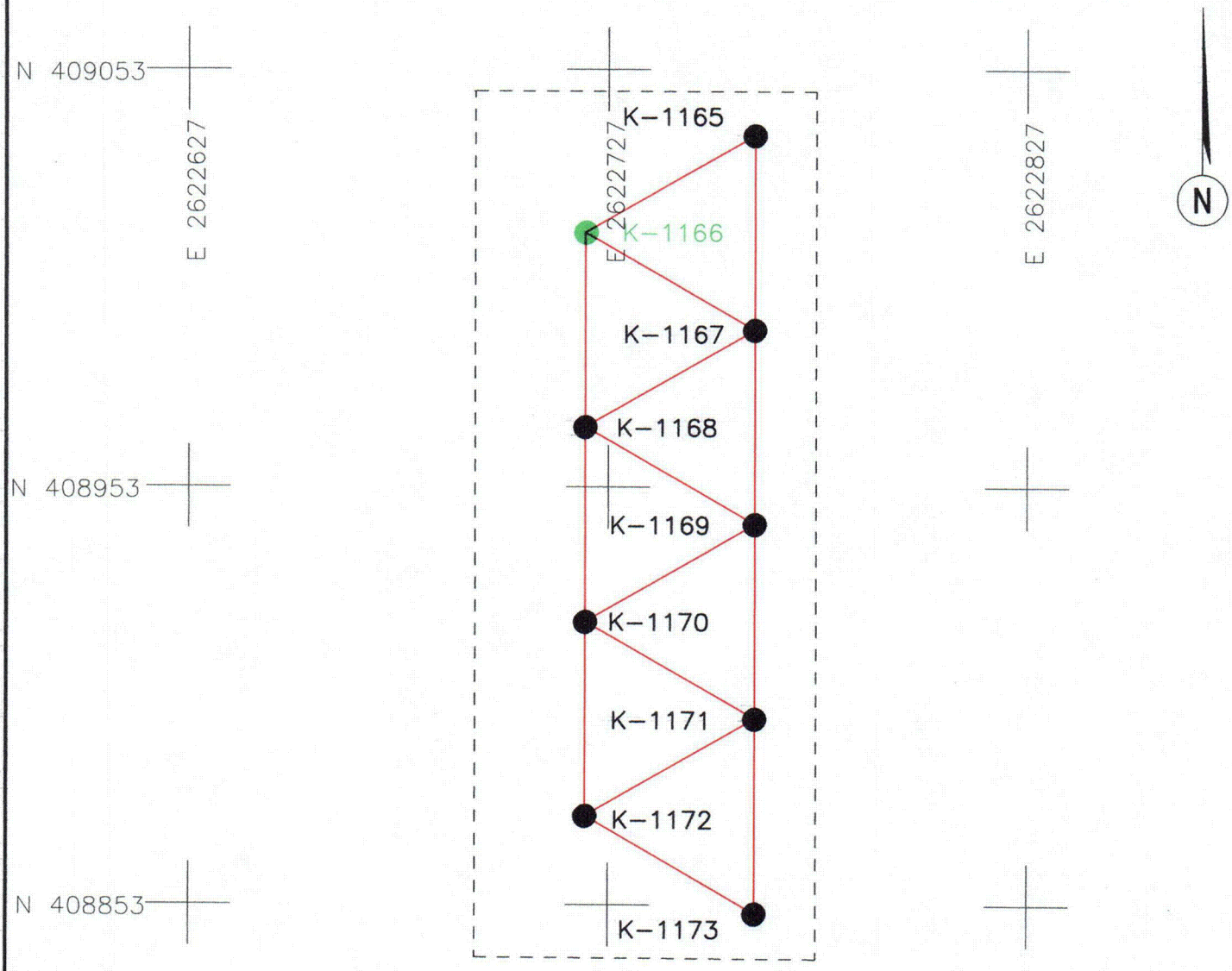
BIASED SOIL SAMPLING LOCATION BASED ON RESULTS OF THE GROSS GAMMA SCAN

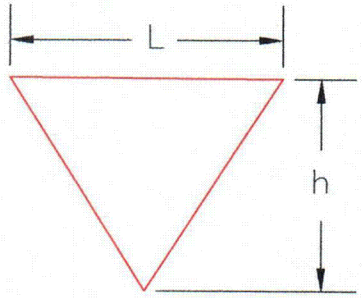
FIGURE A-2
GROSS GAMMA SURVEY BIASED SOIL SAMPLE LOCATIONS
SURVEY UNIT KAISER - FSS-020
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RD 3-3-06
CHECKED	RD 3-3-06
DRAWN	DEB 9/29/05
DRAWING NUMBER	PA4072029A

Penn E&R
Environmental & Remediation, Inc.





N = 9 (COLLECTED 10)
L = 14.2m
h = 12.3m
AREA = 1,570m^2

SCALE – FEET
40 0 40
10 0 10
SCALE – METERS

K-1165
● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K-1166
● RANDOM START POINT

FIGURE A-3
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS-020
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RD 3-3-06
CHECKED	RD 3-3-06
DRAWN	DEB 9/29/05
DRAWING NUMBER	PA4072029

Penn E&R
Environmental & Remediation, Inc.

ATTACHMENT B
TABLE OF CONTENTS

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-020

2. Description: Flux Building Area, South of Survey Unit Kaiser-FSS-016

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – approximately 24.5 meters x 64 meters; Area, A (m^2): 1,570

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 14.2

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 12.3 m.

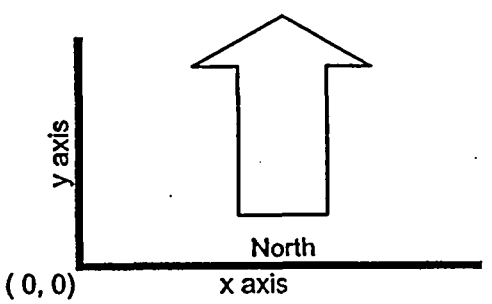
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum Chemical Corporation

SURVEY UNIT: KAISER-FSS-020

RANDOM START POINT

x axis (Meters)	y axis (Meters)
8	56

	x axis	y axis
lower bound	0	0
upper bound	24.5	64



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Lucie # 11438
DL- 10/17/05

October 17, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050788

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on October 4, 2005 for the above captioned project. Nine soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5-work day turn.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach
Laboratory
3... North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050788
Date Reported:	10/17/05
Date Received:	10/4/05
Page Number:	1 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20050788-01						
Client ID:	K-1165						
Date Sampled:	10/3/05 10:40:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.774 +/- 0.089	pCi/g	0.217		10/15/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	20.0	%		10/6/05	10/7/05	RT
Lab ID:	20050788-02						
Client ID:	K-1166						
Date Sampled:	10/3/05 10:45:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.622 +/- 0.167	pCi/g	0.237		10/15/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	19.6	%		10/6/05	10/7/05	RT
Lab ID:	20050788-03						
Client ID:	K-1167						
Date Sampled:	10/3/05 10:50:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	1.12 +/- 0.208	pCi/g	0.250		10/15/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	19.0	%		10/6/05	10/7/05	RT
Lab ID:	20050788-04						
Client ID:	K-1168						
Date Sampled:	10/3/05 10:55:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.680 +/- 0.131	pCi/g	0.176		10/15/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.6	%		10/6/05	10/7/05	RT

BDL = Below Detection Limit

Outreach
boratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20050788
Date Reported: 10/17/05
Date Received: 10/4/05

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050788-05**						
Client ID:	**K-1169**						
Date Sampled:	**10/3/05 11:00:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.941 +/- 0.178	pCi/g	0.286		10/15/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	12.6	%		10/6/05	10/7/05	RT
Lab ID:	**20050788-06**						
Client ID:	**K-1170**						
Date Sampled:	**10/3/05 11:05:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.943 +/- 0.190	pCi/g	0.204		10/15/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.0	%		10/6/05	10/7/05	RT
Lab ID:	**20050788-07**						
Client ID:	**K-1171**						
Date Sampled:	**10/3/05 11:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.606 +/- 0.098	pCi/g	0.214		10/15/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	17.3	%		10/6/05	10/7/05	RT
Lab ID:	**20050788-08**						
Client ID:	**K-1172**						
Date Sampled:	**10/3/05 11:15:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.475 +/- 0.138	pCi/g	0.265		10/15/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	21.9	%		10/6/05	10/7/05	RT

BDL = Below Detection Limit

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050788
Date Reported:	10/17/05
Date Received:	10/4/05
Page Number:	3 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050788-09**						
Client ID:	**K-1173**						
Date Sampled:	**10/3/05 11:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.838 +/- 0.156	pCi/g	0.237		10/15/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	23.3	%		10/6/05	10/7/05	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					NC				10/15/05
Am-241		98.0	94.0	3.4					10/15/05
Co-60		91.0	96.0	5.1					10/15/05
Cs-137		83.0	98.0	17.4					10/15/05
Percent Moisture					2.9				10/7/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN CUSTODY

Results To:
LOCAL 918-384-0566
CELL 774-749-0071

Company KAISER ALUM & CHEM INC.
Name DAVID B. WEYANT
Address 7311 EAST 41ST ST.
City TULSA State OK Zip 74145
Phone 918-384-3535 Fax # 918-384-3171

Bill To:
Company KAISER/PENN E&R
Name DAVID B. WEYANT/PAUL HAND
Address 7311 EAST 41ST ST.
City TULSA State OK Zip 74145

ANALYSIS REQUESTED

PO # KAISER-4072
PROJECT # PA-4000-4072
PROJECT NAME KAISER THORIUM REMED.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 5 DAY
SAMPLER _____ Signature

OUTREACH SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GAMMA SPEC (TH-232)	RETURN TO CLIENT FOR ARCHIVE	MDC<0.5 pCi/gm	ASTM 2216-92 MOIST CONTENT				REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1165	10-3-05	1040	SOIL	1	500ML PLASTIC	NONE								GRAB
	K-1166		1045		1										
	K-1167		1050		1										
	K-1168		1055		1										
	K-1169		1100		1										
	K-1170		1105		1										
	K-1171		1110		1										
	K-1172		1115		1										
	K-1173		1120		1										

RELINQUISHED BY: DAVID B. WEYANT DATE 10-4-05 TIME 825 RECEIVED BY: Ron Sidson DATE 10/4/5 TIME 825

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY

SAMPLE LOGIN

Date Received: *10/4/05 9:31:43 A* **Lab Number:** 20050788 **Due:** 10/11/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050788-01 A	K-1165	Soil	10/03/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050788-02 A	K-1166	Soil	10/03/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050788-03 A	K-1167	Soil	10/03/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050788-04 A	K-1168	Soil	10/03/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050788-05 A	K-1169	Soil	10/03/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050788-06 A	K-1170	Soil	10/03/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050788-07 A	K-1171	Soil	10/03/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050788-08 A	K-1172	Soil	10/03/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050788-09 A	K-1173	Soil	10/03/05	Plastic	16 oz	None	No	No

:nt Moisture (LOD)
Th-232 by Gamma Spec

CONTAINER INSPECTION

Coolers BOX Custody Seals Broken - Y/N/~~NA~~ N/A Temperature N/A Blue Ice / Wet Ice Radiation Survey 1300 fixed _____ removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N/~~NA~~ N/A Chain of Custody Record (Y)/N Labels in Tact (Y)/N Radiation Survey Complete (Y)/N

Anomalies: _____

Inspected By: Michelle Sutton DATE 10.04.05

QA or Designee Review: _____ DATE _____

Sample Custodian Review: Debra Gregory DATE 10-4-05

Project Notes:

Outreach
Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

October 7, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050776

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on September 30, 2005 for the above captioned project. Seven soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with a standard 20-work day turn. Results were faxed early on 10/10/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050776
Date Reported:	10/7/05
Date Received:	9/30/05
Page Number:	1 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050776-01**						
Client ID:	**K-1050**						
Date Sampled:	**9/26/05 3:10:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	5.90 +/- 0.439	pCi/g	0.460		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	28.5	%		9/30/05	10/3/05	RT
Lab ID:	**20050776-02**						
Client ID:	**K-1051**						
Date Sampled:	**9/26/05 3:15:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.26 +/- 0.138	pCi/g	0.254		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	18.0	%		9/30/05	10/3/05	RT
Lab ID:	**20050776-03**						
Client ID:	**K-1052**						
Date Sampled:	**9/26/05 3:20:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.85 +/- 0.122	pCi/g	0.217		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	21.2	%		9/30/05	10/3/05	RT
Lab ID:	**20050776-04**						
Client ID:	**K-1053**						
Date Sampled:	**9/26/05 3:25:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.05 +/- 0.146	pCi/g	0.257		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	19.9	%		9/30/05	10/3/05	RT

BDL = Below Detection Limit

Outreach
Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050776
Date Reported:	10/7/05
Date Received:	9/30/05
Page Number:	2 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050776-05**						
Client ID:	**K-1054**						
Date Sampled:	**9/26/05 3:30:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.80 +/- 0.271	pCi/g	0.315		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	19.3	%		9/30/05	10/3/05	RT
Lab ID:	**20050776-06**						
Client ID:	***K-1055***						
Date Sampled:	**9/26/05 3:35:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
2	HASL 300	0.662 +/- 0.184	pCi/g	0.332		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	24.9	%		9/30/05	10/3/05	RT
Lab ID:	**20050776-07**						
Client ID:	**K-1056**						
Date Sampled:	**9/26/05 3:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.796 +/- 0.196	pCi/g	0.386		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	18.7	%		9/30/05	10/3/05	RT

BDL = Below Detection Limit

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050776
Date Reported:	10/7/05
Date Received:	9/30/05
Page Number:	3 of 3

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Am-241		112.0	101.0	10.1					10/6/05
Co-60		100.0	94.0	6.5					10/6/05
Cs-137		99.0	95.0	4.5					10/6/05
Percent Moisture					0.1				10/3/05

Lab Approval: 

BDL = Below Detection Limit

020

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
LOCAL: 918-364-0566
CELL: 724-799-0071
Company KAISER Alum & Chem Corp.
Name DAVID R. WEYANT
Address 7311 E. 41ST ST.
City TULSA State OK Zip 74145
Phone 724-94-3530 Fax # 918-364-3171

Bill To:
Company KAISER / PENN ENG
Name PAM HARPER / DAVID WEYANT
Address 7311 E. 41ST ST.
City TULSA State OK Zip 74145

PO # KAISER-4072
PROJECT # PA-4000-4072
PROJECT NAME KAISER. Horizon REMED.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 20 DAYS.
SAMPLER Signature DAVID R. WEYANT

ANALYSIS REQUESTED

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GAMMA SPEC (Th-232)	RADIUM to CLIENT for Archive	NDC 2.0.5. DC/QC	ASTM D1216-93 moist content	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1050	9-28-06	15:10	Soil	1	Plastic	None	X	X	X	X	Radium-Grab
	K-1051		15:15		1			X	X	X	X	Comp
	K-1052		15:20		1			X	X	X	X	Radium-Grab
	K-1053		15:25		1			X	X	X	X	
	K-1054		15:30		1			X	X	X	X	
	K-1055		15:35		1			X	X	X	X	
	K-1056		15:40		1			X	X	X	X	

RELINQUISHED BY: DAVID R. WEYANT DATE 9-29-06 TIME 7:45 RECEIVED BY: Ron Tipton DATE 9/30/06 TIME 7:41

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY

SAMPLE LOGIN

Date Received: *9/30/05 9:28:13 A* **Lab Number:** 20050776 **Due:** 10/28/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050776-01 A	K-1050	Soil	09/26/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050776-02 A	K-1051	Soil	09/26/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050776-03 A	K-1052	Soil	09/26/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050776-04 A	K-1053	Soil	09/26/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050776-05 A	K-1054	Soil	09/26/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050776-06 A	K-1055	Soil	09/26/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050776-07 A	K-1056	Soil	09/26/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								

CONTAINER INSPECTION

Coolers PICKUP BOX Custody Seals Broken - Y/N N/A Temperature N/A Blue Ice / Wet Ice Radiation Survey _____fixed_____removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N N/A Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies:_____

_____

_____

Inspected By: _____ DATE_____

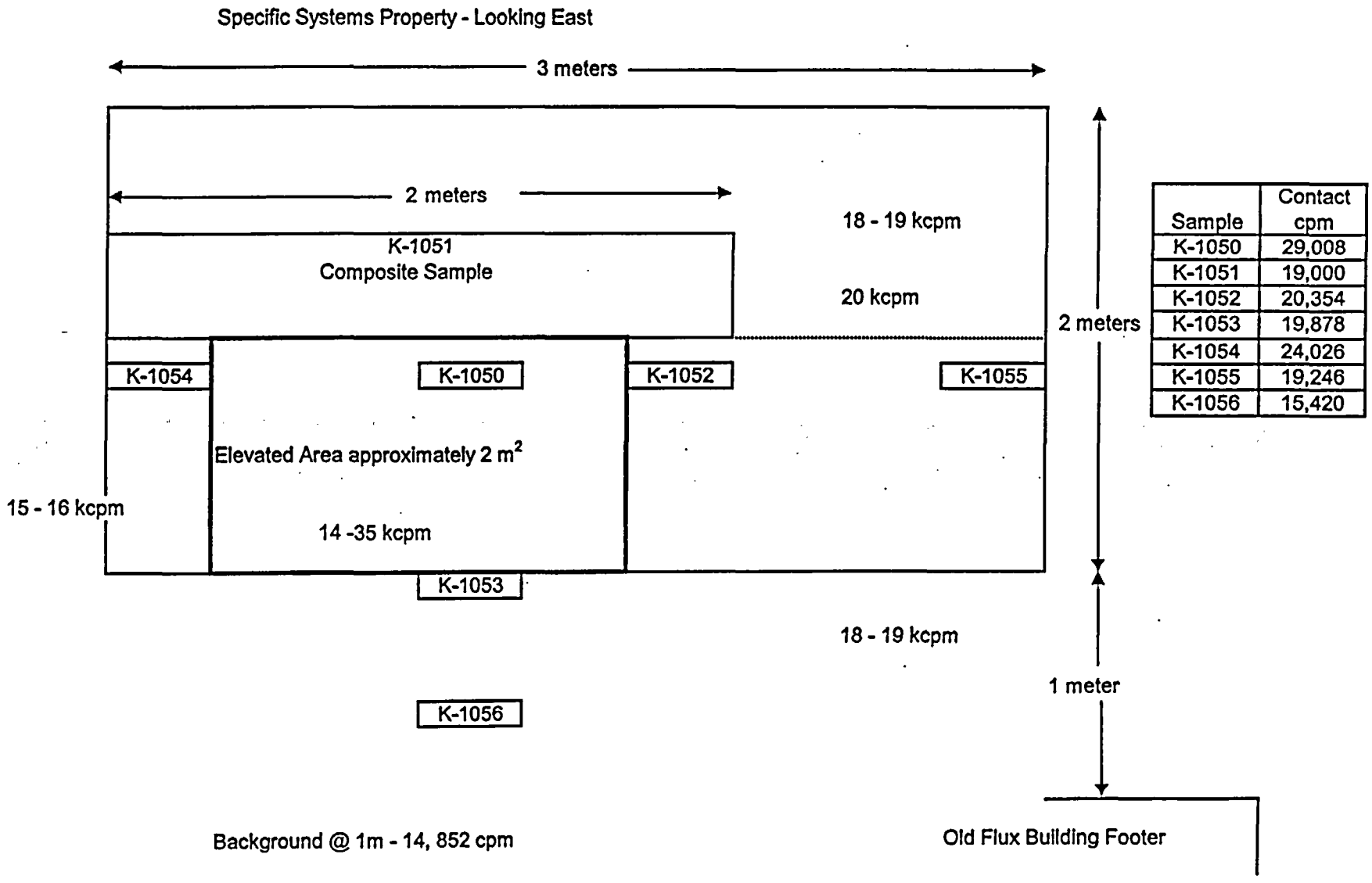
QA or Designee Review: Raymond L. Thomas DATE 09/30/05

Sample Custodian Review: Renee Gregoire DATE 9-30-05

Project Notes:

ATTACHMENT D
TABLE OF CONTENTS

Attachment D, Figure D-1
Sample Locations - Elevated Area
Survey Unit Kaiser-FSS-020
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum and Chemical Company



Sample	Contact cpm
K-1050	29,008
K-1051	19,000
K-1052	20,354
K-1053	19,878
K-1054	24,026
K-1055	19,246
K-1056	15,420

Attachment D
Elevated Measurement Comparison Worksheet
Survey Unit Kaiser-FSS-020
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum and Chemical Corporation

$DCGL_{EMC}$ = Area Factor * $DCGL_W$

Area Factors									
Radio-nuclide	1 m2 (11 ft2)	3 m2 (32 ft2)	10 m2 (108 ft2)	30 m2 (323 ft2)	100 m2 (1,076 ft2)	300 m2 (3,229 ft2)	1,000 m2 (10,764 ft2)	3,000 m2 (32,292 ft2)	10,000 m2 (107,639 ft2)
Th-232	12.5	6.2	3.2	2.3	1.8	1.5	1.1	1	1

$DCGL_{EMC}$ (pCi/g)									
Radio-nuclide	1 m2 (11 ft2)	3 m2 (32 ft2)	10 m2 (108 ft2)	30 m2 (323 ft2)	100 m2 (1,076 ft2)	300 m2 (3,229 ft2)	1,000 m2 (10,764 ft2)	3,000 m2 (32,292 ft2)	10,000 m2 (107,639 ft2)
Th-232	37.5	18.6	9.6	6.9	5.4	4.5	3.3	3	3

$$\frac{\delta}{DCGL} + \sum_{x+1}^{n} \frac{(\delta_{EMC} - \delta)}{DCGL_{EMC}} \leq 1$$

where:

δ = is the average concentration of Th-232 over the entire survey unit,

δ_{EMC} = the average concentration of Th-232 over the elevated area x within the survey unit,

DCGL = the $DCGL_w$ or DCCL for Th-232,

$DCGL_{EMC}$ = (area factor for elevated area x) X (DCGL or DCCL),

x = refers to one of the elevated areas within the survey unit, and

n = the total number of elevated areas within the survey unit.

Elevated Measurement Comparisons

Sample Date	Unit / EMC unit	Unit Area (m^2)	Gross Th-232 (pCi/g)	Net Th-232 (pCi/g)	DCGL (pCi/g)	Fraction (-)
10/3/2005	FSS-020	1570	0.778	0	3	0.00
9/28/2005	EMC unit	2	5.90	5.12	26.4	0.19
					Sum of Fractions:	0.19

SUB-REPORT

SURVEY UNIT KAISER-FSS-021

TABLE OF CONTENTS

ATTACHMENTS

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-021
Survey Unit Kaiser-FSS-021
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility **(Figure 1)**. Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-021, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the north-central portion of the Retention Pond area. Survey Unit Kaiser-FSS-021 is considered a Class 1 survey unit with an approximate surface area of 1,985 m^2. It is bounded to the south by Survey Unit Kaiser-FSS-023, to the east by Survey Unit Kaiser-FSS-017, to the north by Fulton Creek, and to the west by Survey Unit Kaiser-FSS-022 **(Figure 3)**.

Survey Unit Kaiser-FSS-021 consists of an excavation bottom surface soil with one side wall (north wall). No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom and northern side wall surface soil of Survey Unit Kaiser-FSS-021. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom and northern side wall) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 12 approximately equal-distant locations in the survey unit. The statistics for the 12 background measurements are provided below in **Table 1.** Background measurements ranged from 15,959 counts per minute (cpm) to 21,250 cpm moving north to south within the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the south of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 3,811 measurements of gross count rate were made at two second intervals across the survey unit's 1,985 m^2 surface area. The results ranged from 13,197 cpm to 32,181 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	1,985 m^2	
Number of Scan Measurements (2-Second Intervals)	3,811	
Detector Swing Rate: (Swinging the detector a width of 1-meter side to side)	0.26 m/s (MARSSIM recommends 0.5 m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	15,959	13,197
Maximum	21,250	32,181
Average	18,342	18,938
Stand Deviation	1,805	2,363
Median	17,796	18,437

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site). As part of the gross gamma survey, 4 biased soil samples were collected at

locations exhibiting the highest scan rates on the excavation bottom and northern side wall **(Figure A-2, Attachment A)**. The biased soil samples were screened on-site in a lead cave. Results of the sample screening are presented below in **Table 2.** The sample screening levels were below the $DCGL_W$ for the site.

Table 2 – Biased Soil Sample Screening Results

Soil Sample ID	Cave Counter Screening Results (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)
$DCGL_W$	*3.0*		
Site Background	*1.1*	*0.3*	
K-1057	1.71	1.10	1.55
K-1061	2.30	1.17	1.55
K-1062	2.51	1.23	1.55
K-1063	2.05	1.13	1.55

2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 **(Attachment B)**. Once N was determined, the Survey Unit Area (A) of 1,985 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 16 meters and the Height of the Equilateral Triangle (h) of 13.9 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 **(Attachment B)**.

A layout of the soil sampling locations is provided on **Figure A-3** contained in **Attachment A.** The soil sample locations were demarcated in the field using a GPS unit. A total of 9 soil samples (identified as K-1041 through K-1049) were collected at the excavation bottom/side wall surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3.** Analytical data reports are contained in **Attachment C.**

Table 3 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-1041	0.744	0.127	0.221	0	3.0
K-1042	0.928	0.244	0.409	0	3.0
K-1043	0.748	0.194	0.304	0	3.0
K-1044	0.886	0.188	0.305	0	3.0
K-1045	0.663	0.211	0.373	0	3.0
K-1046	0.764	0.223	0.262	0	3.0
K-1047	0.743	0.137	0.179	0	3.0
K-1048	1.35	0.193	0.266	0.25	3.0
K-1049	1.13	0.223	0.331	0.03	3.0
Average	***0.884***				
Standard Dev.	***0.224***				
Minimum	***0.663***				
Maximum	***1.35***				
Median	***0.764***				

All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.35 pCi/g, which fell slightly above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 0.884 pCi/g. The standard deviation of the 9 equal-distant samples was 0.224, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (0.88 pCi/g) between the maximum survey unit soil sample activity concentration (1.35 pCi/g) and the minimum reference background area soil sample activity concentration (0.47 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	182	1.16	S1	K-1041	0.744
R2	168	1.30	S2	K-1042	0.928
R3	362	1.18	S3	K-1043	0.748
R4	361	0.47	S4	K-1044	0.886
R5	192	1.32	S5	K-1045	0.663
R6	149	0.98	S6	K-1046	0.764
R7	149	0.98	S7	K-1047	0.743
R8	353	0.79	S8	K-1048	1.35
R9	274	1.37	S9	K-1049	1.13
	Average	***1.06***		***Average***	***0.884***
	Standard Dev.	***0.29***		***Standard Dev.***	***0.224***
	Minimum	***0.47***		***Minimum***	***0.663***
	Maximum	***1.37***		***Maximum***	***1.35***
	Median	***1.16***		***Median***	***0.764***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the north-central portion of the Retention Pond area resulted in an open land area consisting of an excavation approximately 1,985 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-021 is considered a Class 1 survey unit. The survey unit is bounded to the south by the Survey Unit Kaiser-FSS-023, to the east by Survey Unit Kaiser-FSS-017, to the north by Fulton Creek, and to the west by Survey Unit Kaiser-FSS-022 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom/Side Wall Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-021 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom and northern side wall) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results meet the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-021 prior to backfill with below criteria material (BCM), as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 5.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

Table 5 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-021 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	dpm/100cm^2	0		0.00
TOTAL SUM OF FRACTIONS				***0.00***

The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-021 meets the DP acceptance criteria.

ATTACHMENT A
TABLE OF CONTENTS

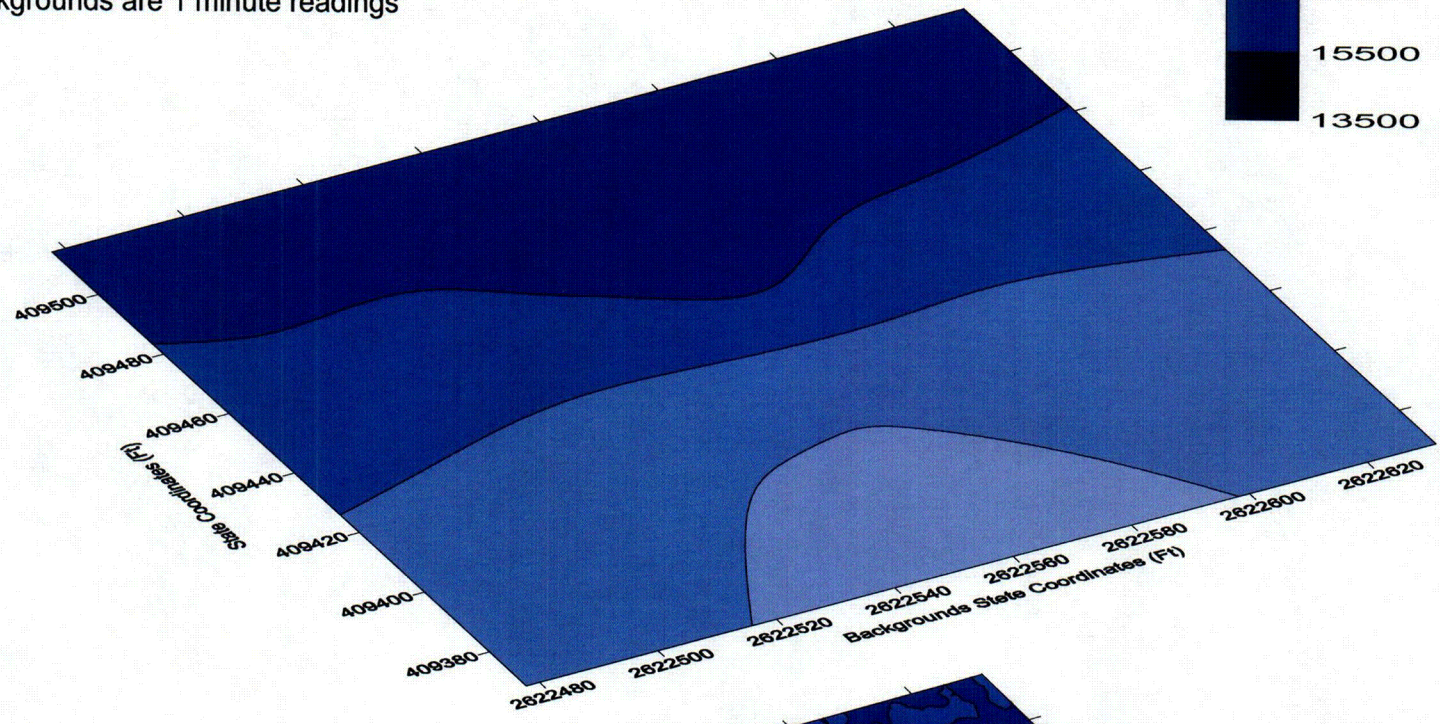
Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit KAISER-FSS-021

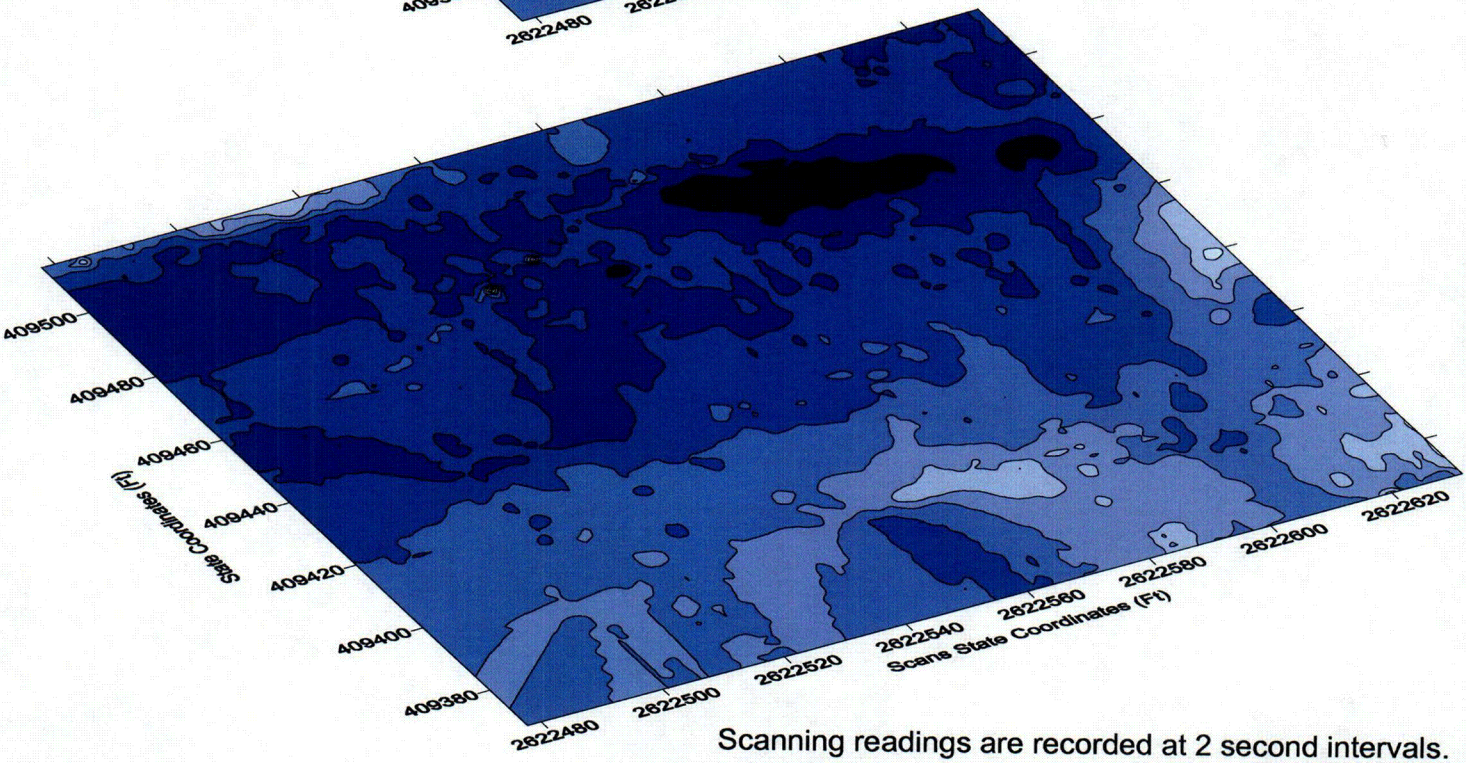
N

CPM NaI # 7

27500
25500
23500
21500
19500
17500
15500
13500

Backgrounds are 1 minute readings





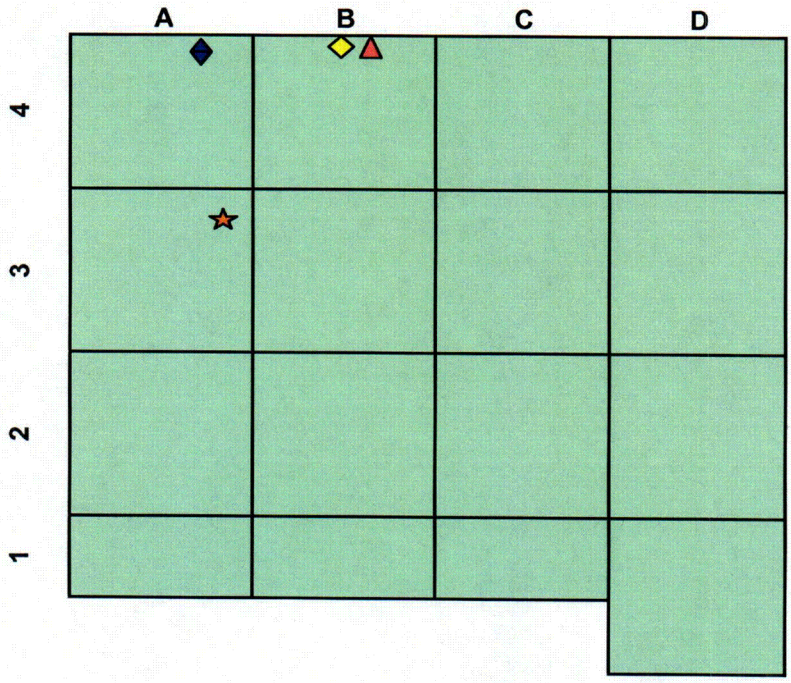
Scanning readings are recorded at 2 second intervals.

C.Cel

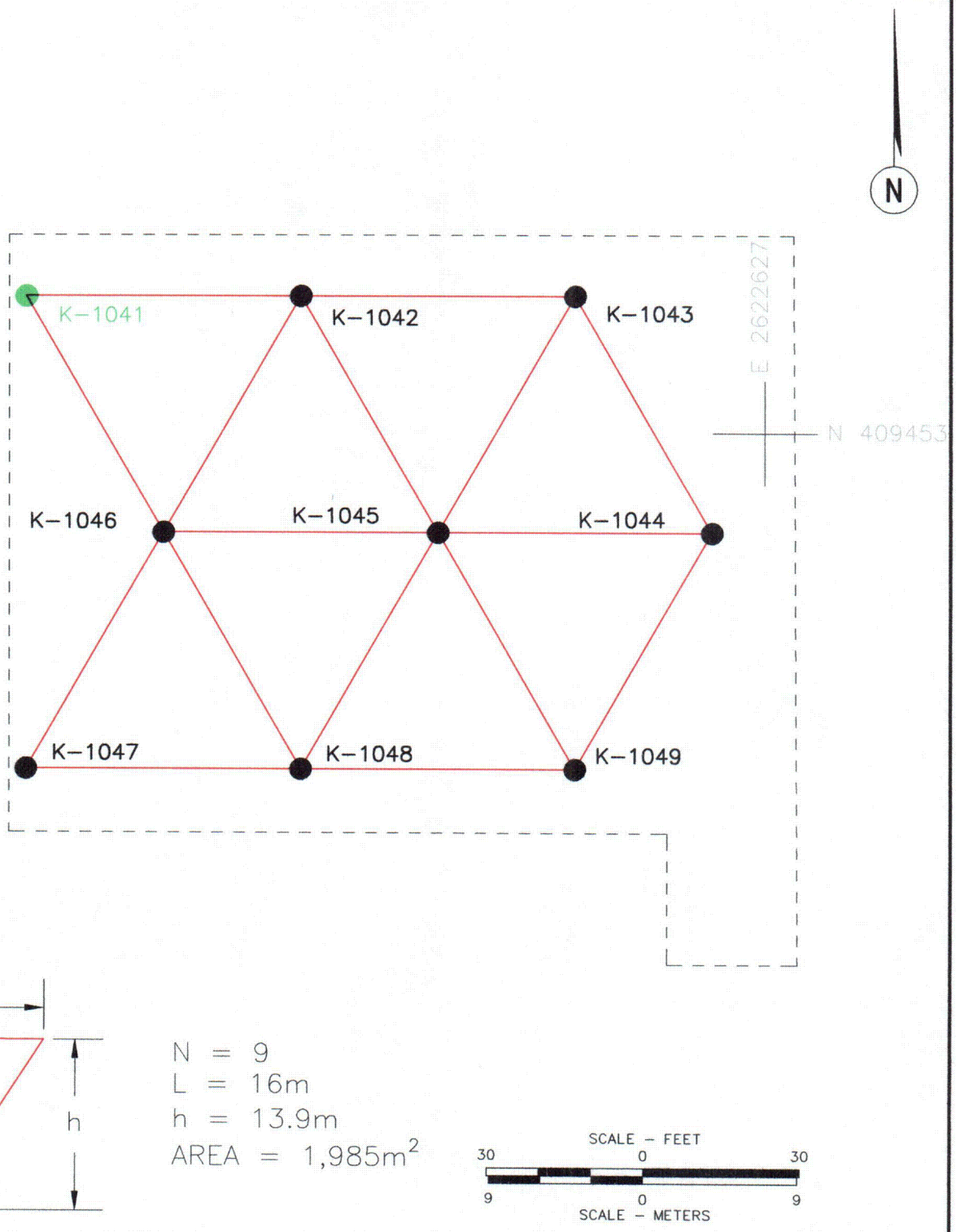
Attachment A, Figure A-2
Gross Gamma Survey - Biased Soil Sample Locations
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

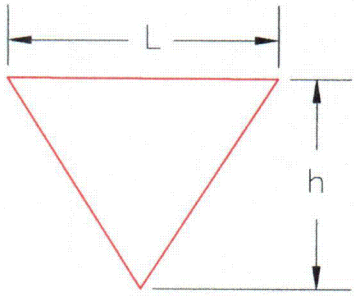
Survey Unit: Kaiser-FSS-021
Area: 1,985 m^2
Grid: 10m x 10m

North



K-1061 - Biased soil sampling location based on the results of the gross gamma scan
K-1062 - Biased soil sampling location based on the results of the gross gamma scan
K-1063 - Biased soil sampling location based on the results of the gross gamma scan
K-1057 - Biased soil sampling location based on the results of the gross gamma scan





N = 9
L = 16m
h = 13.9m
AREA = 1,985m^2

SCALE – FEET
30 0 30
9 0 9
SCALE – METERS

K–1042
● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K–1041
● RANDOM START POINT

FIGURE A–3
SYSTEMATIC SOIL SAMPLING LOCATIONS SURVEY UNIT KAISER – FSS–021 FINAL STATUS SURVEY THORIUM REMEDIATION PROJECT TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	3-3-06
CHECKED	3-3-06
DRAWN	DEB 9/28/05
DRAWING NUMBER	PA4072026a

Penn E&R
Environmental & Remediation, Inc.

C-23

ATTACHMENT B
TABLE OF CONTENTS

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-021

2. Description: Retention Pond Area, West of Survey Unit Kaiser-FSS-017

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – approximately 44 meters x 45 meters; Area, A (m^2): 1,985

5. Estimate of Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 16.0 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 13.9 m.

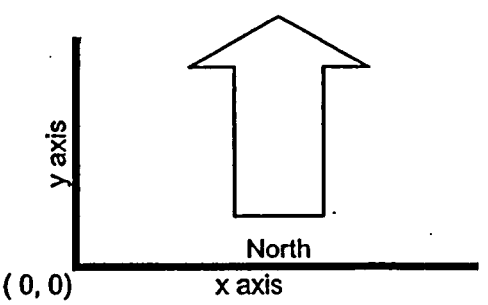
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-021

RANDOM START POINT

x axis (Meters)	y axis (Meters)
0	39

	x axis	y axis
lower bound	0	0
upper bound	45	49



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach
Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

October 7, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050775

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on September 30, 2005 for the above captioned project. Nine soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5-work day turn. Results were faxed 10/7/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach
boratory
... North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050775
Date Reported:	10/7/05
Date Received:	9/30/05
Page Number:	1 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20050775-01						
Client ID:	K-1041						
Date Sampled:	9/29/05 10:15:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.744 +/- 0.127	pCi/g	0.221		10/15/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.7	%		9/30/05	10/3/05	RT
Lab ID:	20050775-02						
Client ID:	K-1042						
Date Sampled:	9/29/05 10:20:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.928 +/- 0.244	pCi/g	0.409		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	12.4	%		9/30/05	10/3/05	RT
Lab ID:	20050775-03						
Client ID:	K-1043						
Date Sampled:	9/29/05 10:25:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.748 +/- 0.194	pCi/g	0.304		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	12.6	%		9/30/05	10/3/05	RT
Lab ID:	20050775-04						
Client ID:	K-1044						
Date Sampled:	9/29/05 10:30:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Th-232	HASL 300	0.886 +/- 0.188	pCi/g	0.305		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.1	%		9/30/05	10/3/05	RT
Lab ID:	20050775-05						
Client ID:	K-1045						
Date Sampled:	9/29/05 10:35:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach
boratory
lorth Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050775
Date Reported:	10/7/05
Date Received:	9/30/05
Page Number:	2 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Th-232	HASL 300	0.663 +/- 0.211	pCi/g	0.373		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	9.4	%		9/30/05	10/3/05	RT
Lab ID:	**20050775-06**						
Client ID:	**K-1046**						
Date Sampled:	**9/29/05 10:40:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.764 +/- 0.223	pCi/g	0.262		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.6	%		9/30/05	10/3/05	RT
Lab ID:	**20050775-07**						
Client ID:	**K-1047**						
Date Sampled:	**9/29/05 10:45:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	0.743 +/- 0.137	pCi/g	0.179		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	10.1	%		9/30/05	10/3/05	RT
Lab ID:	**20050775-08**						
Client ID:	**K-1048**						
Date Sampled:	**9/29/05 10:50:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.35 +/- 0.193	pCi/g	0.266		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	8.5	%		9/30/05	10/3/05	RT
Lab ID:	**20050775-09**						
Client ID:	**K-1049**						
Date Sampled:	**9/29/05 10:55:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Th-232	HASL 300	1.13 +/- 0.223	pCi/g	0.331		10/3/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	10.4	%		9/30/05	10/3/05	RT

BDL = Below Detection Limit

Outreach
Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20050775
Date Reported: 10/7/05
Date Received: 9/30/05
Page Number: 3 of 3

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					NC				10/15/05
Am-241		98.0	94.0	3.4					10/15/05
Am-241		112.0	101.0	10.1					10/6/05
Co-60		91.0	96.0	5.1					10/15/05
Co-60		100.0	94.0	6.5					10/6/05
Cs-137		83.0	98.0	17.4					10/15/05
Cs-137		99.0	95.0	4.5					10/6/05
Percent Moisture					0.1				10/3/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
LOCAL: 918-384-0566
CELL: 724-799-0071

Company: KAISER-ADAM & CABEN INC.
Name: DAVID B. WEIGANT
Address: 7311 E. 41ST STREET
City: TULSA State: OK Zip: 74145
Phone: 774-934-3530 Fax #: 918-384-3171

Bill To:
Company: KAISER/BECHTEL E&R
Name: DAVID B. WEIGANT / PAUL HOWARD
Address: 7311 E. 41ST STREET
City: TULSA State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: KAISER - 4072
PROJECT #: PA-4000-4072
PROJECT NAME: KAISER THORIUM REMED.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 5 DAY
SAMPLER: [signature] (Signature)

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	GAMMA SPEC (Th-232)	RETURN TO CLIENT FOR ARCHIVE	MDC 1.015 pCi/gm	ASTM D2216-92 MOIST. CONTENT	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1041	9-29-05	1015	SOIL	1	500ML PLASTIC	NONE	X	X	X	X	GRAB
	K-1042	"	1020	"	1	"	"	X	X	X	X	"
	K-1043	"	1025	"	1	"	"	X	X	X	X	"
	K-1044	"	1030	"	1	"	"	X	X	X	X	"
	K-1045	"	1035	"	1	"	"	X	X	X	X	"
	K-1046	"	1040	"	1	"	"	X	X	X	X	"
	K-1047	"	1045	"	1	"	"	X	X	X	X	"
	K-1048	"	1050	"	1	"	"	X	X	X	X	"
	K-1049	"	1055	"	1	"	"	X	X	X	X	"

RELINQUISHED BY: [signature] DAVID B. WEIGANT DATE 9/30/05 TIME 745 RECEIVED BY: [signature] KEN Eidson DATE 9/30/05 TIME 745

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: RECEIVED

SAMPLE LOGIN

Date Received: *9/30/05 9:28:03 A* Lab Number: 20050775 Due: 10/7/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050775-01 A	K-1041	Soil	09/29/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050775-02 A	K-1042	Soil	09/29/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050775-03 A	K-1043	Soil	09/29/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050775-04 A	K-1044	Soil	09/29/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050775-05 A	K-1045	Soil	09/29/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050775-06 A	K-1046	Soil	09/29/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050775-07 A	K-1047	Soil	09/29/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050775-08 A	K-1048	Soil	09/29/05	Plastic	16 oz	None	No	No
Percent Moisture (LOD)								
Th-232 by Gamma Spec								
20050775-09 A	K-1049	Soil	09/29/05	Plastic	16 oz	None	No	No

Percent Moisture (LOD)
Th-232 by Gamma Spec

CONTAINER INSPECTION

Coolers Pickup BOX Custody Seals Broken - Y/N Temperature N/A Blue Ice / Wet Ice Radiation Survey _____fixed_____removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies:_____

Inspected By: Michelle Sutton DATE 9.30.05

QA or Designee Review: Raymond Thomas DATE 09/30/05

Sample Custodian Review: Nelson Gregory DATE 9-30-05

Project Notes:

SUB-REPORT

SURVEY UNIT KAISER-FSS-022

TABLE OF CONTENTS

ATTACHMENTS

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-022
Survey Unit Kaiser-FSS-022
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-022, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the north-central portion of the Retention Pond area. Survey Unit Kaiser-FSS-022 is considered a Class 1 survey unit with an approximate surface area of 1,840 m^2. It is bounded to the south by Survey Unit Kaiser-FSS-024, to the east by Survey Unit Kaiser-FSS-021, to the north by Fulton Creek, and to the west by Survey Unit Kaiser-FSS-006 (**Figure 3**).

Survey Unit Kaiser-FSS-022 consists of an excavation bottom surface soil with one side wall (north wall). No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

A concrete weir associated with Fulton Creek is located just outside of the survey unit, in a non-impacted area. Measurements of total and removable alpha contamination were made to verify the status of the weir as non-impacted (by radioactive material from the site).

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom and northern side wall surface soil of Survey Unit Kaiser-FSS-022. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling. A separate survey of a structure located just outside of the survey unit (concrete weir) was completed to verify it's classification as non-impacted. This verification survey is also presented in this section of the report.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom and northern side wall) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 15 approximately equal-distant locations in the survey unit. The statistics for the 15 background measurements are provided below in **Table 1.** Background measurements ranged from 16,834 counts per minute (cpm) to 21,465 cpm moving north to south within the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the south of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 4,657 measurements of gross count rate were made at two second intervals across the survey unit's 1,840 m^2 surface area. The results ranged from 12,465 cpm to 26,587 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is also provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	1,840 m^2	
Number of Scan Measurements (2-Second Intervals):	4,657	
Detector Swing Rate: (Swinging the detector a width of 1-meter side to side)	0.20 m/s (MARSSIM recommends 0.5 m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	16,834	12,465
Maximum	21,465	26,587
Average	19,082	19,264
Stand Deviation	1,403	1,760
Median	18,663	19,065

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the

$DCGL_W$ for the site). As part of the gross gamma survey, 7 biased soil samples were collected at locations exhibiting the highest scan rates on the excavation bottom and northern side wall **(Figure A-2, Attachment A)**. The biased soil samples were screened on-site in a lead cave. Results of the sample screening are presented below in **Table 2.** The sample screening levels were below the $DCGL_W$ for the site.

Table 2 – Biased Soil Sample Screening Results

Soil Sample ID	Cave Counter Screening Results (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)
$DCGL_W$	*3.0*		
Site Background	*1.1*	*0.3*	
K-1238	1.25	1.17	1.57
K-1239	2.56	0.862	1.57
K-1240	2.39	1.20	1.57
K-1241	1.72	1.21	1.57
K-1242	1.74	1.31	1.57
K-1243	2.49	1.29	1.55
K-1244	0.592	1.32	1.55

2.2 Systematic Soil Sampling – Excavation Bottom/Side Wall Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 **(Attachment B)**. Once N was determined, the Survey Unit Area (A) of 1,840 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 15.4 meters and the Height of the Equilateral Triangle (h) of 13.3 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 **(Attachment B)**.

A layout of the soil sampling locations is provided on **Figure A-3** contained in **Attachment A.** The soil sample locations were demarcated in the field using a GPS unit. A total of 9 soil samples (identified as K-1219 through K-1227) were collected at the excavation bottom/side wall surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3.** Analytical data reports are contained in **Attachment C.**

Table 3 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-1219	0.955	0.215	0.458	0	3.0
K-1220	1.17	0.237	0.335	0.07	3.0
K-1221	0.724	0.203	0.326	0	3.0
K-1222	0.809	0.212	0.350	0	3.0
K-1223	1.19	0.247	0.345	0.09	3.0
K-1224	0.972	0.171	0.305	0	3.0
K-1225	0.947	0.167	0.312	0	3.0
K-1226	0.953	0.194	0.264	0	3.0
K-1227	1.11	0.092	0.278	0.01	3.0
Average	***0.981***				
Standard Dev.	***0.156***				
Minimum	***0.724***				
Maximum	***1.19***				
Median	***0.955***				

All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.19 pCi/g, which fell slightly above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 0.981 pCi/g. The standard deviation of the 9 equal-distant samples was 0.156, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (0.55 pCi/g) between the maximum survey unit soil sample activity concentration (1.19 pCi/g) and the minimum reference background area soil sample activity concentration (0.64 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	216	0.64	S1	K-1219	0.955
R2	148	1.37	S2	K-1220	1.17
R3	204	1.35	S3	K-1221	0.724
R4	17	0.91	S4	K-1222	0.809
R5	227	2.25	S5	K-1223	1.19
R6	17	0.91	S6	K-1224	0.972
R7	263	1.54	S7	K-1225	0.947
R8	230	1.31	S8	K-1226	0.953
R9	85	1.18	S9	K-1227	1.11
	Average	***1.27***		***Average***	***0.981***
	Standard Dev.	***0.46***		***Standard Dev.***	***0.156***
	Minimum	***0.64***		***Minimum***	***0.724***
	Maximum	***2.25***		***Maximum***	***1.19***
	Median	***1.31***		***Median***	***0.955***

2.4 Verification Survey of Concrete Weir

As previously noted, a concrete weir (16 m^2 of surface area) associated with Fulton Creek is located just outside of the survey unit in a non-impacted area. Measurements of total and removable alpha contamination were made to verify the status of the weir as non-impacted (by radioactive material from the site). This structure was surveyed and sampled in-place.

The supporting documentation for survey of the concrete weir is contained in **Attachment D** and includes the following:

- **Figure D-1** depicts the non-impacted concrete weir structure
- Alpha Scan MDC Calculation
- **Table D-1**, Gross Alpha Scan Survey Data Summary
- Total Alpha Contamination – Non-Impacted Concrete Weir, Survey Data Conversion Form

Static counts to determine total alpha contamination were taken systematically **(Figure D-1, Attachment D)**. Smear samples of removable alpha contamination were also taken (K-SS-197 through K-SS-209 as indicated on **Figure D-1**). The results of the static counts and the smear samples are presented below in **Table 5**. The results confirm the classification of the weir as non-impacted.

Table 5 – Concrete Weir Total and Removable Alpha Contamination Results

Grid/Sample ID	DCGL-GA (dpm/100cm^2)	Alpha (dpm/100cm^2)	Std. Error (dpm/100cm^2)	MDC (dpm/100cm^2)
Total Contamination				
A-1-4	944	133	78.1	84.2
B1	944	35.3	48.9	84.2
B2	944	35.3	48.9	84.2
B3	944	114	73.2	84.2
B4	944	94.2	67.9	84.2
C1	944	104	70.6	84.2
C2	944	64.7	59.2	84.2
C3	944	114	73.2	84.2
C4	944	241	101	84.2
D2	944	310	113	84.2
D3	944	84.4	65.1	84.2
D4	944	133	78.1	84.2
Removable Contamination				
A/K-SS-197	94.4	0.487	0.712	0.631
B1/K-SS-198	94.4	0.487	0.712	0.631
B2/K-SS-199	94.4	0.219	0.644	0.631
B3/K-SS-200	94.4	0.308	0.668	0.631
B4/K-SS-201	94.4	0.665	0.754	0.631
C1/K-SS-202	94.4	0.665	0.754	0.631
C2/K-SS-203	94.4	0.665	0.754	0.631
C3/K-SS-204	94.4	1.20	0.867	0.631
C4/K-SS-205	94.4	3.08	1.18	0.631
D1/K-SS-206	94.4	0.487	0.712	0.631
D2/K-SS-207	94.4	0.665	0.754	0.631
D3/K-SS-208	94.4	0.665	0.754	0.631
D4/K-SS-209	94.4	0.576	0.733	0.631

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the north-central portion of the Retention Pond resulted in an open land area consisting of an excavation approximately 1,840 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-022 is considered a Class 1 survey unit. The survey unit is bounded to the south by the Survey Unit Kaiser-FSS-024, to the east by Survey Unit Kaiser-FSS-021, to the north by Fulton Creek, and to the west by Survey Unit Kaiser-FSS-006 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom/Side Wall Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-022 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom and northern side wall) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 9 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results met the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-022 prior to backfill with below criteria material (BCM), as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 6.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

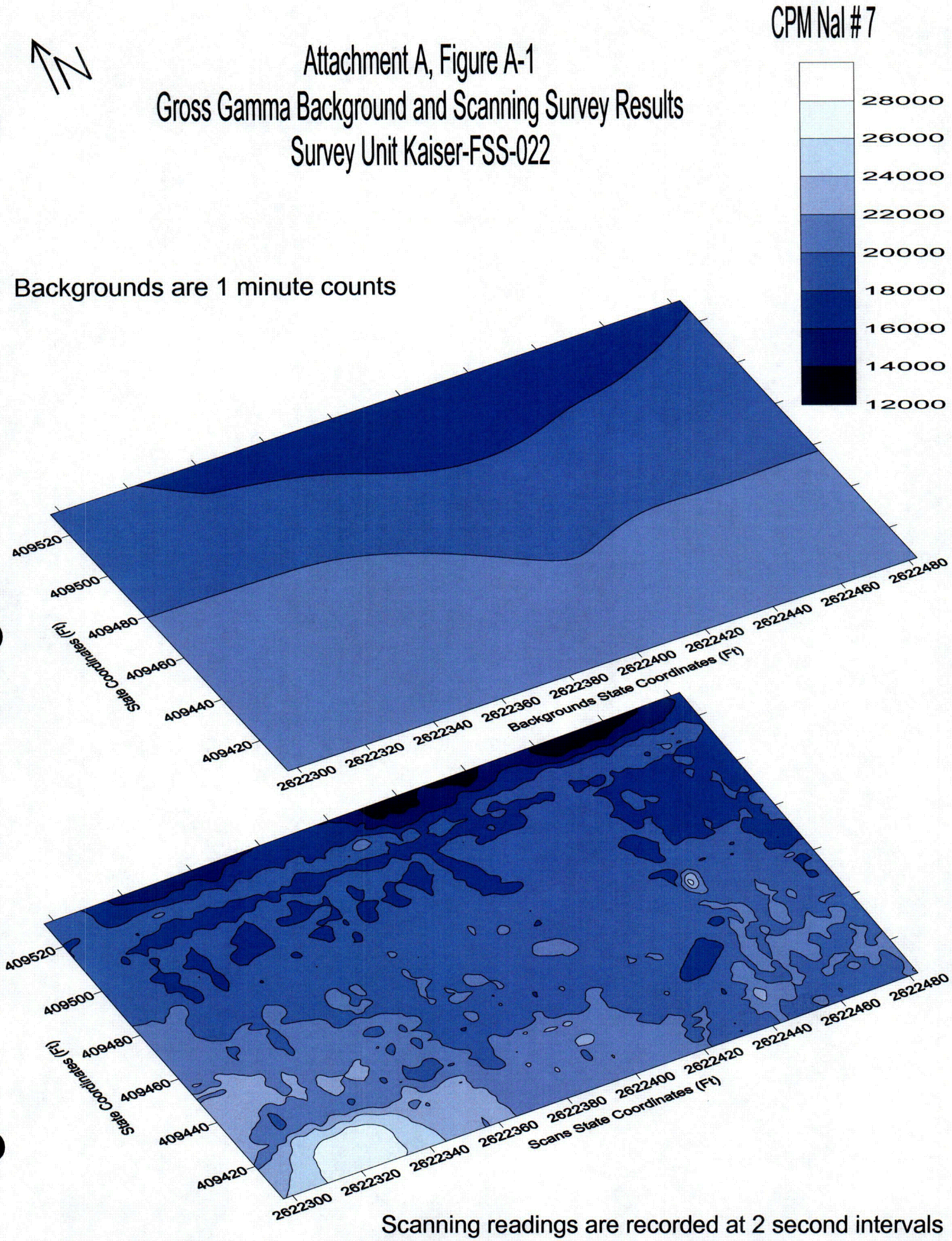
Table 6 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-022 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	$dpm/100cm^2$	0		0.00
TOTAL SUM OF FRACTIONS				***0.00***

The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-022 meets the DP acceptance criteria.

ATTACHMENT A
TABLE OF CONTENTS

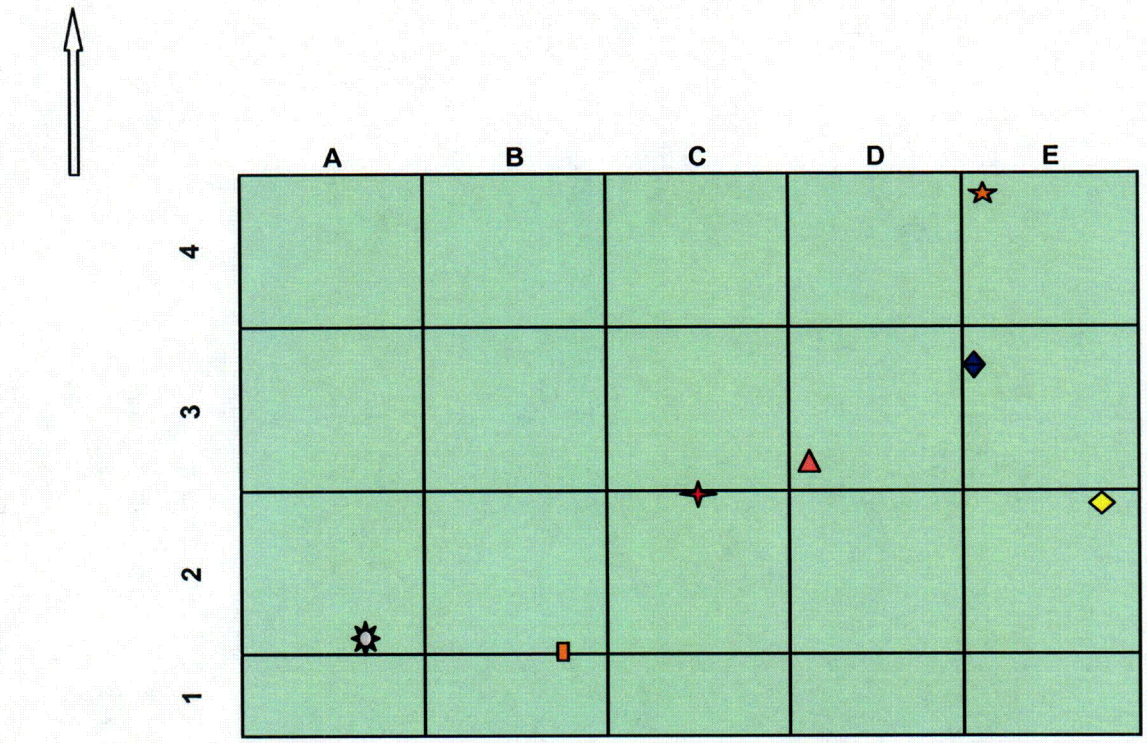
Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-022



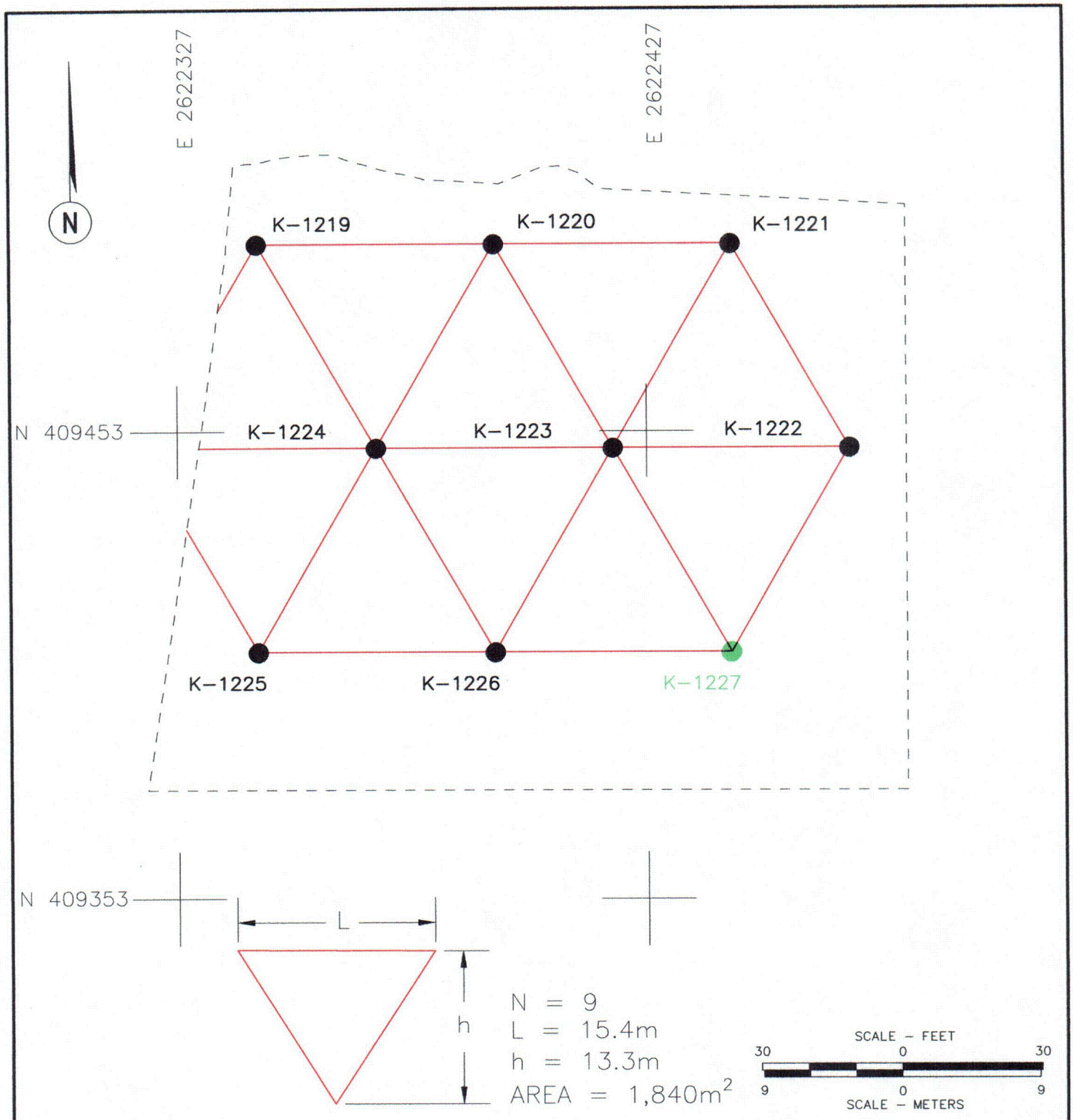
C64

Attachment A, Figure A-2
Gross Gamma Survey - Biased Soil Sample Locations
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Survey Unit: Kaiser-FSS-022
Area: 1,840 m^2
Grid: 10m x 10m



K-1238 - Biased soil sampling location based on the results of the gross gamma scan
K-1239 - Biased soil sampling location based on the results of the gross gamma scan
K-1240 - Biased soil sampling location based on the results of the gross gamma scan
K-1241 - Biased soil sampling location based on the results of the gross gamma scan
K-1242 - Biased soil sampling location based on the results of the gross gamma scan
K-1243 - Biased soil sampling location based on the results of the gross gamma scan
K-1244 - Biased soil sampling location based on the results of the gross gamma scan



K-1219
● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K-1227
● RANDOM START POINT

FIGURE A-3
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS-022
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RD 5-3-06
CHECKED	RD 3-3-06
DRAWN	DEB 10/18/05
DRAWING NUMBER	PA4072035

Penn E&R
Environmental & Remediation, Inc.

ATTACHMENT B
TABLE OF CONTENTS

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-022

2. Description: Retention Pond Area, West of Survey Unit Kaiser-FSS-021

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – approximately 48 meters x 38 meters; Area, A (m^2): 1,840

5. Estimated of Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 15.4 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 13.3 m.

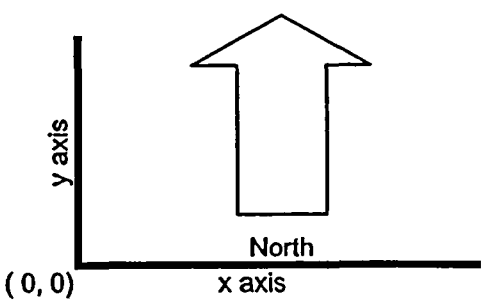
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-022

RANDOM START POINT

x axis (Meters)	y axis (Meters)
38	9

	x axis	y axis
lower bound	0	0
upper bound	48	38



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Lime # 11483
D/- 11/2/05

November 1, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050874

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on October 25, 2005 for the above captioned project. Nine soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5-work day turn. Results were faxed 11/01/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach
boratory
North Aspen
...oken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072
Lab Number:	20050874
Date Reported:	11/1/05
Date Received:	10/25/05
Page Number:	1 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050874-01**						
Client ID:	**K-1219**						
Date Sampled:	**10/24/05 9:30:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.955 +/- 0.215	pCi/g	0.458		10/27/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	6.7	%		10/26/05	10/27/05	RT
Lab ID:	**20050874-02**						
Client ID:	**K-1220**						
Date Sampled:	**10/24/05 9:35:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	1.17 +/- 0.237	pCi/g	0.335		10/27/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	5.9	%		10/26/05	10/27/05	RT
Lab ID:	**20050874-03**						
Client ID:	**K-1221**						
Date Sampled:	**10/24/05 9:40:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.724 +/- 0.203	pCi/g	0.326		10/27/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	5.1	%		10/26/05	10/27/05	RT
Lab ID:	**20050874-04**						
Client ID:	**K-1222**						
Date Sampled:	**10/24/05 9:45:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.809 +/- 0.212	pCi/g	0.350		10/27/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	7.0	%		10/26/05	10/27/05	RT

BDL = Below Detection Limit

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072
Lab Number:	20050874
Date Reported:	11/1/05
Date Received:	10/25/05
Page Number:	2 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050874-05**						
Client ID:	**K-1223**						
Date Sampled:	**10/24/05 9:50:00 AM**						
Matrix:	**Soil**						
	Radiochemical Analyses						
Thorium 232	HASL 300	1.19 +/- 0.247	pCi/g	0.345		10/27/05	SD
	Inorganics Analyses						
Percent Moisture	ASTM D2216-92	25.3	%		10/26/05	10/27/05	RT
Lab ID:	**20050874-06**						
Client ID:	**K-1224**						
Date Sampled:	**10/24/05 9:55:00 AM**						
Matrix:	**Soil**						
	Radiochemical Analyses						
Thorium 232	HASL 300	0.972 +/- 0.171	pCi/g	0.305		10/27/05	SD
	Inorganics Analyses						
Percent Moisture	ASTM D2216-92	7.3	%		10/26/05	10/27/05	RT
Lab ID:	**20050874-07**						
Client ID:	**K-1225**						
Date Sampled:	**10/24/05 10:00:00 AM**						
Matrix:	**Soil**						
	Radiochemical Analyses						
Thorium 232	HASL 300	0.947 +/- 0.167	pCi/g	0.312		10/27/05	SD
	Inorganics Analyses						
Percent Moisture	ASTM D2216-92	5.9	%		10/26/05	10/27/05	RT
Lab ID:	**20050874-08**						
Client ID:	**K-1226**						
Date Sampled:	**10/24/05 10:05:00 AM**						
Matrix:	**Soil**						
	Radiochemical Analyses						
Thorium 232	HASL 300	0.953 +/- 0.194	pCi/g	0.264		10/27/05	SD
	Inorganics Analyses						
Percent Moisture	ASTM D2216-92	10.5	%		10/26/05	10/27/05	RT

BDL = Below Detection Limit

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072
Lab Number:	20050874
Date Reported:	11/1/05
Date Received:	10/25/05
Page Number:	3 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	20050874-09						
Client ID:	K-1227						
Date Sampled:	10/24/05 10:10:00 AM						
Matrix:	Soil						
		Radiochemical Analyses					
Thorium 232	HASL 300	1.11 +/- 0.092	pCi/g	0.278		10/27/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	11.5	%		10/26/05	10/27/05	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					NC				10/27/05
Am-241		87.0	100.0	14.2					10/27/05
Co-60		95.0	100.0	4.9					10/27/05
Cs-137		94.0	100.0	6.5					10/27/05
Percent Moisture					6.7				10/27/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company KAISER-Alum & Chem Inc.
Name DAVID E. WEAVER
Address 7211 E. 41ST ST.
City TULSA State OK Zip 74145
Phone 724-934-3536 Fax # 918-364-7171

Cell: 918-394-0566 724-799-0071

Bill To:
Company KAISER / Prod ENR
Name PAUL HARDA / DAVID E. WEAVER
Address 7211 E. 41ST ST.
City TULSA State OK Zip 74145

ANALYSIS REQUESTED

PO # KAISER-4072
PROJECT # PA-4000-4572
PROJECT NAME KAISER - Thorium Remed. Proj.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 5 DAY
SAMPLER: Signature DAVID W. DUFFY

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Th-230 (SOP RA-02)	Th-232 + Th-232 Ext Analysis	Ra-226 SOP RA-03	Ra-228 SOP RA-04.1	Th-232 ASTM D7035	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1219	10-24-05	0930	Soil	1	500ml Plastic	None	X	X	X	X		Grab
	K-1220		0935		1			X	X	X	X		
	K-1221		0940		1			X	X	X	X		
	K-1222		0945		1			X	X	X	X		
	K-1223		0950		1			X	X	X	X		
	K-1224		0955		1			X	X	X	X		
	K-1225		1000		1			X	X	X	X		
	K-1226		1005		1			X	X	X	X		
	K-1227		1010		1			X	X	X	X		
		"		"		"	"						
				WY									

RELINQUISHED BY: DAVID W. DUFFY DATE 10/25/05 TIME 937 RECEIVED BY: Donna Eidson DATE 10/25/05 TIME 937

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY

SAMPLE . GIN

Date Received: *10/25/05 11:07:50* Lab Number: 20050874 Due: 11/1/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050874-01 A	K-1219	Swipe	10/24/05	Plastic	Sm Zip Bag	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050874-02 A	K-1220	Swipe	10/24/05	Plastic	Sm Zip Bag	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050874-03 A	K-1221	Swipe	10/24/05	Plastic	Sm Zip Bag	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050874-04 A	K-1222	Swipe	10/24/05	Plastic	Sm Zip Bag	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050874-05 A	K-1223	Swipe	10/24/05	Plastic	Sm Zip Bag	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050874-06 A	K-1224	Swipe	10/24/05	Plastic	Sm Zip Bag	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050874-07 A	K-1225	Swipe	10/24/05	Plastic	Sm Zip Bag	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050874-08 A	K-1226	Swipe	10/24/05	Plastic	Sm Zip Bag	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050874-09 A	K-1227	Swipe	10/24/05	Plastic	Sm Zip Bag	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								

Soil SD 10/26/05

CONTAINER INSPECTION

Coolers #1 Custody Seals Broken - Y/N Temperature _____ Blue Ice / Wet Ice Radiation Survey _____fixed_____removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N Chain of Custody Record Y/N Labels in Tact Y/N Radiation Survey Complete Y/N

Anomalies: _____

_____

_____

Inspected By: _____ DATE 10/25/05

QA or Designee Review: Raymond Thomas DATE 10/25/05

Sample Custodian Review: Michelle D DATE 10.25.05

Project Notes:

Outreach Laboratory
North Aspen
broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Lmi # 11465
01 - 10/25/05

October 24, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050852

Dear Mr. Weyant,

Please find enclosed the analytical report for your samples received in our laboratory on October 20, 2005 for the above captioned project. Fourteen swipes were received in good condition and analyzed for Gross Alpha/Beta with a standard 20 work-day turn time. Results were faxed on 10/25/05.

All Quality Control for the requested analyses is reported on the analytical report. The method blank, laboratory control standard and matrix spikes and spike duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions feel free to call.

Laboratory Director

ODEQ ID #9517
NRC ODEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac

CERT. ID# OK001

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: PA-4000-4072
Lab Number: 20050852
Date Reported: 10/24/05
Date Received: 10/20/05

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050852-01**						
Client ID:	**K-SS-197**						
Date Sampled:	**10/18/05 10:12:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.487 +/- 0.712	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	0.688 +/- 2.43	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-02**						
Client ID:	**K-SS-198**						
Date Sampled:	**10/18/05 10:14:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.487 +/- 0.712	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	0.883 +/- 2.44	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-03**						
Client ID:	**K-SS-199**						
Date Sampled:	**10/18/05 10:16:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.219 +/- 0.644	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	2.05 +/- 2.53	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-04**						
Client ID:	**K-SS-200**						
Date Sampled:	**10/18/05 10:18:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.308 +/- 0.668	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	1.27 +/- 2.47	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-05**						
Client ID:	**K-SS-201**						
Date Sampled:	**10/18/05 10:20:00 AM**						
Matrix:	**Swipe**						

BDL = Below Detection Limit

Outreach Laboratory
1 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072
Lab Number:	20050852
Date Reported:	10/24/05
Date Received:	10/20/05
Page Number:	2 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.665 +/- 0.754	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	4.20 +/- 2.68	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-06**						
Client ID:	**K-SS-202**						
Date Sampled:	**10/18/05 10:22:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.665 +/- 0.754	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	0.493 +/- 2.41	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-07**						
Client ID:	**K-SS-203**						
Date Sampled:	**10/18/05 10:24:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.665 +/- 0.754	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	4.01 +/- 2.67	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-08**						
Client ID:	**K-SS-204**						
Date Sampled:	**10/18/05 10:26:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	1.20 +/- 0.867	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	0.493 +/- 2.41	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-09**						
Client ID:	**K-SS-205**						
Date Sampled:	**10/18/05 10:28:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	3.08 +/- 1.18	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	3.32 +/- 2.62	DPM/F	2.57		10/21/05	SD

BDL = Below Detection Limit

Outreach
boratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050852-10**						
Client ID:	**K-SS-206**						
Date Sampled:	**10/18/05 10:30:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.487 +/- 0.712	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	1.57 +/- 2.49	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-11**						
Client ID:	**K-SS-207**						
Date Sampled:	**10/18/05 10:32:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.665 +/- 0.754	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	0.883 +/- 2.44	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-12**						
Client ID:	**K-SS-208**						
Date Sampled:	**10/18/05 10:34:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.665 +/- 0.754	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	1.86 +/- 2.52	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-13**						
Client ID:	**K-SS-209**						
Date Sampled:	**10/18/05 10:36:00 AM**						
Matrix:	**Swipe**						
		Radiochemical Analyses					
Gross Alpha	EPA 900/9310	0.576 +/- 0.733	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	3.42 +/- 2.63	DPM/F	2.57		10/21/05	SD
Lab ID:	**20050852-14**						
Client ID:	**K-SS-210**						
Date Sampled:	**10/18/05 10:38:00 AM**						
Matrix:	**Swipe**						

BDL = Below Detection Limit

Outreach
boratory
North Aspen
broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	PA-4000-4072
Lab Number:	20050852
Date Reported:	10/24/05
Date Received:	10/20/05
Page Number:	4 of

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Radiochemical Analyses							
Gross Alpha	EPA 900/9310	0.308 +/- 0.668	DPM/F	0.631		10/21/05	SD
Gross Beta	EPA 900/9310	2.05 +/- 2.53	DPM/F	2.57		10/21/05	SD

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Gross Alpha	0+/-0.6	115.0	101.0	13.5	NC				10/21/05
Gross Beta	0+/-2.4	87.0	85.0	2.7	NC				10/21/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN CUSTODY

Results To:
Company KAISER Alum & Chem Tpc.
Name DAVID B. WEYANT
Address 7211 E. 41ST ST.
City TULSA State OK Zip 74145
Phone 724-934-2530 Fax # 918-384-3171

Local: 918-384-0516
Cell: 724-799-0071

Bill To:
Company KAISER/Penn E&R
Name CAL HARDA/DAVID B. WEYANT
Address 7211 E. 41ST ST.
City TULSA State OK Zip 74145

ANALYSIS REQUESTED

PO # KAISER-4072
PROJECT # PA-400-4072
PROJECT NAME KAISER-Alum-Thorium Removal
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 20 DAYS
SAMPLER: Signature DAVID B. WEYANT/DAVE DAVIS

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gross Alpha/Beta	Ra-226 & Rn-222	Ra-228	Th-232	Cl227 + Ac227 for Ac chain				REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-SS-197	10-18-05	10:12	SOIL	1	Cloth	NONE	X	X	X	X	X				GRAB
	K-SS-198		10:14		1			X	X	X	X	X	N			
	K-SS-199		10:16		1			X	X	X	X	X			A	
	K-SS-200		10:18		1			X	X	X	X	X				
	K-SS-201		10:20		1			X	X	X	X	X				
	K-SS-202		10:22		1			X	X	X	X	X				
	K-SS-203		10:24		1			X	X	X	X	X				
	K-SS-204		10:26		1			X	X	X	X	X				
	K-SS-205		10:28		1			X	X	X	X	X				
	K-SS-206		10:30		1			X	X	X	X	X				
	K-SS-207		10:32		1			X	X	X	X	X				
	K-SS-208		10:34		1			X	X	X	X	X				
	K-SS-209		10:36		1			X	X	X	X	X				
	K-SS-210		10:38		1			X	X	X	X	X				

RELINQUISHED BY: DAVID B. WEYANT DATE 10-20-05 TIME 1000 RECEIVED BY: Donna Eidson DATE 10/20/05 TIME 1000

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: 2200-22-2
Samples Unpacked By: [illegible]
Temperature: [illegible]
Sample Integrity: [illegible]

Date Receiv. *10/20/05 4:44:01* Lab Numbe. 20050852 Due: 11/17/0.

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050852-01 A Gross Alpha/Beta	K-SS-197	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No
20050852-02 A Gross Alpha/Beta	K-SS-198	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No
20050852-03 A Gross Alpha/Beta	K-SS-199	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No
20050852-04 A Gross Alpha/Beta	K-SS-200	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No
20050852-05 A Gross Alpha/Beta	K-SS-201	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No
20050852-06 A Gross Alpha/Beta	K-SS-202	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No
20050852-07 A Gross Alpha/Beta	K-SS-203	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No
20050852-08 A Gross Alpha/Beta	K-SS-204	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No
20050852-09 A Gross Alpha/Beta	K-SS-205	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No
20050852-10 A Gross Alpha/Beta	K-SS-206	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No
20050852-11 A Gross Alpha/Beta	K-SS-207	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No
20050852-12 A	K-SS-208	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No

20050852-[illegible] Gross Alpha/Beta	K-SS-209	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	[illegible]
20050852-14 A Gross Alpha/Beta	K-SS-210	Swipe	10/18/05	Plastic	Sm Zip Bag	None	No	No

CONTAINER INSPECTION

Coolers 0 Custody Seals Broken - Y/N N/A Temperature N/A Blue Ice/Wet Ice N/A Radiation Survey 1300 fixed _____ removable

SAMPLE INSPECTION

Custody Seals Broken - Y/N N/A Chain of Custody Record Y/N 0 Labels in Tact Y/N 0 Radiation Survey Complete Y/N 0

Anomalies: _____

Inspected By: Michelle Sutton DATE 10/20/05

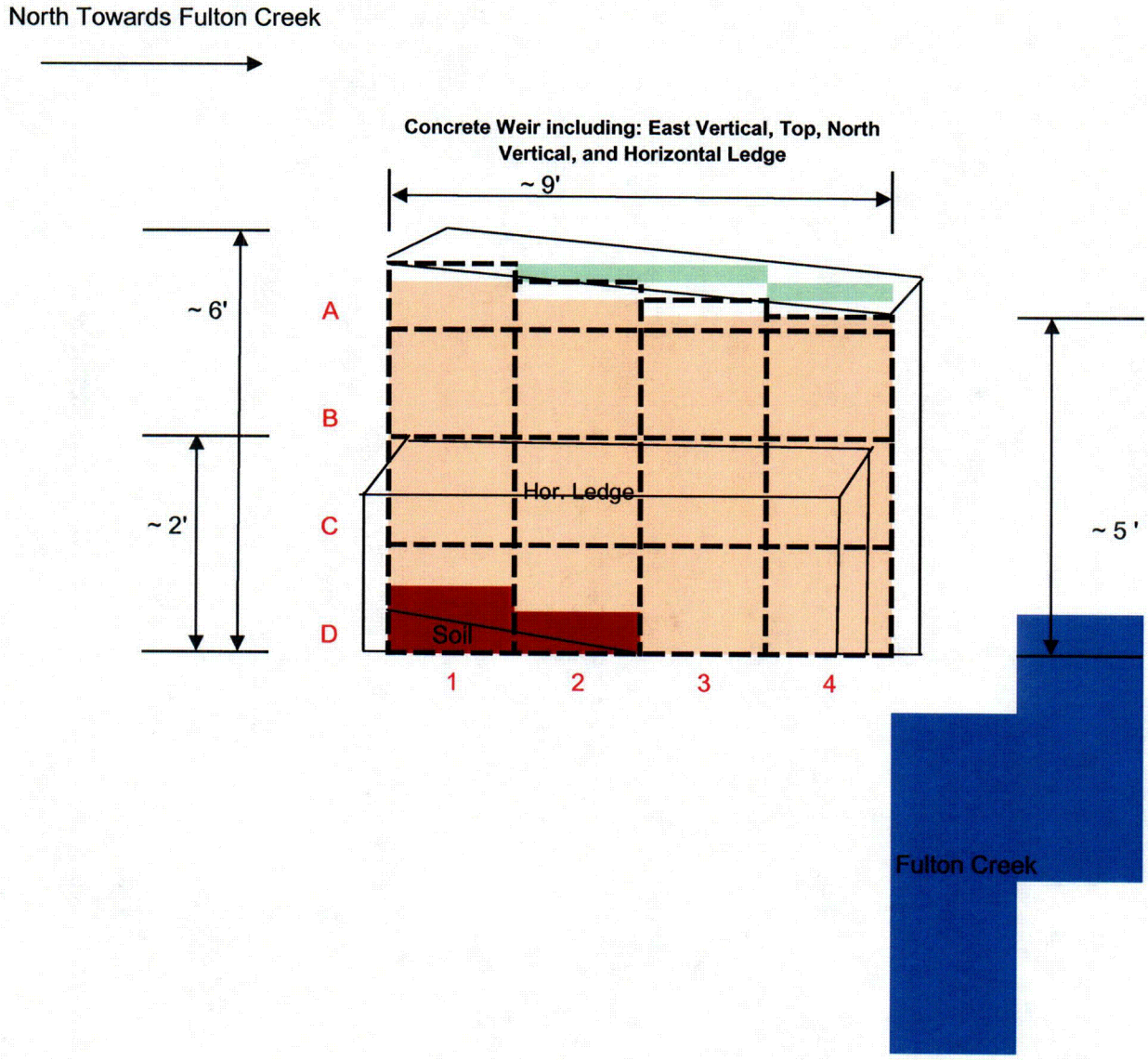
QA or Designee Review: [signature] DATE 10/20/05

Sample Custodian Review: _____ DATE _____

Project Notes:

ATTACHMENT D
TABLE OF CONTENTS

Attachment D, Figure D-1
Non-Impacted Concrete Weir Structure
Located Outside of Survey Unit Kaiser-FSS-022
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation



Alpha Scan MDC Calculation

KAISER-FSS-022

Instrument Serial Number:	193686	Cal. Due:	5/5/2006
Detector Serial Number:	PR190485	Cal. Due:	5/5/2006
Radiation Detected:	Alpha	FSS-022	For < 3 count background

Probability of observing 2 or more counts:

$$P(n \geq 2) = 1 - \left(1 + \frac{(GE+B)d}{60v}\right)\left(e^{\frac{(GE+B)d}{60v}}\right)$$

Probability of observing a single count:

$$P(n \geq 1) = 1 - e^{\frac{-GEd}{60v}}$$

	D Date	G Activity (dpm)	d Detector Width (cm)	E Instrument Efficiency (cpm)	v Scan Speed (cm/s)	B Background Countrate (cpm)	P Probability (-)
1	10/18/2005	359	11.7	0.1618	3.90	N/A	0.95
2							
3							
4							
5							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Comments:

Prepared By:	David B. Weyant	Date:	10/18/05
Reviewed By:	Andrew J. Lombardo	Date:	10/18/05

Notes:

1.) Instrument Efficiency is the 4π instrument efficiency.

Attachment D, Table D-1
Gross Alpha Scan Data Summary
Non-Impacted Concrete Weir Structure
Survey Unit Kaiser-FSS-022
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

ID	Smear #	Date	Tech	Rad. Type	Min (cpm)	Max (cpm)	Weighted Ave (cpm)	Instr. Used	Min (dpm)	Max (dpm)	Weighted Ave (dpm)
A-1-4	K-SS-197	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24
B-1	K-SS-198	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24
B-2	K-SS-199	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24
B-3	K-SS-200	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24
B-4	K-SS-201	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24
C-1	K-SS-202	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24
C-2	K-SS-203	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24
C-3	K-SS-204	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24
C-4	K-SS-205	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24
D-2	K-SS-207	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24
D-3	K-SS-208	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24
D-4	K-SS-209	10/18/05	DWD	alpha	0	10	0	#4	-24	173	-24

Total Alpha Contamination - Non-Impacted Concrete Weir
Survey Data Conversion Form
Form ESC/HPM/M-3-2-2

Date of Survey:	10/18/2005	Type of Radiation:	Alpha
Instrument Serial #:	193686	Calibration Due Date:	5/5/2006
Detector Serial #:	PR190485	Calibration Due Date:	5/5/2006
E_s (Surface Efficiency):	0.25	E_i (Insturment Efficiency):	0.1618
BKG Counts:	12.0	BKG Count Time (min):	10
Active Area of Detector Probe (cm^2):	126	MDC ($dpm/100cm^2$):	84.2

FSS Number	Survey Point Count Time (min)	Gross Counts (cts)	Gross Count Rate (cpm)	Net Count Rate (cpm)	Total Contamination ($dpm/100cm^2$)	95% CL Uncertainty ($dpm/100cm^2$)
A-1-4	2	16	8	7	133	78.1
B-1	2	6	3	2	35.3	48.9
B-2	2	6	3	2	35.3	48.9
B-3	2	14	7	6	114	73.2
B-4	2	12	6	5	94.2	67.9
C-1	2	13	7	5	104	70.6
C-2	2	9	5	3	64.7	59.2
C-3	2	14	7	6	114	73.2
C-4	2	27	14	12	241	101
D-2	2	15	8	6	124	75.7
D-3	2	34	17	16	310	113
D-4	2	11	6	4	84.4	65.1

Comments: Concrete Weir located north of Survey Unit Kaiser-FSS-022

Surface Area is approximately 6 square meters

Prepared By: David B. Weyant	Date: 10/20/2005
Reviewed By: Andrew J. Lombardo	Date: 10/20/2005

SUB-REPORT

SURVEY UNIT KAISER-FSS-023

TABLE OF CONTENTS

ATTACHMENTS

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-023
Survey Unit Kaiser-FSS-023
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility (**Figure 1**). Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-023, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the north-central portion of the Retention Pond area. Survey Unit Kaiser-FSS-023 is considered a Class 1 survey unit with an approximate surface area of 1,750 m^2. It is bounded to the south by Survey Units Kaiser-FSS-027 and Kaiser-FSS-028, to the east by Survey Units Kaiser-FSS-017 and Kaiser-FSS-018, to the north by Survey Units Kaiser-FSS-021 and Kaiser-FSS-022, and to the west by Survey Unit Kaiser-FSS-024 (**Figure 3**).

Survey Unit Kaiser-FSS-023 consists of an excavation bottom surface soil with no side walls. No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom surface soil of Survey Unit Kaiser-FSS-023. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 15 approximately equal-distant locations in the survey unit. The statistics for the 15 background measurements are provided below in **Table 1.** Background measurements ranged from 16,127 counts per minute (cpm) to 23,802 cpm moving northeast to southwest within the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the south-southwest of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 3,130 measurements of gross count rate were made at two second intervals across the survey unit's 1,750 m^2 surface area. The results ranged from 13,674 cpm to 23,818 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is also provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	1,750 m^2	
Number of Scan Measurements (2-Second Intervals):	3,130	
Detector Swing Rate: (Swinging the detector a width of 1-meter side to side)	0.28 m/s (MARSSIM recommends 0.5 m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	16,127	13,674
Maximum	23,802	23,818
Average	19,119	18,603
Standard Deviation	1,991	1,803
Median	18,927	18,501

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site). As part of the gross gamma survey, 6 biased soil samples were collected at locations exhibiting the highest scan rates on the excavation bottom **(Figure A-2, Attachment A).** The biased soil samples were screened on-site in a lead cave. Results of the sample

screening are presented below in **Table 2.** The sample screening levels were below the $DCGL_W$ for the site.

Table 2 – Biased Soil Sample Screening Results

Soil Sample ID	Cave Counter Screening Results (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)
$DCGL_W$	*3.0*		
Site Background	*1.1*	*0.3*	
K-1340	1.44	0.973	1.50
K-1341	1.78	1.06	1.50
K-1342	2.26	1.03	1.50
K-1343	1.90	1.18	1.50
K-1344	2.69	0.878	1.50
K-1345	1.90	0.750	1.50

2.2 Systematic Soil Sampling – Excavation Bottom Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 **(Attachment B).** Once N was determined, the Survey Unit Area (A) of 1,750 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 15.0 meters and the Height of the Equilateral Triangle (h) of 13.0 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 **(Attachment B).**

A layout of the soil sampling locations is provided on **Figure A-3** contained in **Attachment A.** The soil sample locations were demarcated in the field using a GPS unit. A total of 10 soil samples (identified as K-1258 through K-1267) were collected at the excavation bottom surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3.** Analytical data reports are contained in **Attachment C.**

Table 3 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-1258	0.881	0.122	0.372	0	3.0
K-1259	0.890	0.167	0.186	0	3.0
K-1260	0.882	0.109	0.342	0	3.0
K-1261	1.04	0.175	0.204	0	3.0
K-1262	1.18	0.254	0.698	0.08	3.0
K-1263	0.774	0.126	0.353	0	3.0
K-1264	0.681	0.172	0.242	0	3.0
K-1265	0.581	0.095	0.359	0	3.0
K-1266	1.32	0.200	0.490	0.22	3.0
K-1267	0.522	0.149	0.180	0	3.0
Average	***0.875***				
Standard Dev.	***0.253***				
Minimum	***0.522***				
Maximum	***1.32***				
Median	***0.882***				

All 10 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.32 pCi/g, which fell slightly above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 0.875 pCi/g. The standard deviation of the 10 equal-distant samples was 0.253, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (0.86 pCi/g) between the maximum survey unit soil sample activity concentration (1.32 pCi/g) and the minimum reference background area soil sample activity concentration (0.46 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	291	1.29	S1	K-1258	0.881
R2	312	1.26	S2	K-1259	0.890
R3	307	1.02	S3	K-1260	0.882
R4	263	1.54	S4	K-1261	1.04
R5	14	1.13	S5	K-1262	1.18
R6	222	1.19	S6	K-1263	0.774
R7	142	1.36	S7	K-1264	0.681
R8	357	0.94	S8	K-1265	0.581
R9	339	0.46	S9	K-1266	1.32
R10	38	1.02	S10	K-1267	0.522
	Average	***1.12***		***Average***	***0.875***
	Standard Dev.	***0.29***		***Standard Dev.***	***0.253***
	Minimum	***0.46***		***Minimum***	***0.522***
	Maximum	***1.54***		***Maximum***	***1.32***
	Median	***1.16***		***Median***	***0.882***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the north-central portion of the Retention Pond resulted in an open land area consisting of an excavation approximately 1,750 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-023 is considered a Class 1 survey unit. The survey unit is bounded to the south by Survey Units Kaiser-FSS-027 and Kaiser-FSS-028, to the east by Survey Units Kaiser-FSS-017 and Kaiser-FSS-018, to the north by Survey Units Kaiser-FSS-021 and Kaiser-FSS-022, and to the west by Survey Unit Kaiser-FSS-024 (**Figure 2**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-023 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 10 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results met the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-023 prior to backfill with below criteria material (BCM), as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 5.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

Table 5 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-023 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	$dpm/100cm^2$	0		0.00
TOTAL SUM OF FRACTIONS				***0.00***

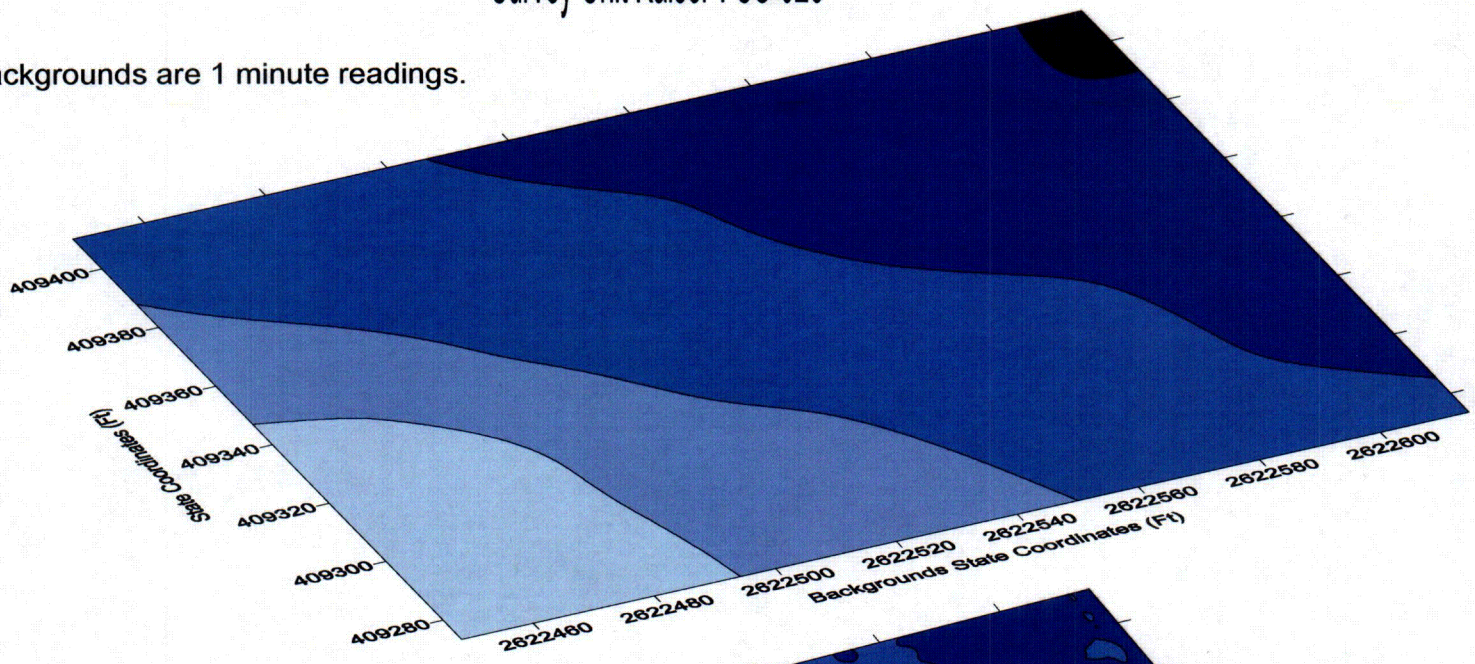
The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-023 meets the DP acceptance criteria.

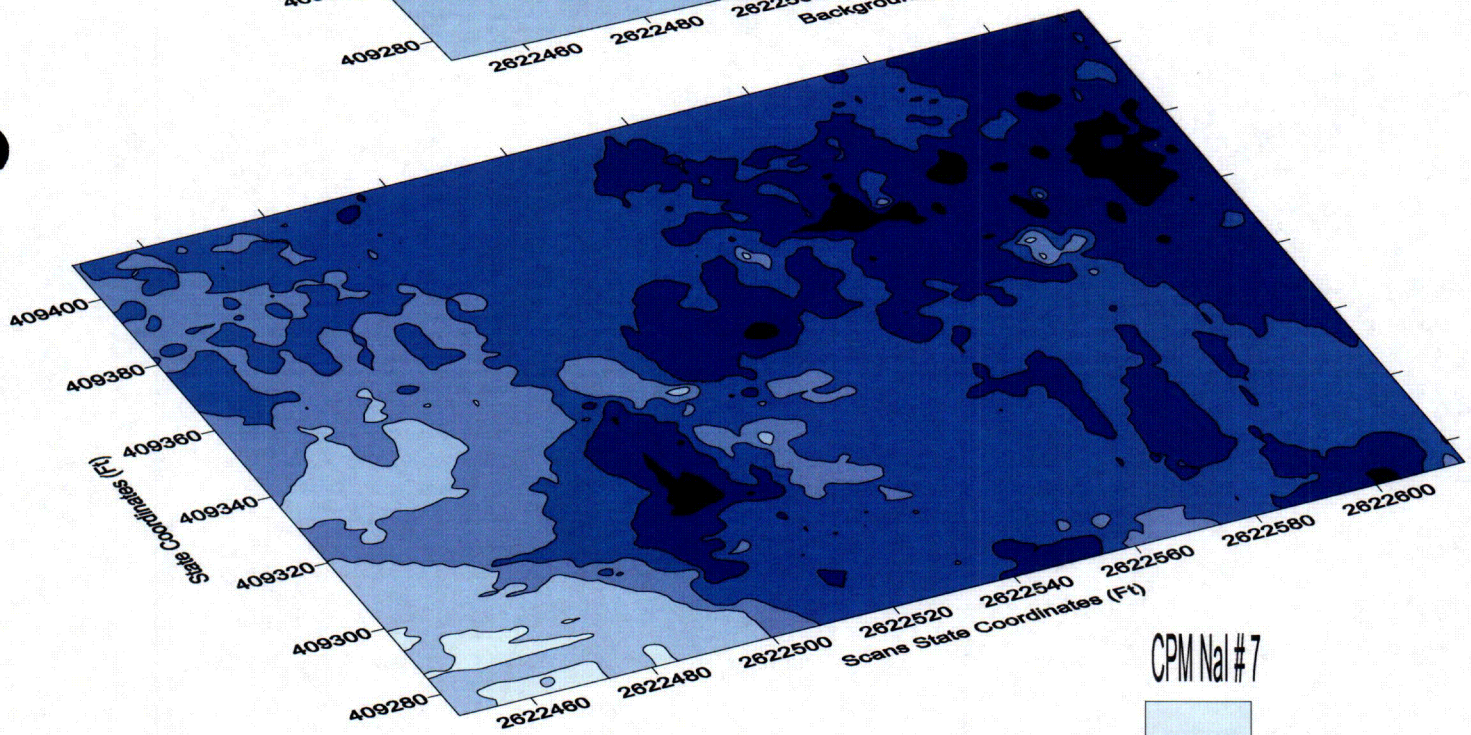
ATTACHMENT A
TABLE OF CONTENTS

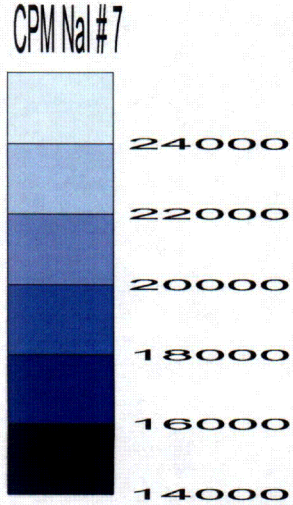
Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-023

N

Backgrounds are 1 minute readings.

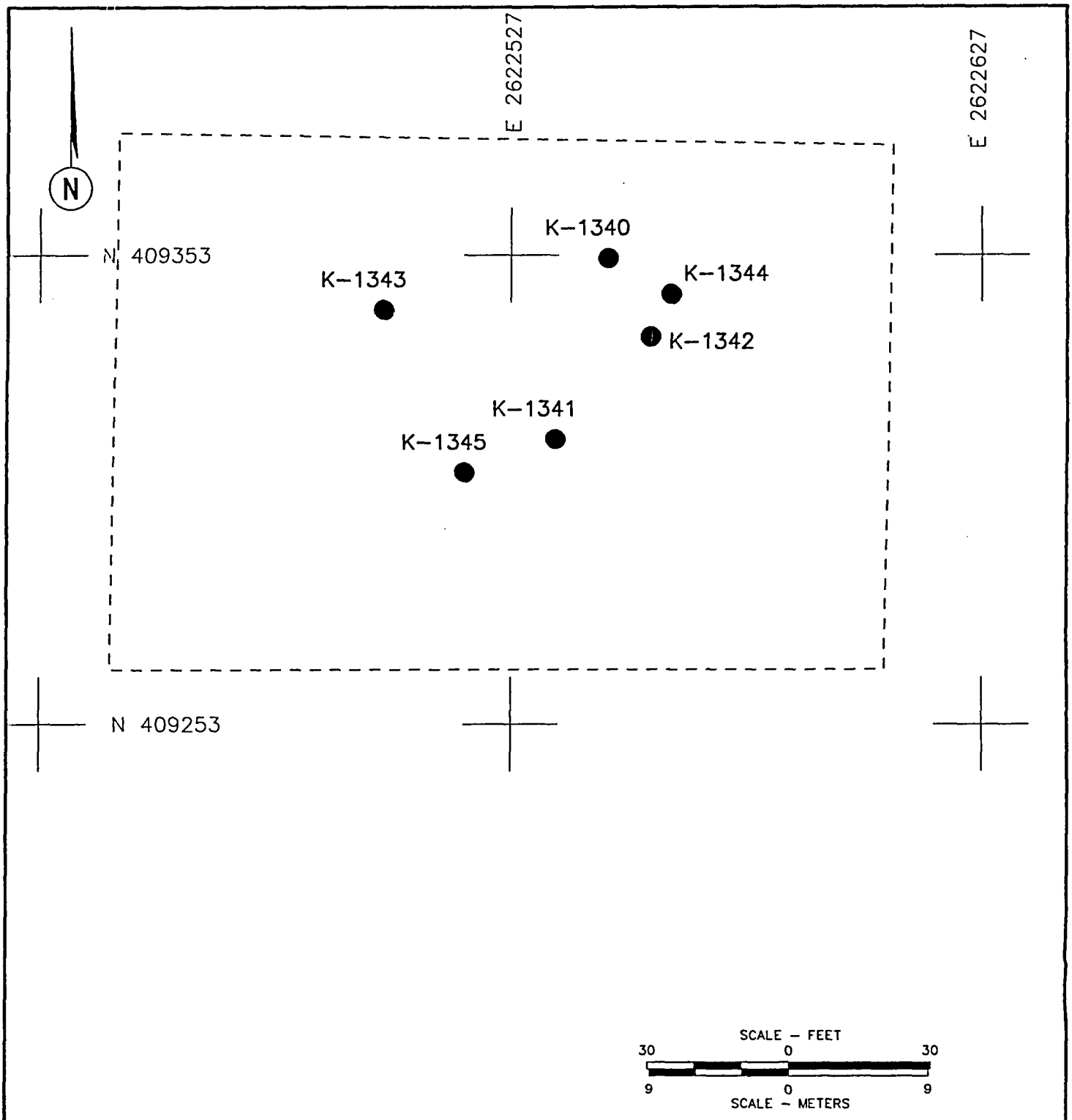






Scanning readings are recorded at 2 second intervals.

C68



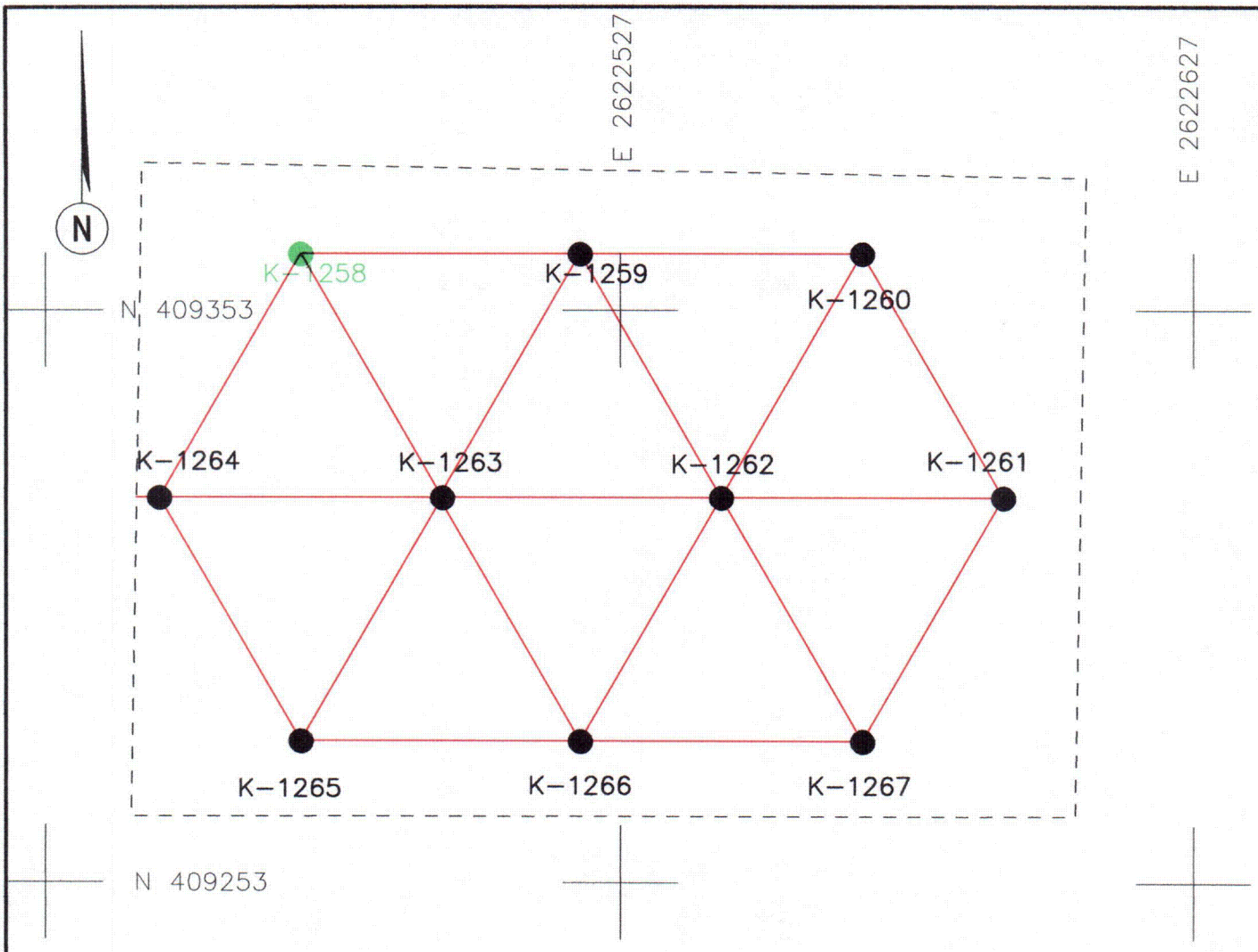
K-1340
● BIASED SOIL SAMPLING LOCATION
BASED ON GROSS GAMMA SCAN RESULTS

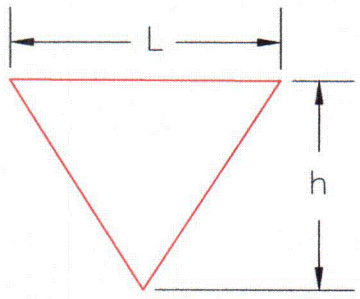
FIGURE A-2
GROSS GAMMA SURVEY BIASED SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS-023
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	3-3-06
CHECKED	3-3-06
DRAWN	DEB 2/20/05
DRAWING NUMBER	PA4072036C

Penn E&R
Environmental & Remediation, Inc.





N = 9 (10 COLLECTED)
L = 15.0m
h = 13.0m
AREA = 1,750m^2

SCALE – FEET
30 0 30
9 0 9
SCALE – METERS

K-1259
● SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K-1258
● RANDOM START POINT

FIGURE A-3
SYSTEMATIC SOIL SAMPLING LOCATIONS
SURVEY UNIT KAISER – FSS-023
FINAL STATUS SURVEY
THORIUM REMEDIATION PROJECT
TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RFD 3-3-06
CHECKED	RFD 3-3-06
DRAWN	DEB 10/18/05
DRAWING NUMBER	PA4072036B

Penn E&R
Environmental & Remediation, Inc.

ATTACHMENT B
TABLE OF CONTENTS

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-023

2. Description: Retention Pond Area, South of Survey Unit Kaiser-FSS-021

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – approximately 50 meters x 35 meters; Area, A (m^2): 1,750

5. Estimated of Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 15.0 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 13.0 m.

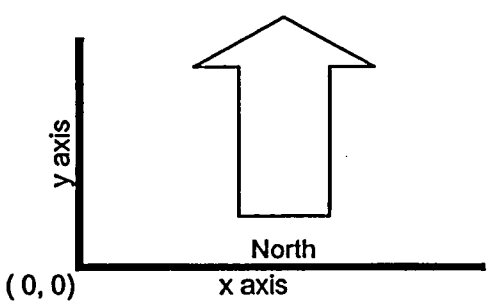
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-023

RANDOM START POINT

x axis (Meters)	y axis (Meters)
9	30

	x axis	y axis
lower bound	0	0
upper bound	50	35



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach
Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Limit 11604
D/- 12/15/05

December 13, 2005

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20050985

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on December 06, 2005 for the above captioned project. Ten soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5-work day turn. Results were faxed early on 12/13/05.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach Laboratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client: Kaiser Aluminum
Client Project: Thorium Remediation
Lab Number: 20050985
Date Reported: 12/13/05
Date Received: 12/6/05

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050985-01**						
Client ID:	**K-1258**						
Date Sampled:	**12/2/05 2:20:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.881 +/- 0.122	pCi/g	0.372		12/7/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	8.3	%		12/6/05	12/7/05	RT
Lab ID:	**20050985-02**						
Client ID:	**K-1259**						
Date Sampled:	**12/2/05 2:25:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.890 +/- 0.167	pCi/g	0.186		12/7/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.5	%		12/6/05	12/7/05	RT
Lab ID:	**20050985-03**						
Client ID:	**K-1260**						
Date Sampled:	**12/2/05 2:30:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.882 +/- 0.109	pCi/g	0.342		12/7/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	25.0	%		12/6/05	12/7/05	RT
Lab ID:	**20050985-04**						
Client ID:	**K-1261**						
Date Sampled:	**12/2/05 2:35:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	1.04 +/- 0.175	pCi/g	0.204		12/7/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	21.4	%		12/6/05	12/7/05	RT
Lab ID:	**20050985-05**						
Client ID:	**K-1262**						
Date Sampled:	**12/2/05 2:40:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	1.18 +/- 0.254	pCi/g	0.698		12/7/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	7.5	%		12/6/05	12/7/05	RT
Lab ID:	**20050985-06**						
Client ID:	**K-1263**						
Date Sampled:	**12/2/05 2:45:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.774 +/- 0.126	pCi/g	0.353		12/7/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	10.9	%		12/6/05	12/7/05	RT
Lab ID:	**20050985-07**						
Client ID:	**K-1264**						
Date Sampled:	**12/2/05 2:50:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.681 +/- 0.172	pCi/g	0.242		12/7/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	15.9	%		12/6/05	12/7/05	RT
Lab ID:	**20050985-08**						
Client ID:	**K-1265**						
Date Sampled:	**12/2/05 2:55:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232-	HASL 300	0.581 +/- 0.095	pCi/g	0.359		12/7/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	18.5	%		12/6/05	12/7/05	RT
Lab ID:	**20050985-09**						
Client ID:	**K-1266**						
Date Sampled:	**12/2/05 3:00:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	1.32 +/- 0.200	pCi/g	0.490		12/8/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.0	%		12/6/05	12/7/05	RT

BDL = Below Detection Limit

Outreach Laboratory
North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20050985
Date Reported:	12/13/05
Date Received:	12/6/05
Page Number:	3 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20050985-10**						
Client ID:	**K-1267**						
Date Sampled:	**12/2/05 3:05:00 PM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.522 +/- 0.149	pCi/g	0.180		12/8/05	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	12.9	%		12/6/05	12/7/05	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Ac228					NC				12/7/05
Am-241		57.0	95.0	50.0					12/7/05
Co-60		96.0	94.0	1.9					12/7/05
Cs-137		86.0	97.0	12.0					12/7/05
Percent Moisture					9.4				12/7/05

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN OF CUSTODY

Results To:
Company: Kaiser Alum & Chem Inc.
Name: David B. Weyant
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145
Phone: 724-934-3539 Fax #: 918-384-3171
Local: 918-384-0566
724-749-0071

Bill To:
Company: Kaiser/Penn E & R.
Name: David B. Weyant / Dave Handa
Address: 7311 E. 41st St.
City: Tulsa State: OK Zip: 74145

ANALYSIS REQUESTED

PO #: Kaiser 4072
PROJECT #: PA-4000-4072
PROJECT NAME: Kaiser Alum Thorium Reuse
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY): 5 Day
SAMPLER: Signature David W. Buffey

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec (Th-232)	Return to Client For Archive	MDC < 0.5 pCi/gm	Astm D2216-92 Moist. Content	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1258	12-3-05	1420	Soil	1	500 ML Plastic	None					Grab
	K-1259		1425		1							
	K-1260		1430		1							
	K-1261		1435		1							
	K-1262		1440		1							
	K-1263		1445		1							
	K-1264		1450		1							
	K-1265		1455		1							
	K-1266		1500		1							
	K-1267	↓	1505	↓	1	↓	↓					

RELINQUISHED BY: David B. Buffey DATE 12-6-05 TIME 913 RECEIVED BY: Donna Eidson DATE 12/6/05 TIME 913

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY

Sample Condition Upon Receipt: OK

Custody Seals Intact: N/A

Cooler Temperature: N/A

SAMPLE L(N

Date Received: *12/6/05 11:33:01* Lab Number: 20050985 Due: 12/13/05

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20050985-01 A	K-1258	Soil	12/02/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050985-02 A	K-1259	Soil	12/02/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050985-03 A	K-1260	Soil	12/02/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050985-04 A	K-1261	Soil	12/02/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050985-05 A	K-1262	Soil	12/02/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050985-06 A	K-1263	Soil	12/02/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050985-07 A	K-1264	Soil	12/02/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050985-08 A	K-1265	Soil	12/02/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050985-09 A	K-1266	Soil	12/02/05	Plastic	16 oz	None	Yes	Yes
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20050985-10 A	K-1267	Soil	12/02/05	Pl[illegible]	16 oz	None	Yes	Yes

Percent M : (LOD)

CONTAINER INSPECTION

Coolers 0 Custody Seals Broken ☐ Temperature Ice Radiation Survey: <300 cpm

SAMPLE INSPECTION

Sample Seal Broken NA Chain of Custody Record ☑ Labels in Tact ☑ Radiation Survey Complete ☑

Anomalies

Inspected By: Michelle Dutton DATE 12/06/05

QA or Designee Review: RT Raymond Utton DATE 12/06/05

Sample Custodian Review: [signature] DATE 12/6/05

Project Notes:

SUB-REPORT

SURVEY UNIT KAISER-FSS-024

TABLE OF CONTENTS

ATTACHMENTS

Final Status Survey Report
Volume I - Pond Parcel Excavation Bottom
Sub-Report No. EB-024
Survey Unit Kaiser-FSS-024
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation
March 22, 2006

1.0 BACKGROUND

This sub-report documents the results of pond parcel excavation bottom final status survey activities completed as part of the Thorium Remediation Project at the Tulsa, Oklahoma facility **(Figure 1)**. Specifically, this technical report addresses the final status survey of Survey Unit Kaiser-FSS-024, an open land area (pond parcel excavation bottom) resulting from the removal of radiologically-affected soil from the north-central portion of the Retention Pond area. Survey Unit Kaiser-FSS-024 is considered a Class 1 survey unit with an approximate surface area of 1,454 m^2. It is bounded to the south by Survey Unit Kaiser-FSS-025, to the east by Survey Unit Kaiser-FSS-023, to the north by Survey Unit Kaiser-FSS-022, and to the west by Survey Units Kaiser-FSS-006 and Kaiser-FSS-011 **(Figure 3)**.

Survey Unit Kaiser-FSS-024 consists of an excavation bottom surface soil with no side walls. No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit. No embedded "structures" were encountered during the removal of the radiologically-affected soil.

2.0 SURVEY ACTIVITIES AND RESULTS

This section of the sub-report presents the final status survey data for the excavation bottom surface soil of Survey Unit Kaiser-FSS-024. The final status survey consisted of a gross gamma scan of the exposed surface soil of the survey unit and systematic soil sampling.

2.1 Gross Gamma Scan

The exposed surface soil of the Class 1 survey unit (excavation bottom) was surveyed through a 100 percent coverage gamma scan to confirm acceptable radiological conditions and identify any elevated areas. During the scanning of the soil, the detector was held close to the ground surface (1 to 2 inches) and moved in a serpentine pattern. Background measurements were obtained at 1-meter above the ground surface at 13 approximately equal-distant locations in the survey unit. The statistics for the 13 background measurements are provided below in **Table 1.** Background measurements ranged from 16,831 counts per minute (cpm) to 21,495 cpm moving northeast to southwest within the survey unit. The scan results increase as the surveyor moves closer to impacted material located to the south-southwest of the survey unit.

Similar results were obtained for the gross gamma scan of the survey unit's surface area. A total of 2,376 measurements of gross count rate were made at two second intervals across the survey unit's 1,454 m^2 surface area. The results ranged from 15,438 cpm to 25,970 cpm. A statistical summary of the 100 percent coverage gamma scan of the survey unit is also provided below in **Table 1.**

Table 1 – Gross Gamma Scan Results Summary

Survey Area:	1,454 m^2	
Number of Scan Measurements (2-Second Intervals):	2,376	
Detector Swing Rate: (Swinging the detector a width of 1-meter side to side)	0.31 m/s (MARSSIM recommends 0.5 m/s)	
Results Summary:	**Background (Gross cpm)**	**Scan (Gross cpm)**
Minimum	16,831	15,438
Maximum	21,495	25,970
Average	18,844	19,202
Standard Deviation	1,392	1,661
Median	18,573	18,980

Contour maps of the gross gamma background and final (as-left condition) scanning survey results are presented on **Figure A-1** contained in **Attachment A.** The 100 percent coverage gross gamma scan did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site). As part of the gross gamma survey, 3 biased soil samples were collected at locations exhibiting the highest scan rates on the excavation bottom **(Figure A-2, Attachment A).** The biased soil samples were screened on-site in a lead cave. Results of the sample

screening are presented below in **Table 2.** The sample screening levels were below the $DCGL_W$ for the site.

Table 2 – Biased Soil Sample Screening Results

Soil Sample ID	Cave Counter Screening Results (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)
$DCGL_W$	*3.0*		
Site Background	*1.1*	*0.3*	
K-1408	1.40	0.856	1.51
K-1458	0.474	1.22	1.51
K-1459	1.89	0.914	1.51

2.2 Systematic Soil Sampling – Excavation Bottom Surface Soil

The final status survey also consisted of systematic soil sampling based on a random start point and an equal-distant triangular grid. The Minimum Number of Samples Required (N) based on the scan MDC was determined to be 9 as documented on Soil Survey Unit Worksheet No. 1 **(Attachment B).** Once N was determined, the Survey Unit Area (A) of 1,454 m^2 along with the N of 9 were used to calculate the Triangular Grid Node Length (L) of 13.7 meters and the Height of the Equilateral Triangle (h) of 11.8 meters. A random start point was generated using the random number feature of Excel and documented on Soil Survey Unit Worksheet No. 2 **(Attachment B).**

A layout of the soil sampling locations is provided on **Figure A-3** contained in **Attachment A.** The soil sample locations were demarcated in the field using a GPS unit. A total of 10 soil samples (identified as K-1438 through K-1447) were collected at the excavation bottom surface (0-6-inch depth interval) level using a clean, decontaminated sampling auger or sharpshooter shovel. The samples were forwarded to Outreach for analysis of Th-232 activity concentration. Analytical results are provided below in **Table 3.** Analytical data reports are contained in **Attachment C.**

Table 3 – Systematic Soil Sample Results

Soil Sample ID	Gross Th-232 (pCi/g)	Std. Error (pCi/g)	MDC (pCi/g)	Net Th-232 (pCi/g)	Net DCGL (pCi/g)
K-1438	1.21	0.175	0.191	0.11	3.0
K-1439	0.660	0.174	0.371	0	3.0
K-1440	1.07	0.075	0.188	0	3.0
K-1441	1.03	0.200	0.512	0	3.0
K-1442	0.792	0.208	0.370	0	3.0
K-1443	0.638	0.088	0.318	0	3.0
K-1444	1.05	0.181	0.404	0	3.0
K-1445	0.907	0.058	0.178	0	3.0
K-1446	1.47	0.225	0.303	0.37	3.0
K-1447	0.872	0.186	0.398	0	3.0
Average	***0.970***				
Standard Dev.	***0.254***				
Minimum	***0.638***				
Maximum	***1.47***				
Median	***0.969***				

All 10 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$). The maximum gross Th-232 activity concentration was 1.47 pCi/g, which fell slightly above the background Th-232 activity of 1.1 pCi/g for the site. The average gross Th-232 activity concentration was 0.970 pCi/g. The standard deviation of the 10 equal-distant samples was 0.254, which fell below the estimated standard deviation of 0.42 (based on the adjacent land final status survey results) used to calculate the minimum number of samples required.

2.3 Wilcoxon Rank Sum (WRS) Testing

The analytical results for the systematic soil samples were evaluated using the procedure contained in **Appendix C, Volume I** of this Final Status Survey Report (Wilcoxon Rank Sum Test). The evaluation showed that the survey unit soil sample results meet the DP statistical criterion based on the first statistical test as described below.

If the difference (1.12 pCi/g) between the maximum survey unit soil sample activity concentration (1.47 pCi/g) and the minimum reference background area soil sample activity concentration (0.35 pCi/g) is less than $DCGL_W$ (3.0 pCi/g), then the survey unit meets the release criterion. **Table 4** presents a summary of the data used to complete the statistical evaluation of the survey unit.

Table 4 – Reference Group and Survey Unit Sample Results

Reference Group	Sample ID	Th-232 (pCi/g)	Survey Unit Group	Sample ID	Th-232 (pCi/g)
R1	350	1.16	S1	K-1438	1.21
R2	217	1.28	S2	K-1439	0.660
R3	268	2.32	S3	K-1440	1.07
R4	298	1.38	S4	K-1441	1.03
R5	248	1.63	S5	K-1442	0.792
R6	165	0.54	S6	K-1443	0.638
R7	17	0.91	S7	K-1444	1.05
R8	281	1.39	S8	K-1445	0.907
R9	199	0.66	S9	K-1446	1.47
R10	3	0.35	S10	K-1447	0.872
	Average	***1.16***		***Average***	***0.970***
	Std. Dev.	***0.58***		***Std. Dev.***	***0.254***
	Minimum	***0.35***		***Minimum***	***0.638***
	Maximum	***2.32***		***Maximum***	***1.47***
	Median	***1.22***		***Median***	***0.969***

3.0 SUMMARY OF FINDINGS

The removal of radiologically-affected soil from the north-central portion of the Retention Pond resulted in an open land area consisting of an excavation approximately 1,454 m^2 in area. This open land area, identified as Survey Unit Kaiser-FSS-024 is considered a Class 1 survey unit. The survey unit is bounded to the south by Survey Unit Kaiser-FSS-025, to the east by Survey Unit Kaiser-FSS-023, to the north by Survey Unit Kaiser-FSS-022, and to the west by Survey Units Kaiser-FSS-006 and Kaiser-FSS-011 (**Figure 3**). This section of the sub-report presents a summary of the final status survey findings and an overall summation of fractions for the survey unit.

3.1 Excavation Bottom Surface Soil

The acceptance criterion for open land areas (pond parcel excavation bottom surface soil) at the Tulsa facility is the $DCGL_W$ of 3.0 pCi/g net Th-232 activity concentration. Final status survey activities for Survey Unit Kaiser-FSS-024 consisted of a gross gamma scan of the exposed surface soil of the survey unit (excavation bottom) and systematic soil sampling. The results of the final status survey activities were as follows:

- The 100 percent coverage gamma scan (final as-left condition) did not indicate the presence of small areas of elevated activity (above the $DCGL_W$ for the site).
- All 10 systematic soil sample results (gross and net) were below the open land area surrogate value of 3.0 pCi/g net Th-232 activity concentration ($DCGL_W$).
- The analytical results met the DP statistical criterion based on the first statistical evaluation of the data (WRS Test procedure).
- No elevated areas were left in-place, therefore, no elevated measurement comparisons were required for this unit.

3.2 Sum of Fractions for Entire Survey Unit

To evaluate the status of Survey Unit Kaiser-FSS-024 prior to backfill with below criteria material (BCM), as a whole (excavation bottom/side wall surface soil, elevated areas, and embedded structures), the fraction of each survey element's average net activity divided by the applicable acceptance criteria is calculated for inclusion in the Sum of Fractions for the entire survey unit. The Total Sum of Fractions for surface soil, elevated areas, and embedded structures respectively is presented below in **Table 5.** As previously mentioned, no embedded structures were encountered within the survey unit and no elevated areas were left in-place for the survey unit.

Table 5 – Fraction of Applicable Acceptance Criteria per Survey Unit Element

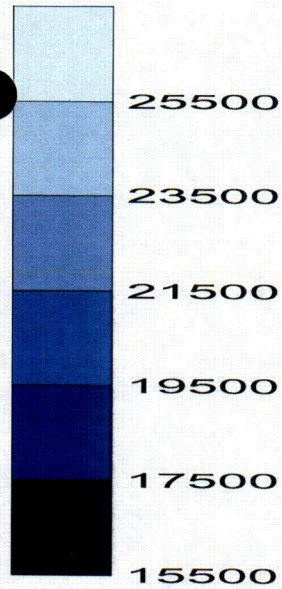
Survey Unit Element	Units	Average Net Activity	Acceptance Criteria	Fraction
-FSS-024 Excavation Bottom Soil	pCi/g	0	3.0	0.00
-Elevated Areas (None Left In-Place)	pCi/g	0		0.00
-Embedded Structures (None Encountered)	dpm/100cm^2	0		0.00
TOTAL SUM OF FRACTIONS				***0.00***

The Sum of Fractions provides a conservative assessment of the survey unit without backfill. The results of the Sum of Fractions assessment show that Survey Unit Kaiser-FSS-024 meets the DP acceptance criteria.

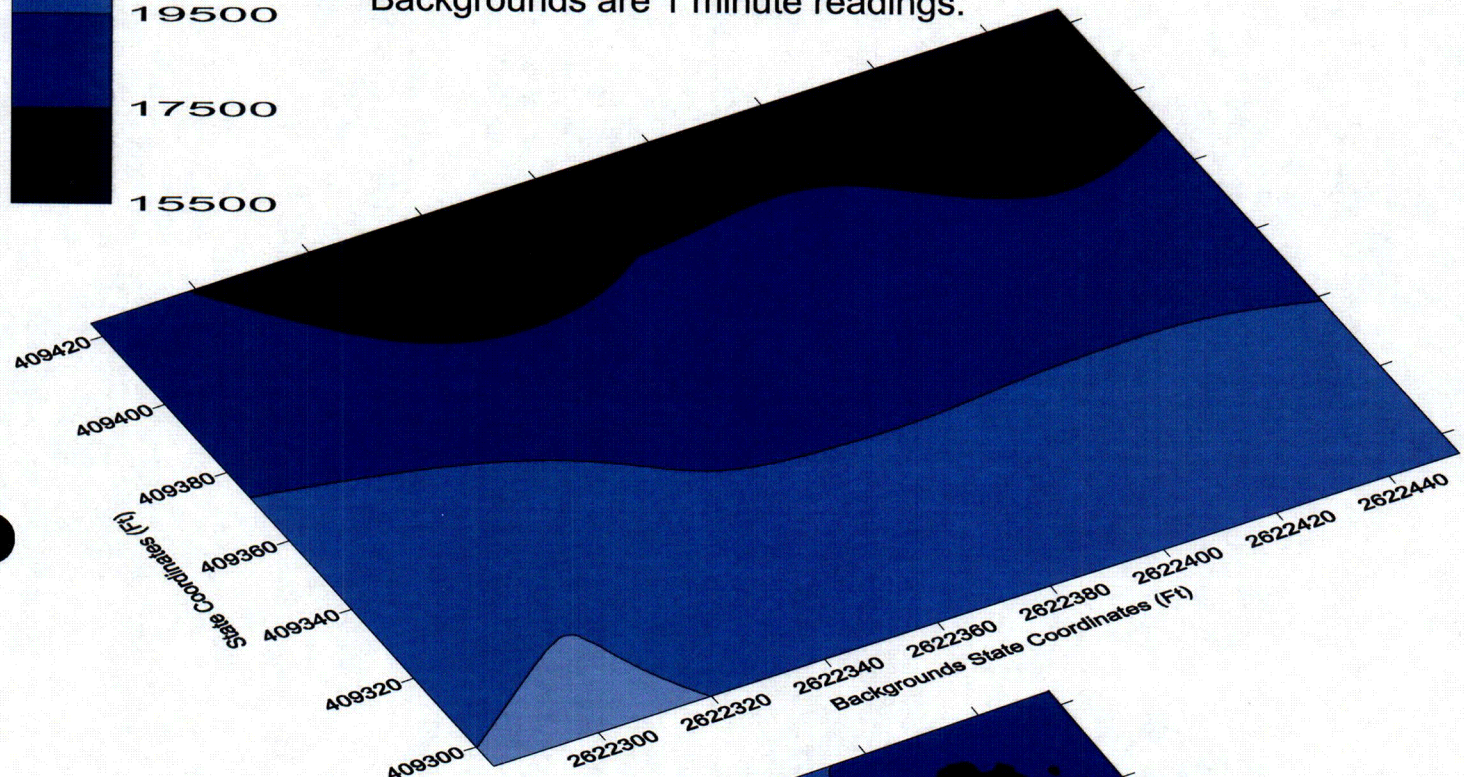
ATTACHMENT A
TABLE OF CONTENTS

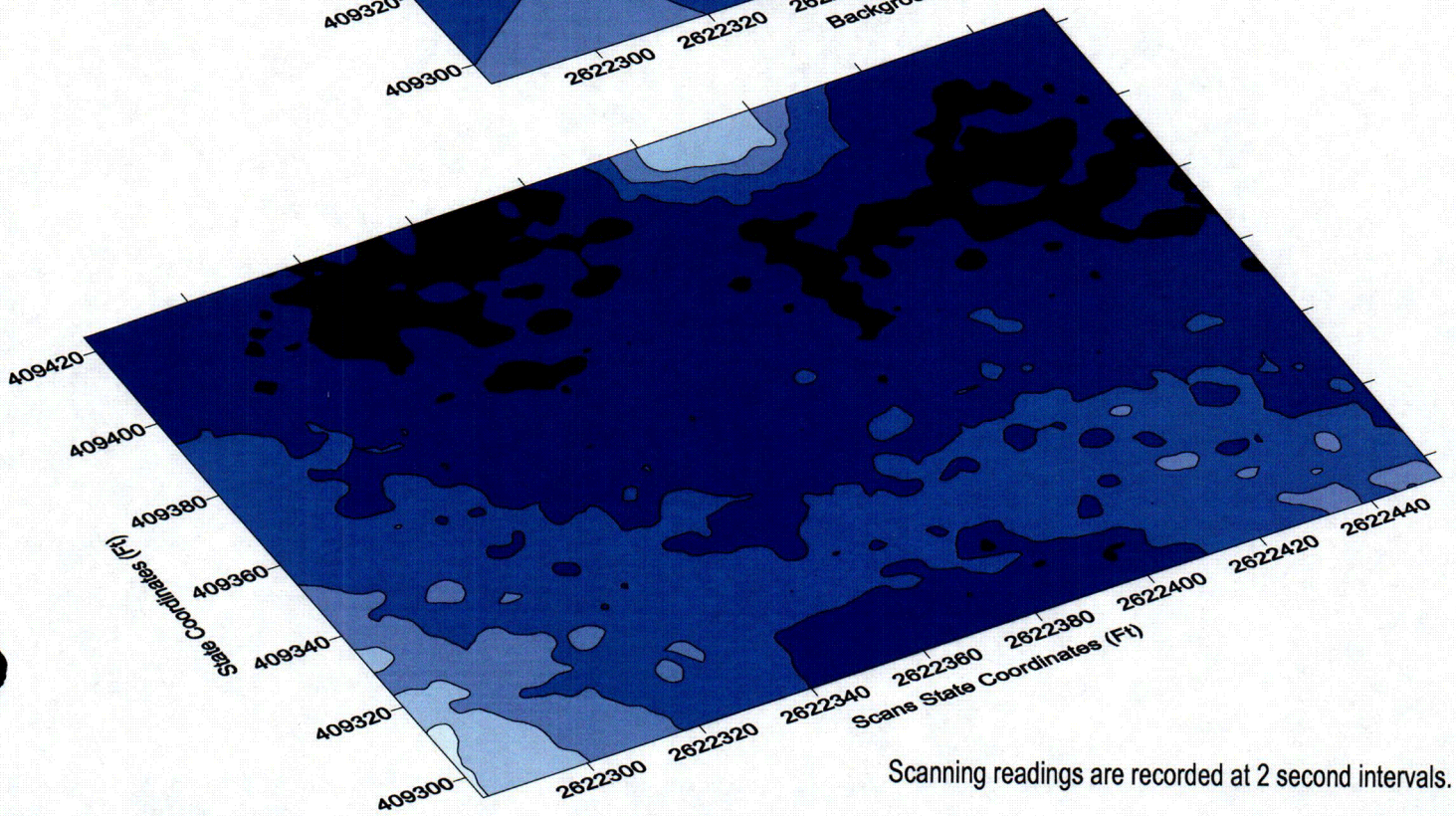
CPM NaI #7

Attachment A, Figure A-1
Gross Gamma Background and Scanning Survey Results
Survey Unit Kaiser-FSS-024



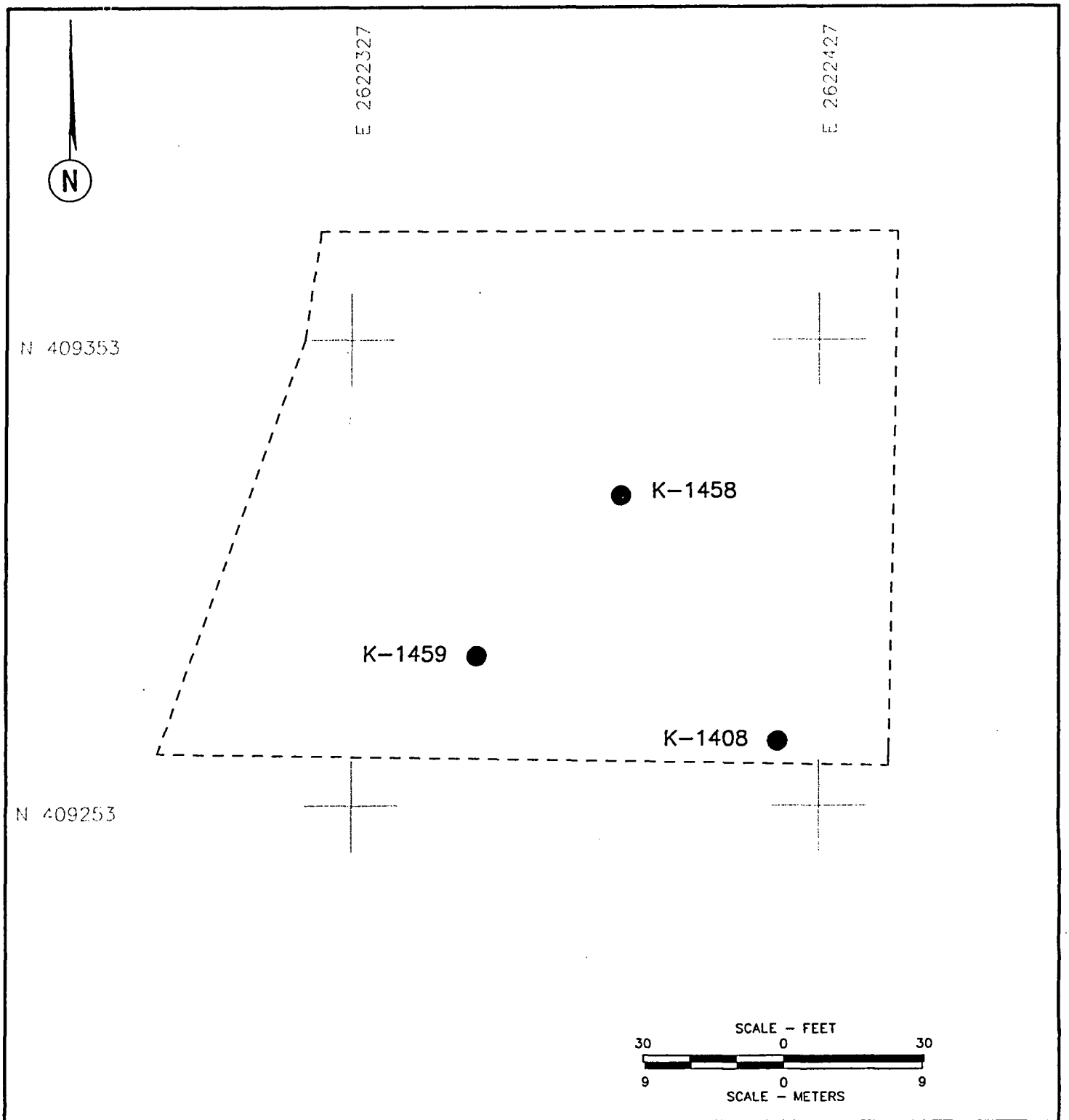
Backgrounds are 1 minute readings.





Scanning readings are recorded at 2 second intervals.

C70



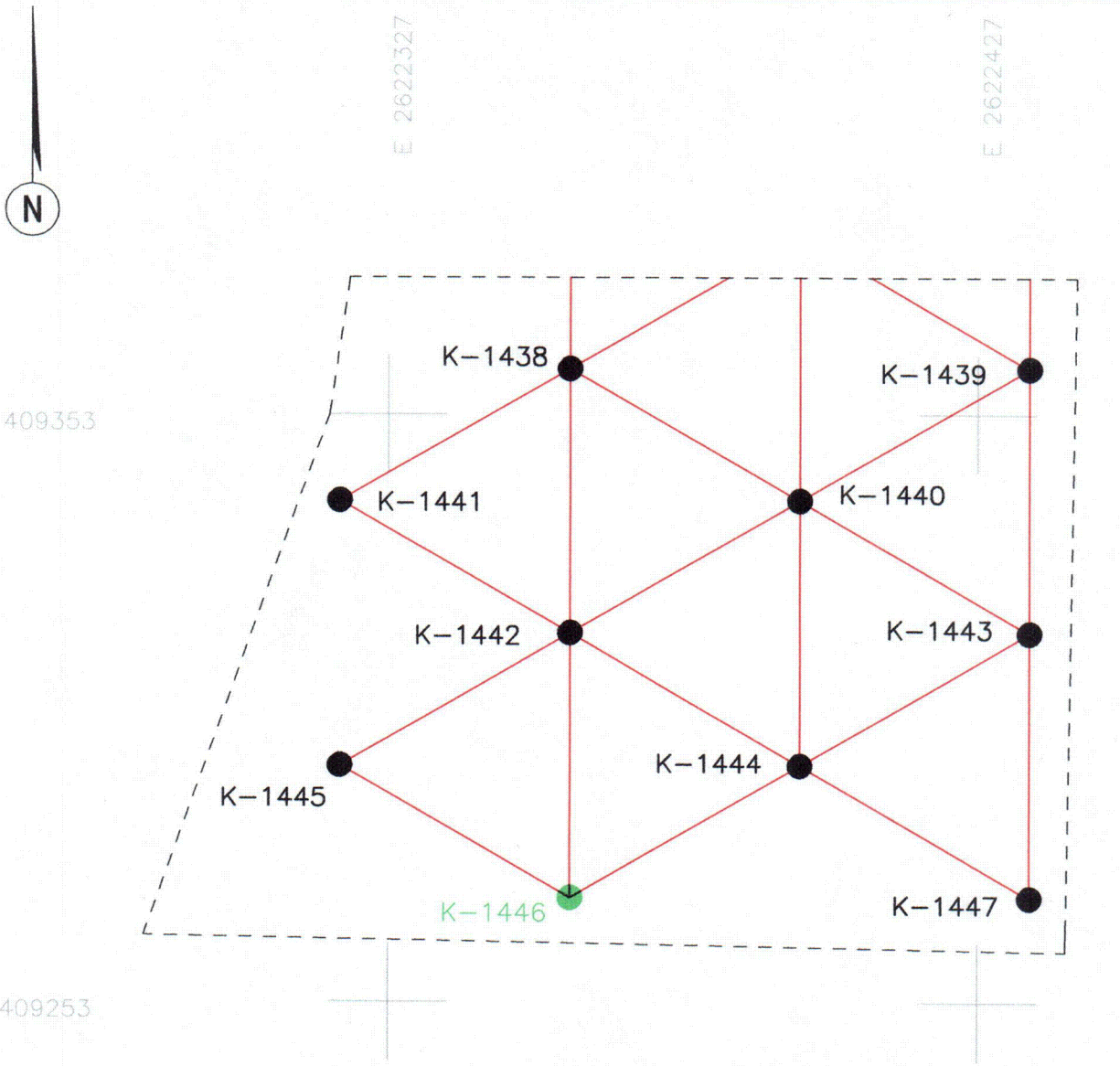
K–1458
● BIASED SOIL SAMPLING LOCATION BASED GROSS GAMMA SCAN RESULTS

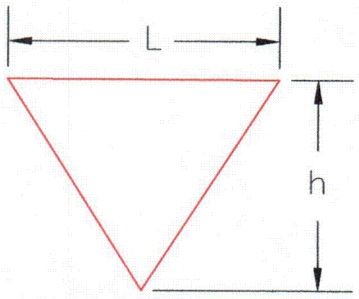
FIGURE A–2
GROSS GAMMA SURVEY BIASED SOIL SAMPLING LOCATIONS SURVEY UNIT KAISER – FSS–024 FINAL STATUS SURVEY THORIUM REMEDIATION PROJECT TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RD 3-3-06
CHECKED	RD 3-3-06
DRAWN	DEB 2/16/06
DRAWING NUMBER	PA4072037B

Penn E&R
Environmental & Remediation, Inc.





N = 9 (COLLECTED 10)
L = 13.7m
h = 11.8m
AREA = 1,454m^2

SCALE – FEET
30 0 30
9 0 9
SCALE – METERS

K-1438
- SYSTEMATIC SOIL SAMPLING LOCATION BASED ON RANDOM START POINT AND AN EQUAL DISTANT TRIANGULAR GRID

K-1446
- RANDOM START POINT

FIGURE A-3
SYSTEMATIC SOIL SAMPLING LOCATIONS SURVEY UNIT KAISER – FSS-024 FINAL STATUS SURVEY THORIUM REMEDIATION PROJECT TULSA, OKLAHOMA FACILITY

PREPARED FOR
KAISER ALUMINUM & CHEMICAL CORPORATION
TULSA, OKLAHOMA

APPROVED	RD 3.3.06
CHECKED	RD 3.3.06
DRAWN	DEB 10/18/05
DRAWING NUMBER	PA4072037A

Penn E&R
Environmental & Remediation, Inc.

ATTACHMENT B
TABLE OF CONTENTS

Soil Survey Unit Work Sheet No. 1
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

1. Soil Survey Unit: KAISER-FSS-024

2. Description: Retention Pond Area, West of Survey Unit Kaiser-FSS-023

3. Net Th-232 Acceptance Criteria (pCi/g): 3.0

4. Dimensions (m): Excavation Bottom – approximately 45 meters x 33 meters; Area, A (m^2): 1,454

5. Estimated of Gross Gamma Scan Background Readings (cpm)
Average: 20,000 Minimum: 10,000 Maximum: 50,000

6. Based on the maximum background gross gamma scan reading, the scan MDC (Minimum Detectable Concentration of Th-232), the corresponding N (Minimum Number of Required Samples) and L (Triangular Grid Node Length) for a standard 2,000 m^2 Class 1 survey unit are:

- Gross Gamma Scan MDC (pCi/g): 4.0
- Minimum Number of Samples (N): 9 Triangular Grid Node Length (L): 16.0 m

7. If the area of the Survey Unit is less than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) for the Survey Unit Area (A), using the following formula: $L_1 = (A/(0.866 \times 9))^{1/2}$: 13.7 m

8. If N is greater than 9 and the A is other than 2,000 m^2, recalculate the corresponding Triangular Grid Node Length (L_1) using the following formula $L_1 = (A/(0.866 \times N))^{1/2}$: N/A

9. If A is greater than 2,000 m^2 and N is equal to 9, recalculate the minimum number of samples (N_1) corresponding to a Triangular Grid Node Length (L) of 16 m using the following formula $N_1 = A / (0.866 \times 16^2)$, N_1: N/A

10. Calculate the height (h) of the equilateral triangle with side length equal to L (or L_1) using the following formula: $h = ((L^2 - (L/2)^2)^{1/2}$: 11.8 m.

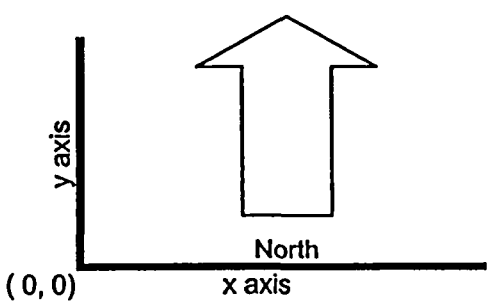
Soil Survey Unit Worksheet No. 2
Random Number Generator for Start Point
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

SURVEY UNIT: KAISER-FSS-024

RANDOM START POINT

x axis (Meters)	y axis (Meters)
22	2

	x axis	y axis
lower bound	0	0
upper bound	45	33



ATTACHMENT C

LABORATORY ANALYTICAL RESULTS

Outreach
boratory
orth Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Lucite 11723 Df-
2/8/06

February 2, 2006

David Weyant
Kaiser Aluminum & Chemical
7311 E. 41st Street
Tulsa, OK 74145

Project: Kaiser Thorium Remediation PA-4000-4072
OUTREACH LAB ID: 20060071

Dear Mr. Weyant:

Please find enclosed the analytical report for your samples received in our laboratory on January 26, 2005 for the above captioned project. Ten soil samples were received in good condition and analyzed by Gamma Spectroscopy without drying and grinding and Percent Moisture with an expedited 5-work day turn. Results were faxed on 2/2/06.

All Quality Control for the requested analyses is reported on the analytical report. The laboratory control standard and duplicates for all analyses were within method control limits with the exception of the Am-241 LCSD % REC and RPD. Results were not affected in any way.

Your samples will be returned as requested.

Thank you for choosing Outreach Laboratory and if you have any questions, please call us at 918-251-2515.

Laboratory Director

ODEQ ID #9517
DEQ LIC. #27522-01

ACCREDITED IN ACCORDANCE WITH nelac
CERT. ID #OK001

Outreach
boratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060071
Date Reported:	2/2/06
Date Received:	1/26/06
Page Number:	1 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20060071-01**						
Client ID:	**K-1438**						
Date Sampled:	**1/25/06 11:00:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	1.21 +/- 0.175	pCi/g	0.191		1/27/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	7.4	%		1/26/06	1/30/06	RT
Lab ID:	**20060071-02**						
Client ID:	**K-1439**						
Date Sampled:	**1/25/06 11:05:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.660 +/- 0.174	pCi/g	0.371		1/27/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	9.4	%		1/26/06	1/30/06	RT
Lab ID:	**20060071-03**						
Client ID:	**K-1440**						
Date Sampled:	**1/25/06 11:10:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	1.07 +/- 0.075	pCi/g	0.188		1/27/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	13.2	%		1/26/06	1/30/06	RT
Lab ID:	**20060071-04**						
Client ID:	**K-1441**						
Date Sampled:	**1/25/06 11:15:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	1.03 +/- 0.200	pCi/g	0.512		1/27/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	14.6	%		1/26/06	1/30/06	RT
ab ID:	**20060071-05**						
ient ID:	**K-1442**						
Date Sampled:	**1/25/06 11:20:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					

BDL = Below Detection Limit

Outreach Laboratory
3[illegible]orth Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060071
Date Reported:	2/2/06
Date Received:	1/26/06
Page Number:	2 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Thorium 232	HASL 300	0.792 +/- 0.208	pCi/g	0.370		1/31/06	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	12.9	%		1/26/06	1/30/06	RT
Lab ID:	**20060071-06**						
Client ID:	**K-1443**						
Date Sampled:	**1/25/06 11:25:00 AM**						
Matrix:	**Soil**						
Radiochemical Analyses							
Thorium 232	HASL 300	0.638 +/- 0.088	pCi/g	0.318		1/31/06	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	13.7	%		1/26/06	1/30/06	RT
Lab ID:	**20060071-07**						
Client ID:	**K-1444**						
Date Sampled:	**1/25/06 11:26:00 AM**						
Matrix:	**Soil**						
Radiochemical Analyses							
Thorium 232	HASL 300	1.05 +/- 0.181	pCi/g	0.404		1/31/06	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	16.9	%		1/26/06	1/30/06	RT
Lab ID:	**20060071-08**						
Client ID:	**K-1445**						
Date Sampled:	**1/25/06 11:30:00 AM**						
Matrix:	**Soil**						
Radiochemical Analyses							
Thorium 232	HASL 300	0.907 +/- 0.058	pCi/g	0.178		1/31/06	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	11.5	%		1/26/06	1/30/06	RT
Lab ID:	**20060071-09**						
Client ID:	**K-1446**						
Date Sampled:	**1/25/06 11:34:00 AM**						
Matrix:	**Soil**						
Radiochemical Analyses							
Thorium 232	HASL 300	1.47 +/- 0.225	pCi/g	0.303		1/31/06	SD
Inorganics Analyses							
Percent Moisture	ASTM D2216-92	24.2	%		1/26/06	1/30/06	RT

BDL = Below Detection Limit

Outreach
boratory
311 North Aspen
Broken Arrow, OK 74012
(918) 251-2515
FAX (918) 251-0008

Client:	Kaiser Aluminum
Client Project:	Thorium Remediation
Lab Number:	20060071
Date Reported:	2/2/06
Date Received:	1/26/06
Page Number:	3 of 3

Analytical Report

	Method	Result	Units	DL	Prep Date	Analysis Date	Analyst
Lab ID:	**20060071-10**						
Client ID:	**K-1447**						
Date Sampled:	**1/25/06 11:37:00 AM**						
Matrix:	**Soil**						
		Radiochemical Analyses					
Thorium 232	HASL 300	0.872 +/- 0.186	pCi/g	0.398		1/31/06	SD
		Inorganics Analyses					
Percent Moisture	ASTM D2216-92	18.4	%		1/26/06	1/30/06	RT

QC Report

Parameter	Blank	LCS %REC	LCSD %REC	LCSD RPD	DUP RPD	MS %REC	MSD %REC	MSD RPD	Date
Th-228					NC				1/27/06
Am-241		81.0	60.0	29.2					1/27/06
Co-60		93.0	95.0	2.2					1/27/06
Cs-137		95.0	87.0	9.7					1/27/06
Percent Moisture					7.2				1/30/06

Lab Approval: _____

BDL = Below Detection Limit

OUTREACH LABORATORY

311 North Aspen
Broken Arrow, OK 74012
Phone: (918) 251-2515
Fax: (918) 251-0008

CHAIN CUSTODY

Results To:
LOCAL 918-384-0566 Cell: 724-799-2271

Company Kaiser-Alum & Chem Inc.
Name DAVID R. WEYAND
Address 7311 E. 41st St.
City Tulsa State OK Zip 74145
Phone 724-993-3330 Fax # 918-384-3171

Bill To:
Company Kaiser/Penn Eng
Name Paula Hall/David R. Weyand
Address 7311 E. 41st St.
City Tulsa State OK Zip 74145

ANALYSIS REQUESTED

PO # Kaiser-4072
PROJECT # PA-4000-4072
PROJECT NAME Kaiser-Alum & Chem. Penn.
REQUESTED TURNAROUND TIME (ADDITIONAL CHARGES MAY APPLY) 5 Day
SAMPLER Signature DAVID R. WEYAND

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	# CONTAINERS	CONTAINER SIZE / PLASTIC OR GLASS	PRESERVATIVE # (1. HNO_3 pH<2; 2. Ice <4°C; 3. HCl pH<2; 4. H_2SO_4 pH<2; 5. NaOH pH>11)	Gamma Spec (4-232)	Pest. and PCB (Client Specific)	MDC 40 CFR Part 61 Appendix B Method 114 (Radon)	REMARKS (I.E. FILTERED, UNFILTERED, GRAB, COMPOSITE)
	K-1438	1-25-06	11:00	Soil	1	Plastic 500ml	None	X	X	X	Grab
	K-1439		11:05		1			X	X	X	
	K-1440		11:10		1			X	X	X	
	K-1441		11:15		1			X	X	X	
	K-1442		11:20		1			X	X	X	
	K-1443		11:25		1			X	X	X	
	K-1444		11:26		1			X	X	X	
	K-1445		11:30		1			X	X	X	
	K-1446		11:34		1			X	X	X	
	K-1447		11:37		1			X	X	X	

RELINQUISHED BY: DAVID R. WEYAND DATE 1-26-06 TIME 1000 RECEIVED BY: Donna Edelson DATE 1/26/06 TIME 1050

RELINQUISHED BY: _____ DATE _____ TIME _____ RECEIVED BY: _____ DATE _____ TIME _____

My signature on this chain of custody form indicates that I am authorized by the above company to release samples for analysis. The company agrees to pay the entire balance upon receipt of sample data and it is understood and agreed that any balance carried over thirty (30) days is subject to a 1.5% per month (18% per annum) late charge. In the event of default, the company becomes legally liable for any reasonable attorney and/or collection fees and all related costs necessary to remit the entire balance to Outreach Technologies, Inc. (Outreach Laboratory).

SAMPLE RETURN/DISPOSAL: All non-hazardous samples shall be disposed of 30 days after issue of final report. All others will be returned at client's expense.

FOR LABORATORY USE ONLY: Received on Ice
Sample Condition Upon Receipt: Good
Custody Seal Intact: Yes No N/A
Cooler Temperature: N/A

SAMPLE LOG-IN

Date Received: *1/26/06 11:07:56* Lab Number: 20060071 Due: 2/2/06

Sample Number	Client Sample ID	Matrix	Date Sampled	Container Type	Container Size	Preservation	Custody Seal	Seal Intact
20060071-01 A	K-1438	Soil	01/25/06	Plastic	16 oz	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060071-02 A	K-1439	Soil	01/25/06	Plastic	16 oz	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060071-03 A	K-1440	Soil	01/25/06	Plastic	16 oz	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060071-04 A	K-1441	Soil	01/25/06	Plastic	16 oz	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060071-05 A	K-1442	Soil	01/25/06	Plastic	16 oz	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060071-06 A	K-1443	Soil	01/25/06	Plastic	16 oz	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060071-07 A	K-1444	Soil	01/25/06	Plastic	16 oz	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060071-08 A	K-1445	Soil	01/25/06	Plastic	16 oz	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060071-09 A	K-1446	Soil	01/25/06	Plastic	16 oz	None	No	No
Gamma Spec - Thorium 232								
Percent Moisture (LOD)								
20060071-10 A	K-1447	Soil	01/25/06	Plastic	16 oz	NaOH, pH > 11	No	No

CONTAINER INSPECTION

Coolers 0 Custody Seals Broken ☐ Temperature: C Ice Radiation Survey: <300 cpm

SAMPLE INSPECTION

Sample Seal Broken No Chain of Custody Record ☑ Labels in Tact ☑ Radiation Survey Complete ☑

Anomalies

Inspected By: _____ DATE _____

QA or Designee Review: Raymond Thomas DATE 01/26/06

Sample Custodian Review: [signature] DATE 1/26/06

Project Notes:

APPENDIX A

SURVEY INSTRUMENTATION QA/QC

APPENDIX A-1

SURVEY UNIT KAISER-FSS-001

Appendix A-1, Table A-1-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-001
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-001	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	206873	PR211675	05/17/04 to 05/17/05	05/22/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.
Ludlum 2360 Alpha-Beta Scaler /Rate Meter with 43-68 100cm^2 Gas Proportional Alpha-Beta Detector	193686	PR190485	05/04/04 to 05/04/05	05/24/04	Simultaneous alpha-beta counting and discrimination - Instrument was used to survey embedded structures.

APPENDIX A-1-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 206873 (meter) and PR211675 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. . Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:206873

Cal Date: 05/17/04 Cal Due Date: 05/17/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☒ applies to applicable instruments and/or detector IAW Mfg. Spec. T 76.1 °F RH 44 % Alt. 1120 Ft.

☒ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck.	☒ Meter Zeroed	☐ Background Subtract	☒ Input Sens. Linearity
☒ F/S Resp. OK	☒ Reset Ck.	☒ Window Operation	☒ Geotropism
☒ Audio. Ck.	☐ Alarm Setting Ck.	☒ Batt. Ck. (Min. Volt) 6.2 VDC	

☒ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 900 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 669 /670 V Ref./Inst. 995 / 1000

COMMENTS: *Digital Calibration done using a 0.1 minute count time. Results reflect that count time.*

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	395000 cpm	395000 cpm
X1K	100 kcpm	100000 cpm	100000 cpm
X100	40 Kcpm	39500 cpm	39500 cpm
X100	10 Kcpm	10000 cpm	10000 cpm
X10	4 Kcpm	3950 cpm	3950 cpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	38 cpm	38 cpm	Log Scale	50 cpm	60 cpm	60 cpm
	400 Kcpm	39116 cpm	39116 cpm		500 Kcpm	500000 cpm	500000 cpm
	40 Kcpm	3917 cpm	3917 cpm		50 Kcpm	50000 cpm	50000 cpm
	4 Kcpm	392 cpm	392 cpm		5 Kcpm	5000 cpm	5000 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N ☐ Beta S/N ☐ Other Cs137 2485

☒ M 500 S/N 187460 ☐ Oscilloscope S/N ☐ Multimeter S/N 020513278

Calibrated By: R. Shank

Reviewed By: Corey E Smith

Date: 05/17/04

Date: 5/17/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument :	Ludlum
Model No,	2221
Serial No.	206783 873
Probe:	44-10
Serial No.	PR 211675

DATE:	5/17/2004
Source:	Cs137
Serial no.	2485
Strength:	I uci

	Background Count (cpm)	Source Count (cpm)	H.V.
1	4777	95849	700
2	5385	98961	750
3	5517	104186	800
4	5600	108132	850
5	5675	108795	**900**
6	5832	109020	950
7	5680	111082	1000
8	5849	111402	1050
9	6073	112078	1100
10	5782	115675	1150
11	N/A	N/A	1200
12	N/A	N/A	1250

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

CONTACT

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	232,512 + 2σ
	207,841 - 2σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:22	5/22/2004	9,353	227,706	218,353	DBW	YES	6.1	YES

238,680 + 3σ

201,672 - 3σ

Comments: Background 5 minute count. Source count 1 minute.

Recalibrated by Enercon to Cs-137.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

6 INCHES

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,206 + 2σ
	7,637 - 2σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:22	5/22/2004	9,353	17,505	8,152	DBW	YES	6.1	YES

Comments: Background 5 minute count. Source count 1 minute.

Recalibrated to Cs-137 by Enercon.

APPENDIX A-1-2

Ludlum Model 2360 Alpha-Beta Scaler/Rate Meter
with Model 43-68 100 cm² Gas Proportional Alpha-Beta Detector
Serial Nos. 193686 (meter) and PR190485 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

6129

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER KAISER ALUMINUM ORDER NO. 215373/281348

Ludlum Measurements, Inc. Model 2360 Serial No. 193686

Mfg. Ludlum Measurements, Inc. Model 43-68 Serial No. PR-190485

Cal. Date 4-May-04 Cal Due Date 4-May-05 Cal. Interval 1 Year Meterface 202-855

heck mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 28 % Alt 705.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☐ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC
☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

strument Volt Set 1575 V

☑ HV Readout (2 points) Ref./Inst. 500 / 491 V Ref./Inst. 1500 / 1992 V

Firmware Version: 39010N24
Alpha Threshold: 120mv
Beta Threshold: 3.5mv
Beta Window: 50mv
Overload Checked But not set
Instrument calibrated with a 39" cable.
High voltage set with detector Connected

(EEPROM Settings)
User Time: 001.0
Alpha Alarm: 050000
Beta Alarm: 050000
A/B Alarm: 050000
Model 2360 Date: 4 May 04
Calibration Date Due: 4 May 05

COMMENTS:
Eff. for Th230 ≈ 35.5% 2pi, Background count 1cpm, Source count 1036cpm, Source Size 2910cpm
Eff. for Th232 ≈ 46.6% 2pi, Background count 1cpm, Source count 64cpm, Source Size 135cpm
for Tc99 ≈ 48.0% 2pi, Background count 93cpm, Source count 6865cpm, Source Size 14100cpm

oration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
x1000	400kcpm	400	400
x1000	100kcpm	100	100
x100	40kcpm	400	400
x100	10kcpm	100	100
x10	4kcpm	400	400
x10	1kcpm	100	100
x1	400kcpm	400	400
x1	100kcpm	100	100

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
gital adout	400kcpm	39985(0)	39985(0)
	40kcpm	3999	3999
	4kcpm	400	400
	400cpm	40	40
	40cpm	4	4

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Log Scale			

lum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of er International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

eference Instruments and/or Sources:

s-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

oha S/N Th230 #5020-03/Th232 #3153 ☑ Beta S/N Tc99 SN: NT-EV ☐ Other

☑ ...1 500 S/N 50800 ☐ Oscilloscope S/N ☑ Multimeter S/N 83990502

Calibrated By: Charles Robb Date 4 May 04

Reviewed By: WA Robbins Date 5 may 04

his certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.

AC Inst ☐ Passed Dielectric (All Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

9/7/10
6/29

Bench Test Data For Detector

Detector 43-68 Serial No. PR-190485 Order #. 215373/281348

Customer KAISER ALUMINUM Alpha Input Sensitivity 120 mV

Counter 2360 Serial No. 193686 Beta Input Sensitivity 3.5 mV

Count Time 1Minute Beta Window 50 mV

Other _____ Distance Source to Detector Surface

High Voltage	Background Alpha	Background Beta	Isotope Th230 Size 2910 cpm Alpha	Isotope Th230 Size 2910 cpm Beta	Isotope Th232 Size 135 cpm Alpha	Isotope Th232 Size 135 cpm Beta	Isotope Tc 99 Size 14100 cpm Alpha	Isotope Tc 99 Size 14100 cpm Beta
1525	2	99	943	411	51	185	0	6731
1550	0	124	1116	428	47	197	0	7566
1575	1	93	1036	500	64	251	1	6865
1600	2	208	1075	526	55	306	18	7471
1625	0	202	1174	483	55	287	149	6722

☑ Gas Proportional detector count rate decreased ≤ 10% after 15 hour static test using 39" cable.

☐ Gas proportional detector count rate decreased ≤ 10% after 5 hour static test using 39" cable and alpha/beta counter.

Signature Charles Disk Date 4 May 04

FORM C4B 04/09/2003

Form HPM/M-2-8-1
Daily Check Log for Ludlum Model 2360 with 43-68 Detector
Instrument 2 Alpha

Instrument/SN: Ludlum Model **2360 193686**					*Check Source(s) Used:* Th-230, S/N 5053-03						
Detector/SN: Model 43-68 /PR190485											
EFF %: α= 17.78 % 4π					*source check acceptance criteria*		α				
CALIB. SOURCE USED: Th-230					**Average (NCPM):**		2,564				
DATE OF CALIB.: **5/4/2004**					**+2 sigma:**		2,655				
CALIB. DUE DATE: **5/4/2005**					**-2 sigma:**		2,474				
PERFORMED BY: **Ludlum Measurements Inc.**					**+3 sigma:**		2,700				
					-3 sigma:		2,429				
TECHNICIAN'S NAME		ALPHA/ BETA	RESPONSE CHECK	DATE	TIME	60 min Bkgrd (cpm)	1 min gross (cpm)	1 min net (cpm)	within +/- 2 sigma	within +/- 3 sigma	<10% drop
DBW	1	Alpha	SAT	5/24/2004	14:01	1.12	2,629	2,628	YES	YES	NA
DBW	2	Alpha	SAT	5/24/2004	18:00	0.83	2,570	2,569	YES	YES	YES

APPENDIX A-2

SURVEY UNIT KAISER-FSS-002

Appendix A-2, Table A-2-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-002
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-002	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	157032	PR206809	03/03/04 to 03/03/05	05/23/04 to 05/26/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-2-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 157032 (meter) and PR206809 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:157032

Cal Date: 03/03/04 Cal Due Date: 03/03/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☐ applies to applicable instruments and/or detector IAW Mfg. Spec. Temp. 68.9 °F RH 27 % Alt. 1120 Ft.

☐ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck. ☒ Meter Zeroed ☐ Background Subtract ☒ Input Sens. Linearity

☒ F/S Resp. OK ☒ Reset Ck. ☒ Window Operation ☒ Geotropism

☒ Audio. Ck. ☐ Alarm Setting Ck. ☒ Batt. Ck. (Min. Volt) 5.2 VDC

☐ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 1000 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 1500 / 1500 V Ref./Inst. 1000 / 1000 V.

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.
Zero button sticks

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	400 Kcpm	400 Kcpm
X1K	100 kcpm	100 Kcpm	100 Kcpm
X100	40 Kcpm	40 Kcpm	40 Kcpm
X100	10 Kcpm	10 Kcpm	10 Kcpm
X10	4 Kcpm	4000 cpm	4000 cpm
X10	1 Kcpm	900 cpm	900 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	39 cpm	39 cpm	Log Scale	50 cpm	50 cpm	50 cpm
	400 Kcpm	39618 cpm	39618 cpm		500 Kcpm	500 Kcpm	500 K cpm
	40 Kcpm	3962 cpm	3962 cpm		50 Kcpm	50 Kcpm	50 Kcpm
	4 Kcpm	397 cpm	397 cpm		5 Kcpm	5 Kcpm	5 Kcpm
	40 cpm	4 cpm	4 cpm		500 cpm	450 cpm	450 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:
Cs-137 Gamma S/N ☐ 6205GF
☐ Alpha S/N _____ ☐ Beta S/N _____ ☐ Other _____

☒ M 500 S/N 187460 ☐ Oscilloscope S/N _____ ☒ Multimeter S/N 020513278

Calibrated By: R. Shank Ralph R Shank Date: 03/03/04

Reviewed By: Kenneth J McClung Date: 03/09/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument :	Ludlum		**DATE:**	3/29/2004		**TEMP.:**	67
Model No,	2221		**Source:**	Cs137	**S.N.**	**R.H.:**	34%
Serial No.	157032		**Strength:**	1.0uci	2485		
Probe:	44-10						
Serial No.	PR206809						

	Voltage	Background Count (cpm)	Source Count (cpm)
1	600	N/A	N/A
2	650	N/A	N/A
3	700	1791	174173
4	750	2001	179682
5	800	2075	190450
6	850	2132	195749
7	900	2187	195411
8	950	2150	197763
9	1000	2061	199119
10	1050	2132	199591
11	1100	2375	211691
12	1150	2723	283180
13	1200	N/A	N/A
14	1250	N/A	N/A
15	1300	N/A	N/A

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 2

Instrument Model:	2221
Instrument S/N:	157032
Detector Model:	44-10
Detector S/N:	PR206809
Calibration Due:	3/3/05

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	241,361 + 2σ		257,378 + 3σ
	177,299 - 2σ		161,282 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	8:40	5/23/2004	9,569	222,844	213,275	DBW	YES	5.6	YES
2	20:20	5/23/2004	9,611	221,330	211,719	DBW	YES	5.5	YES
3	8:10	5/24/2004	9,624	222,263	212,639	DBW	YES	5.5	YES
4	18:30	5/24/2004	9,482	223,653	214,171	DSB	YES	5.4	YES
5	16:05	5/25/2004	9,640	224,336	214,696	DBW	YES	5.5	YES
6	16:55	5/25/2004	9,668	234,858	225,190	DBW	YES	5.5	YES

Comments: Moved cource check location to furnace room (lower background). Background 5 min. count.
Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 2

Instrument Model:	2221
Instrument S/N:	157032
Detector Model:	44-10
Detector S/N:	PR206809
Calibration Due:	3/3/05

6 INCHES

Source S/N:	Cs-137 sn: 547	
Source DPM:	N/A	
Radiation Detected:	gamma	
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,597 + 2σ	8,731 + 3σ
	8,061 - 2σ	7,927 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	8:40	5/23/2004	9,569	17,731	8,162	DBW	YES	5.6	YES
2	20:20	5/23/2004	9,611	17,678	8,067	DBW	YES	5.5	YES
3	8:10	5/24/2004	9,624	17,735	8,111	DBW	YES	5.5	YES
4	18:40	5/24/2004	9,688	17,869	8,181	DSB	YES	5.4	YES
5	16:05	5/25/2004	9,640	17,988	8,348	DBW	YES	5.5	YES

Comments: Moved cource check location to furnace room (lower background). Background 5 min. count.
Source check 1 minute count.

APPENDIX A-3

SURVEY UNIT KAISER-FSS-003

Appendix A-3, Table A-3-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-003
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-003	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	172053	PR206815	01/07/04 to 01/07/05	06/11/04 to 06/12/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-3-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 172053 (meter) and PR206815 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:172053

Cal Date: 01/07/04 Cal Due Date: 01/07/05 Cal. Interval: 12 mo.'s Meterface : 202-159

Check mark ☑ applies to applicable instruments and/or detector IAW Mfg. Spec. T 71.1 °F RH 27 % Alt. 1120 Ft.

☐ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☑ Mechanical Ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity

☑ F/S Resp. OK ☑ Reset Ck. ☑ Window Operation ☑ Geotropism

☑ Audio. Ck. ☐ Alarm Setting Ck. ☑ Batt. Ck. (Min. Volt) 5.2 VDC

☑ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 902 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 1500 /1500 V Ref./Inst. 903 / 902

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Replaced Window switch knob.

Repaired audio control switch. Re-soldered wires.

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	400 Kcpm	400 Kcpm
X1K	100 kcpm	100 Kcpm	100 Kcpm
X100	40 Kcpm	40 Kcpm	40 Kcpm
X100	10 Kcpm	10 Kcpm	10 Kcpm
X10	4 Kcpm	4 Kcpm	4 Kcpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	40 cpm	40 cpm	Log Scale	50 cpm	50 cpm	50 cpm
	400 Kcpm	39729 cpm	39729 cpm		500 Kcpm	500 Kcpm	500 Kcpm
	40 Kcpm	3972 cpm	3972 cpm		50 Kcpm	52000 cpm	52000 cpm
	4 Kcpm	397 cpm	397 cpm		5 Kcpm	5500 cpm	5500 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N N/A ☐ Beta S/N N/A ☐ Other N/A

☐ M 500 S/N 187460 ☐ Oscilloscope S/N N/A ☐ Multimeter S/N 020513278

Calibrated By: R. Shank Date:01/07/04

Reviewed By: Date: 1/7/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument:	Ludlum	**DATE:**	3/29/2004	**TEMP.:**	69.5
Model No,	2221	**Source:**	Cs137	**S.N.**	**R.H.:** 32%
Serial No.	172053	**Strength:**	1.0uci	2485	
Probe:	44-10				
Serial No.	PR 206815				

	Voltage	Background Count (cpm)	Source Count (cpm)
1	600	N/A	N/A
2	650	N/A	N/A
3	700	N/A	N/A
4	750	N/A	178420
5	800	1942	185365
6	850	2085	194623
7	900	2106	196757
8	950	2135	199112
9	1000	2279	199343
10	1050	2342	201764
11	1100	2149	200173
12	1150	2488	224774
13	1200	2662	319364
14	1250	N/A	N/A
15	1300	N/A	N/A

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 1

Instrument Model:	2221
Instrument S/N:	172053
Detector Model:	44-10
Detector S/N:	PR206815
Calibration Due:	1/7/05

CONTACT

Source S/N:	Cs-137 sn: 547	
Source DPM:	N/A	
Radiation Detected:	gamma	
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	228,802 + 2σ	231,927 + 3σ
	216,297 - 2σ	213,171 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:50	6/11/2004	9,519	230,396	220,877	DBW	YES	5.8	YES
2	17:30	6/11/2004	9,382	227,955	218,573	DBW	YES	5.7	YES
3	7:20	6/12/2004	9,338	233,372	224,034	DBW	YES	5.7	YES
4	16:40	6/12/2004	9,521	231,228	221,707	DBW	YES	5.7	YES

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check log for Ludlum Model 2221 with 44-10 Detector
Instrument 1

Instrument Model:	2221
Instrument S/N:	172053
Detector Model:	44-10
Detector S/N:	PR206815
Calibration Due:	1/7/05

6 INCHES

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,924 + 2σ
	8,263 - 2σ

									9,088 + 3σ
									8,098 - 3σ
	Time	**Date**	**Background Count Rate**	**Source Count Rate**	**Net Source Count Rate**	**Technician**	**W/IN +/- 2σ**	**Batt check (volts)**	**W/IN +/- 3σ**
1	7:50	6/11/2004	9,519	17,978	8,459	DBW	YES	5.8	YES
2	17:20	6/11/2004	9,382	17,679	8,297	DBW	YES	5.7	YES
3	7:20	6/12/2004	9,338	17,618	8,280	DBW	YES	5.7	YES
4	16:40	6/12/2004	9,521	17,891	8,370	DBW	YES	5.7	YES

Comments: Background 5 minute count. Source check 1 minute count.

APPENDIX A-4

SURVEY UNIT KAISER-FSS-004

Appendix A-4, Table A-4-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-004
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-004	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	172053	PR206815	01/07/04 to 01/07/05	06/14/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-4-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 172053 (meter) and PR206815 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:172053

Cal Date: 01/07/04 Cal Due Date: 01/07/05 Cal. Interval: 12 mo.'s Meterface : 202-159

Check mark ☑ applies to applicable instruments and/or detector IAW Mfg. Spec. T 71.1 °F RH 27 % Alt. 1120 Ft.

☐ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☑ Mechanical Ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity

☑ F/S Resp. OK ☑ Reset Ck. ☑ Window Operation ☑ Geotropism

☑ Audio. Ck. ☐ Alarm Setting Ck. ☑ Batt. Ck. (Min. Volt) 5.2 VDC

☑ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 902 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 1500 /1500 V Ref./Inst. 903 / 902

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Replaced Window switch knob.

Repaired audio control switch. Re-soldered wires.

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	400 Kcpm	400 Kcpm
X1K	100 kcpm	100 Kcpm	100 Kcpm
X100	40 Kcpm	40 Kcpm	40 Kcpm
X100	10 Kcpm	10 Kcpm	10 Kcpm
X10	4 Kcpm	4 Kcpm	4 Kcpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	40 cpm	40 cpm	Log Scale	50 cpm	50 cpm	50 cpm
	400 Kcpm	39729 cpm	39729 cpm		500 Kcpm	500 Kcpm	500 Kcpm
	40 Kcpm	3972 cpm	3972 cpm		50 Kcpm	52000 cpm	52000 cpm
	4 Kcpm	397 cpm	397 cpm		5 Kcpm	5500 cpm	5500 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N N/A ☐ Beta S/N N/A ☐ Other N/A

☐ M 500 S/N 187460 ☐ Oscilloscope S/N N/A ☐ Multimeter S/N 020513278

Calibrated By: R. Shank Date:01/07/04

Reviewed By: Date: 1/7/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument:	Ludlum	**DATE:**	3/29/2004	**TEMP.:**	69.5
Model No,	2221	**Source:**	Cs137	**S.N.**	**R.H.:** 32%
Serial No.	172053	**Strength:**	1.0uci	2485	
Probe:	44-10				
Serial No.	PR 206815				

	Voltage	Background Count (cpm)	Source Count (cpm)
1	600	N/A	N/A
2	650	N/A	N/A
3	700	N/A	N/A
4	750	N/A	178420
5	800	1942	185365
6	850	2085	194623
7	900	2106	196757
8	950	2135	199112
9	1000	2279	199343
10	1050	2342	201764
11	1100	2149	200173
12	1150	2488	224774
13	1200	2662	319364
14	1250	N/A	N/A
15	1300	N/A	N/A

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 1

Instrument Model:	2221
Instrument S/N:	172053
Detector Model:	44-10
Detector S/N:	PR206815
Calibration Due:	1/7/05

CONTACT

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	228,802 + 2σ
	216,297 - 2σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	11:00	6/14/2004	9,467	237,500	228,033	DBW	YES	5.7	YES
2	17:25	6/14/2004	9,503	232,604	223,101	DSB	YES	5.7	YES

231,927 + 3σ
213,171 - 3σ

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 1

Instrument Model:	2221
Instrument S/N:	172053
Detector Model:	44-10
Detector S/N:	PR206815
Calibration Due:	1/7/05

6 INCHES

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,924 + 2σ
	8,263 - 2σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	11:00	6/14/2004	9,467	17,947	8,480	DBW	YES	5.7	YES
2	17:25	6/14/2004	9,503	17,939	8,436	DSB	YES	5.7	YES
							9,088 + 3σ		
							8,098 - 3σ		

Comments: Background 5 minute count. Source check 1 minute count.

APPENDIX A-5

SURVEY UNIT KAISER-FSS-005

Appendix A-5, Table A-5-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-005
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-005	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	172053	PR206815	01/07/04 to 01/07/05	06/15/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-5-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 172053 (meter) and PR206815 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. . Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:172053

Cal Date: 01/07/04 Cal Due Date: 01/07/05 Cal. Interval: 12 mo.'s Meterface : 202-159

Check mark ☑ applies to applicable instruments and/or detector IAW Mfg. Spec. T 71.1 °F RH 27% Alt. 1120 Ft.

☐ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☑ Mechanical Ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity

☑ F/S Resp. OK ☑ Reset Ck. ☑ Window Operation ☑ Geotropism

☑ Audio. Ck. ☐ Alarm Setting Ck. ☑ Batt. Ck. (Min. Volt) 5.2 VDC

☑ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 902 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 1500 /1500 V Ref./Inst. 903 / 902

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Replaced Window switch knob.

Repaired audio control switch. Re-soldered wires.

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	400 Kcpm	400 Kcpm
X1K	100 kcpm	100 Kcpm	100 Kcpm
X100	40 Kcpm	40 Kcpm	40 Kcpm
X100	10 Kcpm	10 Kcpm	10 Kcpm
X10	4 Kcpm	4 Kcpm	4 Kcpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	40 cpm	40 cpm	Log Scale	50 cpm	50 cpm	50 cpm
	400 Kcpm	39729 cpm	39729 cpm		500 Kcpm	500 Kcpm	500 Kcpm
	40 Kcpm	3972 cpm	3972 cpm		50 Kcpm	52000 cpm	52000 cpm
	4 Kcpm	397 cpm	397 cpm		5 Kcpm	5500 cpm	5500 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N N/A ☐ Beta S/N N/A ☐ Other N/A

☐ M 500 S/N 187460 ☐ Oscilloscope S/N N/A ☐ Multimeter S/N 020513278

Calibrated By: R. Shank Date:01/07/04

Reviewed By: Date: 1/7/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument :	Ludlum	**DATE:**	3/29/2004	**TEMP.:**	69.5
Model No,	2221	**Source:**	Cs137	**S.N.**	**R.H.:** 32%
Serial No.	172053	**Strength:**	1.0uci	2485	
Probe:	44-10				
Serial No.	PR 206815				

	Voltage	Background Count (cpm)	Source Count (cpm)
1	600	N/A	N/A
2	650	N/A	N/A
3	700	N/A	N/A
4	750	N/A	178420
5	800	1942	185365
6	850	2085	194623
7	900	2106	196757
8	950	2135	199112
9	1000	2279	199343
10	1050	2342	201764
11	1100	2149	200173
12	1150	2488	224774
13	1200	2662	319364
14	1250	N/A	N/A
15	1300	N/A	N/A

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 1

Instrument Model:	2221
Instrument S/N:	172053
Detector Model:	44-10
Detector S/N:	PR206815
Calibration Due:	1/7/05

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	228,802 + 2σ		231,927 + 3σ
	216,297 - 2σ		213,171 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:30	6/15/2004	9,569	234,354	224,785	DBW	YES	5.7	YES
2	17:00	6/15/2004	9,600	236,893	227,293	DBW	YES	5.6	YES

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 1

Instrument Model:	2221
Instrument S/N:	172053
Detector Model:	44-10
Detector S/N:	PR206815
Calibration Due:	1/7/05

6 INCHES

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,924 + 2σ		9,088 + 3σ
	8,263 - 2σ		8,098 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:30	6/15/2004	9,568	17,880	8,312	DBW	YES	5.7	YES
2	17:00	6/15/2004	9,600	17,863	8,263	DBW	NO	5.6	YES

Comments: Background 5 minute count. Source check 1 minute count.

APPENDIX A-6

SURVEY UNIT KAISER-FSS-006

Appendix A-6, Table A-6-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-006
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-006	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	206873	PR211675	05/17/04 to 05/17/05	07/13/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-6-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 206873 (meter) and PR211675 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-1 Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. . Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:206873

Cal Date: 05/17/04 Cal Due Date: 05/17/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☒ applies to applicable instruments and/or detector IAW Mfg. Spec. T 76.1 °F RH 44 % Alt. 1120 Ft.

☒ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck.	☒ Meter Zeroed	☐ Background Subtract	☒ Input Sens. Linearity
☒ F/S Resp. OK	☒ Reset Ck.	☒ Window Operation	☒ Geotropism
☒ Audio. Ck.	☐ Alarm Setting Ck.	☒ Batt. Ck. (Min. Volt) 6.2 VDC	

☒ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 900 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 669 /670 V Ref./Inst. 995 / 1000

COMMENTS: *Digital Calibration done using a 0.1 minute count time. Results reflect that count time.*

Gamma Calibration: *GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.*

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	395000 cpm	395000 cpm
X1K	100 kcpm	100000 cpm	100000 cpm
X100	40 Kcpm	39500 cpm	39500 cpm
X100	10 Kcpm	10000 cpm	10000 cpm
X10	4 Kcpm	3950 cpm	3950 cpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	38 cpm	38 cpm	Log Scale	50 cpm	60 cpm	60 cpm
	400 Kcpm	39116 cpm	39116 cpm		500 Kcpm	500000 cpm	500000 cpm
	40 Kcpm	3917 cpm	3917 cpm		50 Kcpm	50000 cpm	50000 cpm
	4 Kcpm	392 cpm	392 cpm		5 Kcpm	5000 cpm	5000 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N ☐ Beta S/N ☐ Other Cs137 2485

☒ M 500 S/N 187460 ☐ Oscilloscope S/N ☐ Multimeter S/N 020513278

Calibrated By: R. Shank Date: 05/17/04

Reviewed By: Date: 5/17/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument:	Ludlum	**DATE:**	3/29/2004	**TEMP.:**	69.5
Model No,	2221	**Source:**	Cs137 **S.N.**	**R.H.:**	32%
Serial No.	172053	**Strength:**	1.0uci 2485		
Probe:	44-10				
Serial No.	PR 206815				

	Voltage	Background Count (cpm)	Source Count (cpm)
1	600	N/A	N/A
2	650	N/A	N/A
3	700	N/A	N/A
4	750	N/A	178420
5	800	1942	185365
6	850	2085	194623
7	900	2106	196757
8	950	2135	199112
9	1000	2279	199343
10	1050	2342	201764
11	1100	2149	200173
12	1150	2488	224774
13	1200	2662	319364
14	1250	N/A	N/A
15	1300	N/A	N/A

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

CONTACT

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	232,512 + 2σ
	207,841 - 2σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	14:25	7/13/2004	9,237	229,740	220,503	DBW	YES	5.9	YES

238,680 + 3σ
201,672 - 3σ

Comments: Background 5 minute count. Source count 1 minute.
Recalibrated by Enercon to Cs-137.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

6 INCHES

Source S/N:	Cs-137 sn: 547	
Source DPM:	N/A	
Radiation Detected:	gamma	
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,206 + 2σ	8,347 + 3σ
	7,637 - 2σ	7,495 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	14:25	7/13/2004	9,237	17,534	8,297	DBW	NO	5.9	YES

Comments: Background 5 minute count. Source count 1 minute.

Recalibrated to Cs-137 by Enercon.

APPENDIX A-7

SURVEY UNIT KAISER-FSS-007

Appendix A-7, Table A-7-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-007
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-007	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	157032	PR206809	03/03/04 to 03/03/05	06/23/04 to 7/6/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.
Ludlum 2360 Alpha-Beta Scaler /Rate Meter with 43-68 100cm^2 Gas Proportional Alpha-Beta Detector	193686	PR190485	05/04/04 to 05/04/05	06/25/04	Simultaneous alpha-beta counting and discrimination - Instrument was used to survey embedded structures.

APPENDIX A-7-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 157032 (meter) and PR206809 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:157032

Cal Date: 03/03/04 Cal Due Date: 03/03/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☐ applies to applicable instruments and/or detector IAW Mfg. Spec. Temp. 68.9 °F RH 27 % Alt. 1120 Ft.

☐ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck. ☒ Meter Zeroed ☐ Background Subtract ☒ Input Sens. Linearity

☒ F/S Resp. OK ☒ Reset Ck. ☒ Window Operation ☒ Geotropism

☒ Audio. Ck. ☐ Alarm Setting Ck. ☒ Batt. Ck. (Min. Volt) 5.2 VDC

☐ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 1000 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 1500 / 1500 V Ref./Inst. 1000 / 1000 V.

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Zero button sticks

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	400 Kcpm	400 Kcpm
X1K	100 kcpm	100 Kcpm	100 Kcpm
X100	40 Kcpm	40 Kcpm	40 Kcpm
X100	10 Kcpm	10 Kcpm	10 Kcpm
X10	4 Kcpm	4000 cpm	4000 cpm
X10	1 Kcpm	900 cpm	900 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	39 cpm	39 cpm	Log Scale	50 cpm	50 cpm	50 cpm
	400 Kcpm	39618 cpm	39618 cpm		500 Kcpm	500 Kcpm	500 K cpm
	40 Kcpm	3962 cpm	3962 cpm		50 Kcpm	50 Kcpm	50 Kcpm
	4 Kcpm	397 cpm	397 cpm		5 Kcpm	5 Kcpm	5 Kcpm
	40 cpm	4 cpm	4 cpm		500 cpm	450 cpm	450 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N _____ ☐ Beta S/N _____ ☐ Other _____

☒ M 500 S/N 187460 ☐ Oscilloscope S/N _____ ☒ Multimeter S/N 020513278

Calibrated By: R. Shank Date: 03/03/04

Reviewed By: Date: 03/09/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument :	Ludlum		**DATE:**	3/29/2004		**TEMP.:**	67
Model No,	2221		**Source:**	Cs137	**S.N.**	**R.H.:**	34%
Serial No.	157032		**Strength:**	1.0uci	2485		
Probe:	44-10						
Serial No.	PR206809						

	Voltage	Background Count (cpm)	Source Count (cpm)
1	600	N/A	N/A
2	650	N/A	N/A
3	700	1791	174173
4	750	2001	179682
5	800	2075	190450
6	850	2132	195749
7	900	2187	195411
8	950	2150	197763
9	1000	2061	199119
10	1050	2132	199591
11	1100	2375	211691
12	1150	2723	283180
13	1200	N/A	N/A
14	1250	N/A	N/A
15	1300	N/A	N/A

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 2

Instrument Model:	2221
Instrument S/N:	157032
Detector Model:	44-10
Detector S/N:	PR206809
Calibration Due:	3/3/05

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	241,361 + 2σ		257,378 + 3σ
	177,299 - 2σ		161,282 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	8:10	6/23/2004	9,350	232,928	223,578	DBW	YES	5.4	YES
2	8:01	6/24/2004	9,506	228,859	219,353	DBW	YES	5.4	YES
3	7:40	6/25/2004	9,646	226,937	217,291	DBW	YES	5.3	YES
4	17:05	6/25/2004	9,558	230,925	221,367	DBW	YES	5.3	YES
5	7:32	6/28/2004	9,615	225,912	216,297	DBW	YES	5.3	YES
6	17:10	6/28/2004	9,467	229,191	219,724	DBW	YES	5.3	YES
7	8:00	6/29/2004	9,530	228,833	219,303	DSB	YES	5.3	YES
8	15:08	6/29/2004	9,538	232,488	222,950	DBW	YES	5.2	YES
9	7:48	6/30/2004	9,388	230,968	221,580	DBW	YES	5.3	YES
10	16:10	6/30/2004	9,472	233,316	223,844	DBW	YES	5.2	YES
11	7:15	7/1/2004	9,423	222,091	212,668	DBW	YES	5.2	YES
12	17:10	7/1/2004	9,628	232,271	222,643	DBW	YES	5.1	YES
13	7:15	7/6/2004	9,689	231,872	222,183	DBW	YES	6.0	YES
14	15:30	7/6/2004	9,539	225,444	215,905	DBW	YES	6.0	YES

Comments: Moved cource check location to furnace room (lower background). Background 5 min. count.
Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 2

Instrument Model:	2221
Instrument S/N:	157032
Detector Model:	44-10
Detector S/N:	PR206809
Calibration Due:	3/3/05

6 INCHES

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,597 + 2σ		8,731 + 3σ
	8,061 - 2σ		7,927 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	8:10	6/23/2004	9,350	17,882	8,532	DBW	YES	5.4	YES
2	8:01	6/24/2004	9,506	17,839	8,333	DBW	YES	5.4	YES
3	7:40	6/25/2004	9,646	17,728	8,082	DBW	YES	5.3	YES
4	17:05	6/25/2004	9,558	17,524	7,966	DBW	YES	5.3	YES
5	7:32	6/28/2004	9,615	17,752	8,137	DBW	YES	5.3	YES
6	17:10	6/28/2004	9,462	17,981	8,519	DBW	YES	5.3	YES
7	8:00	6/29/2004	9,530	17,681	8,151	DSB	YES	5.3	YES
8	15:08	6/29/2004	9,538	17,757	8,219	DBW	YES	5.2	YES
9	7:48	6/30/2004	9,388	17,927	8,539	DBW	YES	5.3	YES
10	16:10	6/30/2004	9,472	17,981	8,509	DBW	YES	5.2	YES
11	7:15	7/1/2004	9,423	17,802	8,379	DBW	YES	5.2	YES
12	17:10	7/1/2004	9,620	17,718	8,098	DBW	YES	5.1	YES
13	7:15	7/6/2001	9,689	17,738	8,049	DBW	NO	6.0	YES
14	15:30	7/6/2004	9,539	17,693	8,154	DBW	YES	6.0	YES

Comments: Moved cource check location to furnace room (lower background). Background 5 min. count.
Source check 1 minute count.

APPENDIX A-7-2

Ludlum Model 2360 Alpha-Beta Scaler/Rate Meter with Model 43-68 100 cm^2 Gas Proportional Alpha-Beta Detector Serial Nos. 193686 (meter) and PR190485 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

6129

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER KAISER ALUMINUM ORDER NO. 215373/281348

Ludlum Measurements, Inc. Model 2360 Serial No. 193686

Mfg. Ludlum Measurements, Inc. Model 43-68 Serial No. PR-190485

Cal. Date 4-May-04 Cal Due Date 4-May-05 Cal. Interval 1 Year Meterface 202-855

heck mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 28 % Alt 705.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☐ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC
☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

strument Volt Set 1575 V

☑ HV Readout (2 points) Ref./Inst. 500 / 491 V Ref./Inst. 1500 / 1992 V

Firmware Version: 39010N24
Alpha Threshold: 120mv
Beta Threshold: 3.5mv
Beta Window: 50mv
Overload Checked But not set
Instrument calibrated with a 39" cable.
High voltage set with detector Connected

(EEPROM Settings)
User Time: 001.0
Alpha Alarm: 050000
Beta Alarm: 050000
A/B Alarm: 050000
Model 2360 Date: 4 May 04
Calibration Date Due: 4 May 05

COMMENTS:
Eff. for Th230 ≈ 35.5% 2pi, Background count 1cpm, Source count 1036cpm, Source Size 2910cpm
Eff. for Th232 ≈ 46.6% 2pi, Background count 1cpm, Source count 64cpm, Source Size 135cpm
for Tc99 ≈ 48.0% 2pi, Background count 93cpm, Source count 6865cpm, Source Size 14100cpm

...ration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
x1000	400kcpm	400	400
x1000	100kcpm	100	100
x100	40kcpm	400	400
x100	10kcpm	100	100
x10	4kcpm	400	400
x10	1kcpm	100	100
x1	400kcpm	400	400
x1	100kcpm	100	100

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
gital adout	400kcpm	39985(0)	39985(0)	Log Scale			
	40kcpm	3999	3999				
	4kcpm	400	400				
	400cpm	40	40				
	40cpm	4	4				

...lum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of ...er International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. ...calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

...eference Instruments and/or Sources:

...s-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

...oha S/N Th230 #5020-03/Th232 #3153 ☑ Beta S/N Tc99 SN: NT-EV ☐ Other

☑ ...1 500 S/N 50800 ☐ Oscilloscope S/N ☑ Multimeter S/N 83990502

Calibrated By: Charles Robb Date 4 May 04

Reviewed By: W Robbins Date 5 may 04

...his certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.

☐ AC Inst ☐ ...

Designer and Manufacturer
of
Scientific and Industrial
Instruments

POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

9/1-10
6/29

Bench Test Data For Detector

Detector 43-68 Serial No. PR-190485 Order #. 215373/281348

Customer KAISER ALUMINUM Alpha Input Sensitivity 120 mV

Counter 2360 Serial No. 193686 Beta Input Sensitivity 3.5 mV

Count Time 1Minute Beta Window 50 mV

Other _____ Distance Source to Detector Surface

High Voltage	Background Alpha	Background Beta	Isotope Th230 Size 2910 cpm Alpha	Isotope Th230 Size 2910 cpm Beta	Isotope Th232 Size 135 cpm Alpha	Isotope Th232 Size 135 cpm Beta	Isotope Tc 99 Size 14100 cpm Alpha	Isotope Tc 99 Size 14100 cpm Beta
1525	2	99	943	411	51	185	0	6731
1550	0	124	1116	428	47	197	0	7566
1575	1	93	1036	500	64	251	1	6865
1600	2	208	1075	526	55	306	18	7471
1625	0	202	1174	483	55	287	149	6722

☑ Gas Proportional detector count rate decreased ≤ 10% after 15 hour static test using 39" cable.

☐ Gas proportional detector count rate decreased ≤ 10% after 5 hour static test using 39" cable and alpha/beta counter.

Signature Charles Link Date 4 May 04

Form HPM/M-2-8-1
Daily Check Log for Ludlum Model 2360 with 43-68 Detector
Instrument 2 Alpha

Instrument/SN: Ludlum Model 2360 193686					*Check Source(s) Used:* Th-230, S/N 5053-03							
Detector/SN: Model 43-68 /PR190485												
EFF %: α= 17.78 % 4π					*source check acceptance criteria*		α					
CALIB. SOURCE USED: Th-230					**Average (NCPM):**		2,564					
DATE OF CALIB.: 5/4/2004					**+2 sigma:**		2,655					
CALIB. DUE DATE: 5/4/2005					**-2 sigma:**		2,474					
PERFORMED BY: Ludlum Measurements Inc.					**+3 sigma:**		2,700					
					-3 sigma:		2,429					
TECHNICIAN'S NAME		ALPHA/ BETA	RESPONSE CHECK	DATE	TIME	60 min Bkgrd (cpm)	1 min gross (cpm)	1 min net (cpm)	within +/- 2 sigma	within +/- 3 sigma	<10% drop	
DBW	1	Alpha	SAT	6/25/2004	10:36	1.13	2,549	2,548	YES	YES	NA	
DBW	2	Alpha	SAT	6/25/2004	16:00	0.98	2,524	2,523	YES	YES	YES	

APPENDIX A-8

SURVEY UNIT KAISER-FSS-008

Appendix A-8, Table A-8-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-008
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-008	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	206873	PR211675	05/17/04 to 05/17/05	07/14/04 to 07/15/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-8-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 206873 (meter) and PR211675 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:206873

Cal Date: 05/17/04 Cal Due Date: 05/17/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☒ applies to applicable instruments and/or detector IAW Mfg. Spec. T 76.1 °F RH 44 % Alt. 1120 Ft.

☒ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck.	☒ Meter Zeroed	☐ Background Subtract	☒ Input Sens. Linearity
☒ F/S Resp. OK	☒ Reset Ck.	☒ Window Operation	☒ Geotropism
☒ Audio. Ck.	☐ Alarm Setting Ck.	☒ Batt. Ck. (Min. Volt) 6.2 VDC	

☒ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 900 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 669 /670 V Ref./Inst. 995 / 1000

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	395000 cpm	395000 cpm
X1K	100 kcpm	100000 cpm	100000 cpm
X100	40 Kcpm	39500 cpm	39500 cpm
X100	10 Kcpm	10000 cpm	10000 cpm
X10	4 Kcpm	3950 cpm	3950 cpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	38 cpm	38 cpm	Log Scale	50 cpm	60 cpm	60 cpm
	400 Kcpm	39116 cpm	39116 cpm		500 Kcpm	500000 cpm	500000 cpm
	40 Kcpm	3917 cpm	3917 cpm		50 Kcpm	50000 cpm	50000 cpm
	4 Kcpm	392 cpm	392 cpm		5 Kcpm	5000 cpm	5000 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N ☐ Beta S/N ☐ Other Cs137 2485

☒ M 500 S/N 187460 ☐ Oscilloscope S/N ☐ Multimeter S/N 020513278

Calibrated By: R. Shank Date: 05/17/04

Reviewed By: Date: 5/17/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument :	Ludlum	**DATE:**	5/17/2004
Model No,	2221	**Source:**	Cs137
Serial No.	206783 873	**Serial no.**	2485
Probe:	44-10	**Strength:**	I uci
Serial No.	PR 211675		

	Background Count (cpm)	Source Count (cpm)	H.V.
1	4777	95849	700
2	5385	98961	750
3	5517	104186	800
4	5600	108132	850
5	5675	108795	900
6	5832	109020	950
7	5680	111082	1000
8	5849	111402	1050
9	6073	112078	1100
10	5782	115675	1150
11	N/A	N/A	1200
12	N/A	N/A	1250

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	232,512 + 2σ		238,680 + 3σ
	207,841 - 2σ		201,672 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	5:40	7/14/2004	9,285	234,516	225,231	DBW	YES	5.9	YES
2	6:30	7/14/2004	9,281	231,135	221,854	DBW	YES	5.9	YES
3	21:22	7/14/2004	9,192	233,126	223,934	DBW	YES	5.9	YES
4	4:30	7/15/2004	9,407	234,159	224,752	DBW	YES	5.8	YES
5	17:00	7/15/2004	9,386	233,206	223,820	DBW	YES	5.8	YES

Comments: Background 5 minute count. Source count 1 minute.
Recalibrated by Enercon to Cs-137.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

6 INCHES

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,206 + 2σ		8,347 + 3σ
	7,637 - 2σ		7,495 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	5:40	7/14/2004	9,285	17,371	8,086	DBW	YES	5.9	YES
2	6:30	7/14/2004	9,281	17,217	7,936	DBW	YES	5.9	YES
3	21:22	7/14/2004	9,192	17,443	8,251	DBW	NO	5.9	YES
4	4:30	7/15/2004	9,407	17,368	7,961	DBW	YES	5.8	YES

Comments: Background 5 minute count. Source count 1 minute.

Recalibrated to Cs-137 by Enercon.

APPENDIX A-9

SURVEY UNIT KAISER-FSS-009

Appendix A-9, Table A-9-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-009
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-009	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	206873	PR211675	05/17/04 to 05/17/05	07/13/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-9-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 206873 (meter) and PR211675 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. . Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:206873

Cal Date: 05/17/04 Cal Due Date: 05/17/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☒ applies to applicable instruments and/or detector IAW Mfg. Spec. T 76.1 °F RH 44 % Alt. 1120 Ft.

☒ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck.	☒ Meter Zeroed	☐ Background Subtract	☒ Input Sens. Linearity
☒ F/S Resp. OK	☒ Reset Ck.	☒ Window Operation	☒ Geotropism
☒ Audio. Ck.	☐ Alarm Setting Ck.	☒ Batt. Ck. (Min. Volt) 6.2 VDC	

☒ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 900 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 669 /670 V Ref./Inst. 995 / 1000

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	395000 cpm	395000 cpm
X1K	100 kcpm	100000 cpm	100000 cpm
X100	40 Kcpm	39500 cpm	39500 cpm
X100	10 Kcpm	10000 cpm	10000 cpm
X10	4 Kcpm	3950 cpm	3950 cpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	38 cpm	38 cpm	Log Scale	50 cpm	60 cpm	60 cpm
	400 Kcpm	39116 cpm	39116 cpm		500 Kcpm	500000 cpm	500000 cpm
	40 Kcpm	3917 cpm	3917 cpm		50 Kcpm	50000 cpm	50000 cpm
	4 Kcpm	392 cpm	392 cpm		5 Kcpm	5000 cpm	5000 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐6205GE

PLATEAU

Instrument :	Ludlum
Model No,	2221
Serial No.	206783 873
Probe:	44-10
Serial No.	PR 211675

DATE:	5/17/2004
Source:	Cs137
Serial no.	2485
Strength:	I uci

	Background Count (cpm)	Source Count (cpm)	H.V.
1	4777	95849	700
2	5385	98961	750
3	5517	104186	800
4	5600	108132	850
5	5675	108795	900
6	5832	109020	950
7	5680	111082	1000
8	5849	111402	1050
9	6073	112078	1100
10	5782	115675	1150
11	N/A	N/A	1200
12	N/A	N/A	1250

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

CONTACT

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	232,512 + 2σ
	207,841 - 2σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	14:25	7/13/2004	9,237	229,740	220,503	DBW	YES	5.9	YES

238,680 + 3σ
201,672 - 3σ

Comments: Background 5 minute count. Source count 1 minute.
Recalibrated by Enercon to Cs-137.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

	Instrument Model:	2221			Source S/N:	Cs-137 sn: 547			
	Instrument S/N:	206873			Source DPM:	N/A			
	Detector Model:	44-10			Radiation Detected:	gamma			
	Detector S/N:	PR211675			Acceptable Range:	8,206 + 2σ		8,347 + 3σ	
	Calibration Due:	5/17/05		6 INCHES	(Refer to Penn E&R/HPM/M-2-1-1)	7,637 - 2σ		7,495 - 3σ	
	Time	**Date**	**Background Count Rate**	**Source Count Rate**	**Net Source Count Rate**	**Technician**	**W/IN +/- 2σ**	**Batt check (volts)**	**W/IN +/- 3σ**
1	14:25	7/13/2004	9,237	17,534	8,297	DBW	NO	5.9	YES
	Comments:	Background 5 minute count. Source count 1 minute.							
		Recalibrated to Cs-137 by Enercon.							

APPENDIX A-10

SURVEY UNIT KAISER-FSS-010

Appendix A-10, Table A-10-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-010
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-010	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	206873	PR211675	05/17/04 to 05/17/05	06/15/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-10-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 206873 (meter) and PR211675 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-1 Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. . Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:206873

Cal Date: 05/17/04 Cal Due Date: 05/17/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☒ applies to applicable instruments and/or detector IAW Mfg. Spec. T 76.1 °F RH 44 % Alt. 1120 Ft.

☒ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck.	☒ Meter Zeroed	☐ Background Subtract	☒ Input Sens. Linearity
☒ F/S Resp. OK	☒ Reset Ck.	☒ Window Operation	☒ Geotropism
☒ Audio. Ck.	☐ Alarm Setting Ck.	☒ Batt. Ck. (Min. Volt) 6.2 VDC	

☒ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 900 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 669 /670 V Ref./Inst. 995 / 1000

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	395000 cpm	395000 cpm
X1K	100 kcpm	100000 cpm	100000 cpm
X100	40 Kcpm	39500 cpm	39500 cpm
X100	10 Kcpm	10000 cpm	10000 cpm
X10	4 Kcpm	3950 cpm	3950 cpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	38 cpm	38 cpm	Log Scale	50 cpm	60 cpm	60 cpm
	400 Kcpm	39116 cpm	39116 cpm		500 Kcpm	500000 cpm	500000 cpm
	40 Kcpm	3917 cpm	3917 cpm		50 Kcpm	50000 cpm	50000 cpm
	4 Kcpm	392 cpm	392 cpm		5 Kcpm	5000 cpm	5000 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N ☐ Beta S/N ☐ Other Cs137 2485

☒ M 500 S/N 187460 ☐ Oscilloscope S/N ☐ Multimeter S/N 020513278

Calibrated By: R. Shank Date: 05/17/04

Reviewed By: Date: 5/17/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument :	Ludlum
Model No,	2221
Serial No.	206783
Probe:	44-10
Serial No.	PR 211675

DATE:	5/17/2004
Source:	Cs137
Serial no.	2485
Strength:	I uci

	Background Count (cpm)	Source Count (cpm)	H.V.
1	4777	95849	700
2	5385	98961	750
3	5517	104186	800
4	5600	108132	850
5	5675	108795	900
6	5832	109020	950
7	5680	111082	1000
8	5849	111402	1050
9	6073	112078	1100
10	5782	115675	1150
11	N/A	N/A	1200
12	N/A	N/A	1250

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221		Source S/N:	Cs-137 sn: 547				
Instrument S/N:	206873		Source DPM:	N/A				
Detector Model:	44-10		Radiation Detected:	gamma				
Detector S/N:	PR211675		Acceptable Range:	232,512 + 2σ		238,680 + 3σ		
Calibration Due:	5/17/05	CONTACT	(Refer to Penn E&R/HPM/M-2-1-1)	207,841 - 2σ		201,672 - 3σ		

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	10:30	6/15/2004	9,387	225,180	215,793	DBW	YES	6.1	YES

Comments: Background 5 minute count. Source count 1 minute.
Recalibrated by Enercon to Cs-137.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

6 INCHES

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,206 + 2σ
	7,637 - 2σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	10:30	6/15/2004	9,387	17,599	8,212	DBW	YES	6.1	YES

Comments: Background 5 minute count. Source count 1 minute.
Recalibrated to Cs-137 by Enercon.

APPENDIX A-11

SURVEY UNIT KAISER-FSS-011

Appendix A-11, Table A-11-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-011
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-011	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	206873	PR211675	05/17/04 to 05/17/05	07/23/04 to 08/02/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-11-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 206873 (meter) and PR211675 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. . Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:206873

Cal Date: 05/17/04 Cal Due Date: 05/17/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☒ applies to applicable instruments and/or detector IAW Mfg. Spec. T 76.1 °F RH 44 % Alt. 1120 Ft.

☒ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck.	☒ Meter Zeroed	☐ Background Subtract	☒ Input Sens. Linearity
☒ F/S Resp. OK	☒ Reset Ck.	☒ Window Operation	☒ Geotropism
☒ Audio. Ck.	☐ Alarm Setting Ck.	☒ Batt. Ck. (Min. Volt) 6.2 VDC	

☒ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 900 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 669 /670 V Ref./Inst. 995 / 1000

COMMENTS: *Digital Calibration done using a 0.1 minute count time. Results reflect that count time.*

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	395000 cpm	395000 cpm
X1K	100 kcpm	100000 cpm	100000 cpm
X100	40 Kcpm	39500 cpm	39500 cpm
X100	10 Kcpm	10000 cpm	10000 cpm
X10	4 Kcpm	3950 cpm	3950 cpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	38 cpm	38 cpm	Log Scale	50 cpm	60 cpm	60 cpm
	400 Kcpm	39116 cpm	39116 cpm		500 Kcpm	500000 cpm	500000 cpm
	40 Kcpm	3917 cpm	3917 cpm		50 Kcpm	50000 cpm	50000 cpm
	4 Kcpm	392 cpm	392 cpm		5 Kcpm	5000 cpm	5000 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N ☐ Beta S/N ☐ Other Cs137 2485

☒ M 500 S/N 187460 ☐ Oscilloscope S/N ☐ Multimeter S/N 020513278

Calibrated By: R. Shank Date: 05/17/04

Reviewed By: Date: 5/17/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument : Ludlum
Model No, 2221
Serial No. 206783 873 yd
Probe: 44-10
Serial No. PR 211675

DATE: 5/17/2004
Source: Cs137
Serial no. 2485
Strength: I uci

	Background Count (cpm)	Source Count (cpm)	H.V.
1	4777	95849	700
2	5385	98961	750
3	5517	104186	800
4	5600	108132	850
5	5675	108795	900
6	5832	109020	950
7	5680	111082	1000
8	5849	111402	1050
9	6073	112078	1100
10	5782	115675	1150
11	N/A	N/A	1200
12	N/A	N/A	1250

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	232,512 + 2σ		238,680 + 3σ
	207,841 - 2σ		201,672 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:40	7/23/2004	9,566	232,800	223,234	DBW	YES	5.7	YES
2	17:05	7/23/2004	9,368	244,306	234,938	DBW	NO	5.7	YES
3	12:34	7/27/2004	9,378	247,422	238,044	DBW	NO	5.7	YES
4	16:22	7/27/2004	9,272	241,411	232,139	DBW	YES	5.7	YES
5	11:00	8/2/2004	9,270	234,017	224,747	DSB	YES	5.7	YES
6	18:00	8/2/2004	9,288	233,986	224,698	DSB	YES	5.7	YES

Comments: Background 5 minute count. Source count 1 minute.

Form HPM/m-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

6 INCHES

Source S/N:	Cs-137 sn: 547	
Source DPM:	N/A	
Radiation Detected:	gamma	
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,206 + 2σ	8,347 + 3σ
	7,637 - 2σ	7,495 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:40	7/23/2004	9,566	17,614	8,048	DBW	YES	5.7	YES
2	17:05	7/23/2004	9,368	17,664	8,296	DBW	NO	5.7	YES
3	12:34	7/27/2004	9,378	17,708	9,330	DBW	NO	5.7	YES
4	16:22	7/27/2004	9,272	17,631	8,359	DBW	NO	5.7	NO
5	16:30	7/27/2004	9,272	17,289	8,017	DBW	YES	5.7	YES
6	11:00	8/2/2004	9,270	17,558	8,288	DSB	NO	5.7	YES
7	18:00	8/2/2004	9,288	17,403	8,115	DSB	YES	5.7	YES

Comments: Background 5 minute count. Source count 1 minute.
Recalibrated to Cs-137 by Enercon.

APPENDIX A-12

SURVEY UNIT KAISER-FSS-012

Appendix A-12, Table A-12-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-012
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-012	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	206873	PR211675	05/17/04 to 05/17/05	8/02/04 to 8/18/04	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-12-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 206873 (meter) and PR211675 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:206873

Cal Date: 05/17/04 Cal Due Date: 05/17/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☒ applies to applicable instruments and/or detector IAW Mfg. Spec. T 76.1 °F RH 44 % Alt. 1120 Ft.

☒ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck.	☒ Meter Zeroed	☐ Background Subtract	☒ Input Sens. Linearity
☒ F/S Resp. OK	☒ Reset Ck.	☒ Window Operation	☒ Geotropism
☒ Audio. Ck.	☐ Alarm Setting Ck.	☒ Batt. Ck. (Min. Volt) 6.2 VDC	

☒ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 900 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 669 /670 V Ref./Inst. 995 / 1000

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	395000 cpm	395000 cpm
X1K	100 kcpm	100000 cpm	100000 cpm
X100	40 Kcpm	39500 cpm	39500 cpm
X100	10 Kcpm	10000 cpm	10000 cpm
X10	4 Kcpm	3950 cpm	3950 cpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	38 cpm	38 cpm	Log Scale	50 cpm	60 cpm	60 cpm
	400 Kcpm	39116 cpm	39116 cpm		500 Kcpm	500000 cpm	500000 cpm
	40 Kcpm	3917 cpm	3917 cpm		50 Kcpm	50000 cpm	50000 cpm
	4 Kcpm	392 cpm	392 cpm		5 Kcpm	5000 cpm	5000 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N ☐ Beta S/N ☐ Other Cs 137 2485

☒ M 500 S/N 187460 ☐ Oscilloscope S/N ☐ Multimeter S/N 020513278

Calibrated By: R. Shank Date: 05/17/04

Reviewed By: Date: 5/17/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument :	Ludlum	**DATE:**	5/17/2004
Model No,	2221	**Source:**	Cs137
Serial No.	206782 875	**Serial no.**	2485
Probe:	44-10	**Strength:**	I uci
Serial No.	PR 211675		

	Background Count (cpm)	Source Count (cpm)	H.V.
1	4777	95849	700
2	5385	98961	750
3	5517	104186	800
4	5600	108132	850
5	5675	108795	900
6	5832	109020	950
7	5680	111082	1000
8	5849	111402	1050
9	6073	112078	1100
10	5782	115675	1150
11	N/A	N/A	1200
12	N/A	N/A	1250

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	232,512 + 2σ		238,680 + 3σ
	207,841 - 2σ		201,672 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	11:00	8/2/2004	9,270	234,017	224,747	DSB	YES	5.7	YES
2	18:00	8/2/2004	9,288	233,986	224,698	DSB	YES	5.7	YES
3	14:10	8/18/2004	9,136	244,535	235,399	DBW	NO	5.7	YES
4	16:00	8/18/2004	9,238	2,339,848	2,330,610	DSB	NO	5.7	YES

Comments: Background 5 minute count. Source count 1 minute.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

6 INCHES

Source S/N:	Cs-137 sn: 547	
Source DPM:	N/A	
Radiation Detected:	gamma	
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,206 + 2σ	8,347 + 3σ
	7,637 - 2σ	7,495 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	11:00	8/2/2004	9,270	17,558	8,288	DSB	NO	5.7	YES
2	18:00	8/2/2004	9,288	17,403	8,115	DSB	YES	5.7	YES
3	14:10	8/18/2004	9,136	17,420	8,284	DBW	YES	5.7	YES
4	16:00	8/18/2004	9,238	17,418	8,180	DSB	YES	5.7	YES

Comments: Background 5 minute count. Source count 1 minute.

APPENDIX A-13

SURVEY UNIT KAISER-FSS-013

Appendix A-13, Table A-13-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-013
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-013	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	206873	PR211675	05/17/04 to 05/17/05	02/22/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.
Ludlum 2360 Alpha-Beta Scaler /Rate Meter with 43-68 100cm^2 Gas Proportional Alpha-Beta Detector	193686	PR190485	05/04/04 to 05/04/05	1/31/05 to 03/03/05	Simultaneous alpha-beta counting and discrimination - Instrument was used to survey embedded structures.

APPENDIX A-13-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 206873 (meter) and PR211675 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:206873

Cal Date: 05/17/04 Cal Due Date: 05/17/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☒ applies to applicable instruments and/or detector IAW Mfg. Spec. T 76.1 °F RH 44 % Alt. 1120 Ft.

☒ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck.	☒ Meter Zeroed	☐ Background Subtract	☒ Input Sens. Linearity
☒ F/S Resp. OK	☒ Reset Ck.	☒ Window Operation	☒ Geotropism
☒ Audio. Ck.	☐ Alarm Setting Ck.	☒ Batt. Ck. (Min. Volt) 6.2 VDC	

☒ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 900 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 669 /670 V Ref./Inst. 995 / 1000

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	395000 cpm	395000 cpm
X1K	100 kcpm	100000 cpm	100000 cpm
X100	40 Kcpm	39500 cpm	39500 cpm
X100	10 Kcpm	10000 cpm	10000 cpm
X10	4 Kcpm	3950 cpm	3950 cpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	38 cpm	38 cpm	Log Scale	50 cpm	60 cpm	60 cpm
	400 Kcpm	39116 cpm	39116 cpm		500 Kcpm	500000 cpm	500000 cpm
	40 Kcpm	3917 cpm	3917 cpm		50 Kcpm	50000 cpm	50000 cpm
	4 Kcpm	392 cpm	392 cpm		5 Kcpm	5000 cpm	5000 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N ☐ Beta S/N ☐ Other Cs137 2485

☒ M 500 S/N 187460 ☐ Oscilloscope S/N ☐ Multimeter S/N 020513278

Calibrated By: R. Shank R. Shank Date: 05/17/04

Reviewed By: Date: 5/17/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument : Ludlum
Model No, 2221
Serial No. 206783873
Probe: 44-10
Serial No. PR 211675

DATE: 5/17/2004
Source: Cs137
Serial no. 2485
Strength: I uci

	Background Count (cpm)	Source Count (cpm)	H.V.
1	4777	95849	700
2	5385	98961	750
3	5517	104186	800
4	5600	108132	850
5	5675	108795	**900**
6	5832	109020	950
7	5680	111082	1000
8	5849	111402	1050
9	6073	112078	1100
10	5782	115675	1150
11	N/A	N/A	1200
12	N/A	N/A	1250

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

	Instrument Model:	2221			Source S/N:	Cs-137 sn: 547			
	Instrument S/N:	206873			Source DPM:	N/A			
	Detector Model:	44-10			Radiation Detected:	gamma			
	Detector S/N:	PR211675			Acceptable Range:	232,512 + 2σ		238,680 + 3σ	
	Calibration Due:	5/17/05	CONTACT		(Refer to Penn E&R/HPM/M-2-1-1)	207,841 - 2σ		201,672 - 3σ	
	Time	**Date**	**Background Count Rate**	**Source Count Rate**	**Net Source Count Rate**	**Technician**	**W/IN +/- 2σ**	**Batt check (volts)**	**W/IN +/- 3σ**
1	9:50	2/22/2005	8,991	215,720	206,729	MDT	YES	5.5	YES
	Comments:	Background 5 minute count. Source count 1 minute.							

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

6 INCHES

Source S/N:	Cs-137 sn: 547	
Source DPM:	N/A	
Radiation Detected:	gamma	
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,206 + 2σ	8,347 + 3σ
	7,637 - 2σ	7,495 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	9:55	2/22/2005	8,991	16,733	7,742	MDT	YES	5.5	YES

Comments: Background 5 minute count. Source count 1 minute.

APPENDIX A-13-2

Ludlum Model 2360 Alpha-Beta Scaler/Rate Meter with Model 43-68 100 cm^2 Gas Proportional Alpha-Beta Detector Serial Nos. 193686 (meter) and PR190485 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

6129

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER KAISER ALUMINUM ORDER NO. 215373/281348

Mfg. Ludlum Measurements, Inc. Model 2360 Serial No. 193686

Mfg. Ludlum Measurements, Inc. Model 43-68 Serial No. PR-190485

Cal. Date 4-May-04 Cal Due Date 4-May-05 Cal. Interval 1 Year Meterface 202-855

heck mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 28 % Alt 705.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☐ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

strument Volt Set 1575 V

☑ HV Readout (2 points) Ref./Inst. 500 / 491 V Ref./Inst. 1500 / 1992 V

Firmware Version: 39010N24
Alpha Threshold: 120mv
Beta Threshold: 3.5mv
Beta Window: 50mv
Overload Checked But not set
Instrument calibrated with a 39" cable.
High voltage set with detector Connected

(EEPROM Settings)
User Time: 001.0
Alpha Alarm: 050000
Beta Alarm: 050000
A/B Alarm: 050000
Model 2360 Date: 4 May 04
Calibration Date Due: 4 May 05

COMMENTS:
Eff. for Th230 ≈ 35.5% 2pi, Background count 1cpm, Source count 1036cpm, Source Size 2910cpm
Eff. for Th232 ≈ 46.6% 2pi, Background count 1cpm, Source count 64cpm, Source Size 135cpm
for Tc99 ≈ 48.0% 2pi, Background count 93cpm, Source count 6865cpm, Source Size 14100cpm

oration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
x1000	400kcpm	400	400
x1000	100kcpm	100	100
x100	40kcpm	400	400
x100	10kcpm	100	100
x10	4kcpm	400	400
x10	1kcpm	100	100
x1	400kcpm	400	400
x1	100kcpm	100	100

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
gital adout	400kcpm	399856	399856
	40kcpm	3999	3999
	4kcpm	400	400
	400cpm	40	40
	40cpm	4	4

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Log Scale			

lum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of er International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

eference Instruments and/or Sources:

s-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

pha S/N Th230 5020-03/Th232 3153 ☑ Beta S/N Tc99 SN: NT-EV ☐ Other

☑ ...1 500 S/N 50800 ☐ Oscilloscope S/N ☑ Multimeter S/N 83990502

Calibrated By: Charles Robb Date 4 May 04

Reviewed By: W Robbins Date 5 may 04

his certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
ORM C226 11/26/2003

AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

9mA
6/29

Bench Test Data For Detector

Detector 43-68 Serial No. PR-190485 Order #. 215373/281348

Customer KAISER ALUMINUM Alpha Input Sensitivity 120 mV

Counter 2360 Serial No. 193686 Beta Input Sensitivity 3.5 mV

Count Time 1 Minute Beta Window 50 mV

Other _____ Distance Source to Detector Surface

High Voltage	Background		Isotope Th230 Size 2910 apm		Isotope Th232 Size 135 cpm		Isotope Tc 99 Size 14100 cpm	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
1525	2	99	943	411	51	185	0	6731
1550	0	124	1116	428	47	197	0	7566
1575	1	93	1036	500	64	251	1	6865
1600	2	208	1075	526	55	306	18	7471
1625	0	202	1174	483	55	287	149	6722

☑ Gas Proportional detector count rate decreased ≤ 10% after 15 hour static test using 39" cable.

☐ Gas proportional detector count rate decreased ≤ 10% after 5 hour static test using 39" cable and alpha/beta counter.

Signature Charles Link Date 4 May 04

FORM C4B 04/09/2003

Form HPM/M-2-8-1
Daily Check Log for Ludlum Model 2360 with 43-68 Detector
Instrument 2 Alpha

Instrument/SN: Ludlum Model **2360 193686**					*Check Source(s) Used:* Th-230, S/N 5053-03							
Detector/SN: Model 43-68 /PR190485												
EFF %: α= 17.78 % 4π					*source check acceptance criteria*		*α*					
CALIB. SOURCE USED: Th-230					**Average (NCPM):**		2,564					
DATE OF CALIB.: **5/4/2004**					**+2 sigma:**		2,655					
CALIB. DUE DATE: **5/4/2005**					**-2 sigma:**		2,474					
PERFORMED BY: **Ludlum Measurements Inc.**					**+3 sigma:**		2,700					
					-3 sigma:		2,429					
TECHNICIAN'S NAME		ALPHA/ BETA	RESPONSE CHECK	DATE	TIME	60 min Bkgrd (cpm)	1 min gross (cpm)	1 min net (cpm)	within +/- 2 sigma	within +/- 3 sigma	<10% drop	
DBW	1	Alpha	SAT	1/31/2005	13:43	1.40	2,532	2,531	YES	YES	NA	
DBW	2	Alpha	SAT	1/31/2005	17:38	1.62	2,493	2,491	YES	YES	YES	
DBW	3	Alpha	SAT	2/1/2005	9:58	1.08	2,504	2,503	YES	YES	NA	
DBW	4	Alpha	SAT	2/1/2005	8:22	0.83	2,494	2,493	YES	YES	YES	
DBW	5	Alpha	SAT	2/2/2005	17:17	1.13	2,443	2,442	NO	YES	YES	
DBW	6	Alpha	SAT	2/3/2005	10:47	1.13	2,446	2,445	NO	YES	NA	
DBW	7	Alpha	SAT	2/5/2005	17:18	1.23	2,439	2,438	NO	YES	YES	
DBW	8	Alpha	SAT	2/8/2005	10:41	1.00	2,516	2,515	YES	YES	NA	
DBW	9	Alpha	SAT	2/14/2005	13:12	1.08	2,538	2,537	YES	YES	NA	
DBW	10	Alpha	SAT	2/14/2005	16:48	1.82	2,557	2,555	YES	YES	YES	
MDT	11	Alpha	SAT	2/15/2005	10:30	1.08	2,598	2,597	YES	YES	YES	
DBW	12	Alpha	SAT	2/15/2005	18:02	1.15	2,568	2,567	YES	YES	YES	
MDT	13	Alpha	SAT	3/2/2005	10:30	0.83	2,498	2,497	YES	YES	NA	
MDT	14	Alpha	SAT	3/2/2005	17:30	0.83	2,574	2,573	YES	YES	YES	
MDT	15	Alpha	SAT	3/3/2005	9:30	1.00	2,433	2,432	YES	YES	NA	
MDT	16	Alpha	SAT	3/3/2005	17:28	1.00	2,455	2,454	NO	YES	YES	

APPENDIX A-14

SURVEY UNIT KAISER-FSS-014

Appendix A-14, Table A-14-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-014
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-014	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	157032	PR206809	03/03/04 to 03/03/05	01/18/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	206873	PR211675	05/17/04 to 05/17/05	03/08/05 to 03/17/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.
Ludlum 2360 Alpha-Beta Scaler /Rate Meter with 43-68 100cm^2 Gas Proportional Alpha-Beta Detector	193686	PR190485	05/04/04 to 05/04/05	03/29/05	Simultaneous alpha-beta counting and discrimination - Instrument was used to survey embedded structures.

APPENDIX A-14-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 157032 (meter) and PR206809 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:157032

Cal Date: 03/03/04 Cal Due Date: 03/03/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☐ applies to applicable instruments and/or detector IAW Mfg. Spec. Temp. 68.9 °F RH 27 % Alt. 1120 Ft.

☐ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck. ☒ Meter Zeroed ☐ Background Subtract ☒ Input Sens. Linearity

☒ F/S Resp. OK ☒ Reset Ck. ☒ Window Operation ☒ Geotropism

☒ Audio. Ck. ☐ Alarm Setting Ck. ☒ Batt. Ck. (Min. Volt) 5.2 VDC

☐ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 1000 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 1500 / 1500 V Ref./Inst. 1000 / 1000 V.

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Zero button sticks

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	400 Kcpm	400 Kcpm
X1K	100 kcpm	100 Kcpm	100 Kcpm
X100	40 Kcpm	40 Kcpm	40 Kcpm
X100	10 Kcpm	10 Kcpm	10 Kcpm
X10	4 Kcpm	4000 cpm	4000 cpm
X10	1 Kcpm	900 cpm	900 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	39 cpm	39 cpm	Log Scale	50 cpm	50 cpm	50 cpm
	400 Kcpm	39618 cpm	39618 cpm		500 Kcpm	500 Kcpm	500 K cpm
	40 Kcpm	3962 cpm	3962 cpm		50 Kcpm	50 Kcpm	50 Kcpm
	4 Kcpm	397 cpm	397 cpm		5 Kcpm	5 Kcpm	5 Kcpm
	40 cpm	4 cpm	4 cpm		500 cpm	450 cpm	450 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N _____ ☐ Beta S/N _____ ☐ Other _____

☒ M 500 S/N 187460 ☐ Oscilloscope S/N _____ ☒ Multimeter S/N 020513278

Calibrated By: R. Shank Date: 03/03/04

Reviewed By: Date: 03/09/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument :	Ludlum		**DATE:**	3/29/2004		**TEMP.:**	67
Model No,	2221		**Source:**	Cs137	**S.N.**	**R.H.:**	34%
Serial No.	157032		**Strength:**	1.0uci	2485		
Probe:	44-10						
Serial No.	PR206809						

	Voltage	Background Count (cpm)	Source Count (cpm)
1	600	N/A	N/A
2	650	N/A	N/A
3	700	1791	174173
4	750	2001	179682
5	800	2075	190450
6	850	2132	195749
7	900	2187	195411
8	950	2150	197763
9	1000	2061	199119
10	1050	2132	199591
11	1100	2375	211691
12	1150	2723	283180
13	1200	N/A	N/A
14	1250	N/A	N/A
15	1300	N/A	N/A

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 2

Instrument Model:	2221
Instrument S/N:	157032
Detector Model:	44-10
Detector S/N:	PR206809
Calibration Due:	3/3/05

CONTACT

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	241,361 + 2σ
	177,299 - 2σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	13:10	1/18/2005	9,459	230,991	221,532	DBW	YES	5.4	YES

257,378 + 3σ
161,282 - 3σ

Comments: Moved cource check location to furnace room (lower background). Background 5 min. count.
Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 2

Instrument Model:	2221
Instrument S/N:	157032
Detector Model:	44-10
Detector S/N:	PR206809
Calibration Due:	3/3/05

6 INCHES

Source S/N:	Cs-137 sn: 547	
Source DPM:	N/A	
Radiation Detected:	gamma	
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,597 + 2σ	8,731 + 3σ
	8,061 - 2σ	7,927 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	13:10	1/18/2005	9,486	17,296	7,810	DBW	NO	5.4	YES

Comments: Moved cource check location to furnace room (lower background). Background 5 min. count.
Source check 1 minute count.

APPENDIX A-14-2

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 206873 (meter) and PR211675 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:206873

Cal Date: 05/17/04 Cal Due Date: 05/17/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☒ applies to applicable instruments and/or detector IAW Mfg. Spec. T 76.1 °F RH 44 % Alt. 1120 Ft.

☒ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck.	☒ Meter Zeroed	☐ Background Subtract	☒ Input Sens. Linearity
☒ F/S Resp. OK	☒ Reset Ck.	☒ Window Operation	☒ Geotropism
☒ Audio. Ck.	☐ Alarm Setting Ck.	☒ Batt. Ck. (Min. Volt) 6.2 VDC	

☒ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 900 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 669 /670 V Ref./Inst. 995 / 1000

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	395000 cpm	395000 cpm
X1K	100 kcpm	100000 cpm	100000 cpm
X100	40 Kcpm	39500 cpm	39500 cpm
X100	10 Kcpm	10000 cpm	10000 cpm
X10	4 Kcpm	3950 cpm	3950 cpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	38 cpm	38 cpm	Log Scale	50 cpm	60 cpm	60 cpm
	400 Kcpm	39116 cpm	39116 cpm		500 Kcpm	500000 cpm	500000 cpm
	40 Kcpm	3917 cpm	3917 cpm		50 Kcpm	50000 cpm	50000 cpm
	4 Kcpm	392 cpm	392 cpm		5 Kcpm	5000 cpm	5000 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N ☐ Beta S/N ☐ Other Cs137 2485

☒ M 500 S/N 187460 ☐ Oscilloscope S/N ☐ Multimeter S/N 020513278

Calibrated By: R. Shank Date: 05/17/04

Reviewed By: Date: 5/17/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument :	Ludlum
Model No,	2221
Serial No.	206783
Probe:	44-10
Serial No.	PR 211675

DATE:	5/17/2004
Source:	Cs137
Serial no.	2485
Strength:	I uci

	Background Count (cpm)	Source Count (cpm)	H.V.
1	4777	95849	700
2	5385	98961	750
3	5517	104186	800
4	5600	108132	850
5	5675	108795	900
6	5832	109020	950
7	5680	111082	1000
8	5849	111402	1050
9	6073	112078	1100
10	5782	115675	1150
11	N/A	N/A	1200
12	N/A	N/A	1250

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	232,512 + 2σ		238,680 + 3σ
	207,841 - 2σ		201,672 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	8:00	3/8/2005	9,017	224,022	215,005	EJ	YES	5.5	YES
2	7:30	3/9/2005	9,040	217,866	208,826	EJ	YES	5.4	YES
3	8:30	3/10/2005	9,004	228,707	219,703	EJ	YES	5.4	YES
4	10:23	3/15/2005	9,127	225,075	215,948	EJ	YES	5.4	YES
5	7:50	3/16/2005	9,136	226,195	217,059	EJ	YES	5.3	YES
6	7:35	3/17/2005	8,929	222,191	213,262	EJ	YES	5.3	YES

Comments: Background 5 minute count. Source count 1 minute.

Recalibrated by Enercon to Cs-137.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

6 INCHES

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,206 + 2σ		8,347 + 3σ
	7,637 - 2σ		7,495 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	8:00	3/8/2005	9,017	16,745	7,728	EJ	YES	5.5	YES
2	7:30	3/9/2005	9,040	16,859	7,813	EJ	YES	5.4	YES
3	8:30	3/10/2005	9,004	16,868	7,864	EJ	YES	5.4	YES
4	10:27	3/15/2005	9,127	16,999	7,872	EJ	YES	5.4	YES
5	7:59	3/16/2005	9,136	17,125	7,986	EJ	YES	5.3	YES
6	7:35	3/17/2005	8,929	16,802	7,873	EJ	YES	5.3	YES

Comments: Background 5 minute count. Source count 1 minute.

Recalibrated to Cs-137 by Enercon.

APPENDIX A-14-3

Ludlum Model 2360 Alpha-Beta Scaler/Rate Meter with Model 43-68 100 cm^2 Gas Proportional Alpha-Beta Detector Serial Nos. 193686 (meter) and PR190485 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

6129

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER KAISER ALUMINUM ORDER NO. 215373/281348

Ludlum Measurements, Inc. Model 2360 Serial No. 193686

Mfg. Ludlum Measurements, Inc. Model 43-68 Serial No. PR-190485

Cal. Date 4-May-04 Cal Due Date 4-May-05 Cal. Interval 1 Year Meterface 202-855

heck mark ☑ applies to applicable Instr. and/or detector IAW mfg. spec. T. 75 °F RH 28 % Alt 705.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☐ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC
☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

strument Volt Set 1575 V

☑ HV Readout (2 points) Ref./Inst. 500 / 491 V Ref./Inst. 1500 / 1992 V

Firmware Version: 39010N24
Alpha Threshold: 120mv
Beta Threshold: 3.5mv
Beta Window: 50mv
Overload Checked But not set
Instrument calibrated with a 39" cable.
High voltage set with detector Connected

(EEPROM Settings)
User Time: 001.0
Alpha Alarm: 050000
Beta Alarm: 050000
A/B Alarm: 050000
Model 2360 Date: 4 May 04
Calibration Date Due: 4 May 05

COMMENTS:
Eff. for Th230 ≈ 35.5% 2pi, Background count 1cpm, Source count 1036cpm, Source Size 2910cpm
Eff. for Th232 ≈ 46.6% 2pi, Background count 1cpm, Source count 64cpm, Source Size 135cpm
for Tc99 ≈ 48.0% 2pi, Background count 93cpm, Source count 6865cpm, Source Size 14100cpm

oration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
x1000	400kcpm	400	400
x1000	100kcpm	100	100
x100	40kcpm	400	400
x100	10kcpm	100	100
x10	4kcpm	400	400
x10	1kcpm	100	100
x1	400kcpm	400	400
x1	100kcpm	100	100

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
gital adout	400kcpm	39985(0)	39985(0)
	40kcpm	3999	3999
	4kcpm	400	400
	400cpm	40	40
	40cpm	4	4

Log Scale	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*

lum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of er International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

eference Instruments and/or Sources:

s-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

pha S/N Th230 #5020-03/Th232 #3153 ☑ Beta S/N Tc99 SN: NT-EV ☐ Other

☑ ...500 S/N 50800 ☐ Oscilloscope S/N ☑ Multimeter S/N 83990502

Calibrated By: Charles Robb Date 4 May 04

Reviewed By: WQ Robb Date 5 may 04

☐ AC Inst ☐ Record Dielectric (Hi Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

gm1-0
6/29

Bench Test Data For Detector

Detector 43-68 Serial No. PR-190485 Order #. 215373/281348

Customer KAISER ALUMINUM Alpha Input Sensitivity 120 mV

Counter 2360 Serial No. 193686 Beta Input Sensitivity 3.5 mV

Count Time 1Minute Beta Window 50 mV

Other _____ Distance Source to Detector Surface

High Voltage	Background Alpha	Background Beta	Isotope Th230 Size 2910 cpm Alpha	Isotope Th230 Size 2910 cpm Beta	Isotope Th232 Size 135 cpm Alpha	Isotope Th232 Size 135 cpm Beta	Isotope Tc 99 Size 14100 cpm Alpha	Isotope Tc 99 Size 14100 cpm Beta
1525	2	99	943	411	51	185	0	6731
1550	0	124	1116	428	47	197	0	7566
1575	1	93	1036	500	64	251	1	6865
1600	2	208	1075	526	55	306	18	7471
1625	0	202	1174	483	55	287	149	6722

☑ Gas Proportional detector count rate decreased ≤ 10% after 15 hour static test using 39" cable.

☐ Gas proportional detector count rate decreased ≤ 10% after 5 hour static test using 39" cable and alpha/beta counter.

Signature Charles Lisk Date 4 May 04

Form HPM/M-2-8-1
Daily Check Log for Ludlum Model 2360 with 43-68 Detector
Instrument 2 Alpha

Instrument/SN: Ludlum Model 2360 193686					*Check Source(s) Used:* Th-230, S/N 5053-03							
Detector/SN: Model 43-68 /PR190485												
EFF %: α= 17.78 % 4π					*source check acceptance criteria*		α					
CALIB. SOURCE USED: Th-230					**Average (NCPM):**		2,564					
DATE OF CALIB.: 5/4/2004					**+2 sigma:**		2,655					
CALIB. DUE DATE: 5/4/2005					**-2 sigma:**		2,474					
PERFORMED BY: Ludlum Measurements Inc.					**+3 sigma:**		2,700					
					-3 sigma:		2,429					
TECHNICIAN'S NAME		ALPHA/ BETA	RESPONSE CHECK	DATE	TIME	60 min Bkgrd (cpm)	1 min gross (cpm)	1 min net (cpm)	within +/- 2 sigma	within +/- 3 sigma	<10% drop	
DBW	1	Alpha	SAT	3/29/2005	10:10	1.20	2,521	2,520	YES	YES	NA	

APPENDIX A-15

SURVEY UNIT KAISER-FSS-015

Appendix A-15, Table A-15-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-015
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-015	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	206873	PR211675	05/17/04 to 05/17/05	04/14/05 to 04/28/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.
Ludlum 2360 Alpha-Beta Scaler /Rate Meter with 43-68 100cm^2 Gas Proportional Alpha Beta Detector	185779	PR126794	03/01/05 to 03/01/06	04/24/05 to 05/05/05	Simultaneous alpha-beta counting and discrimination - Instrument was used to survey embedded structures.

APPENDIX A-15-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 206873 (meter) and PR211675 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. . Order No.N/A

Mfg.: Ludlum Model 2221 Serial No.:206873

Cal Date: 05/17/04 Cal Due Date: 05/17/05 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☒ applies to applicable instruments and/or detector IAW Mfg. Spec. T 76.1 °F RH 44 % Alt. 1120 Ft.

☒ New Instrument Instrument Received ☐ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☒ Mechanical Ck.	☒ Meter Zeroed	☐ Background Subtract	☒ Input Sens. Linearity
☒ F/S Resp. OK	☒ Reset Ck.	☒ Window Operation	☒ Geotropism
☒ Audio. Ck.	☐ Alarm Setting Ck.	☒ Batt. Ck. (Min. Volt) 6.2 VDC	

☒ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 900 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☐ HV Readout (2 points) Ref./Inst. 669 /670 V Ref./Inst. 995 / 1000

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	395000 cpm	395000 cpm
X1K	100 kcpm	100000 cpm	100000 cpm
X100	40 Kcpm	39500 cpm	39500 cpm
X100	10 Kcpm	10000 cpm	10000 cpm
X10	4 Kcpm	3950 cpm	3950 cpm
X10	1 Kcpm	1000 cpm	1000 cpm
X1	400 cpm	400 cpm	400 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	38 cpm	38 cpm	Log Scale	50 cpm	60 cpm	60 cpm
	400 Kcpm	39116 cpm	39116 cpm		500 Kcpm	500000 cpm	500000 cpm
	40 Kcpm	3917 cpm	3917 cpm		50 Kcpm	50000 cpm	50000 cpm
	4 Kcpm	392 cpm	392 cpm		5 Kcpm	5000 cpm	5000 cpm
	40 cpm	4 cpm	4 cpm		500 cpm	475 cpm	475 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N ☐ Beta S/N ☐ Other Cs137 2485

☒ M 500 S/N 187460 ☐ Oscilloscope S/N ☐ Multimeter S/N 020513278

Calibrated By: R. Shank Date: 05/17/04

Reviewed By: Date: 5/17/04

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument :	Ludlum
Model No,	2221
Serial No.	206783 873
Probe:	44-10
Serial No.	PR 211675

DATE:	5/17/2004
Source:	Cs137
Serial no.	2485
Strength:	I uci

	Background Count (cpm)	Source Count (cpm)	H.V.
1	4777	95849	700
2	5385	98961	750
3	5517	104186	800
4	5600	108132	850
5	5675	108795	900
6	5832	109020	950
7	5680	111082	1000
8	5849	111402	1050
9	6073	112078	1100
10	5782	115675	1150
11	N/A	N/A	1200
12	N/A	N/A	1250

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	232,512 + 2σ		238,680 + 3σ
	207,841 - 2σ		201,672 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:45	4/14/2005	8,720	223,502	215,182	EJ	YES	5.8	YES
2	7:10	4/15/2005	8,602	223,065	214,463	EJ	YES	5.8	YES
3	9:48	4/18/2005	8,898	213,377	204,479	DBW	NO	5.8	YES
4	7:45	4/19/2005	8,836	224,678	215,842	DD	YES	5.8	YES
5	7:30	4/20/2005	8,675	228,493	219,818	EJ	YES	5.7	YES
6	6:35	4/21/2005	8,191	228,306	220,115	DD	YES	5.6	YES
7	7:15	4/23/2005	8,386	229,354	220,968	DD	YES	5.6	YES
8	7:20	4/25/2005	8,361	227,396	219,035	DD	YES	5.6	YES
9	7:45	4/26/2005	8,227	221,283	213,056	DD	YES	5.6	YES
10	7:45	4/27/2005	8,170	223,008	214,838	DD	YES	5.6	YES
11	7:40	4/28/2005	8,363	222,096	213,733	DD	YES	5.6	YES

Comments: Background 5 minute count. Source count 1 minute.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 3

Instrument Model:	2221
Instrument S/N:	206873
Detector Model:	44-10
Detector S/N:	PR211675
Calibration Due:	5/17/05

6 INCHES

Source S/N:	Cs-137 sn: 547	
Source DPM:	N/A	
Radiation Detected:	gamma	
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	8,206 + 2σ	8,347 + 3σ
	7,637 - 2σ	7,495 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:45	4/14/2005	8,720	16,782	8,062	EJ	YES	5.8	YES
2	7:10	4/15/2005	8,602	16,593	7,991	EJ	YES	5.8	YES
3	9:48	4/18/2005	8,898	16,418	7,520	DBW	NO	5.8	YES
4	7:45	4/19/2005	8,836	16,483	7,647	DD	YES	5.8	YES
5	8:35	4/20/2005	8,675	16,244	7,569	EJ	YES	5.7	YES
6	6:40	4/21/2005	8,191	16,319	8,128	DD	YES	5.6	YES
7	7:15	4/23/2005	8,386	16,272	7,886	DD	YES	5.6	YES
8	7:20	4/25/2005	8,361	16,545	8,184	DD	YES	5.6	YES
9	7:50	4/26/2005	8,227	16,586	8,359	DD	NO	5.6	NO
10	7:51	4/26/2005	8,227	16,127	7,900	DD	YES	5.6	YES
11	7:45	4/27/2005	8,170	16,245	8,075	DD	YES	5.6	YES
12	7:40	4/28/2005	8,363	16,218	7,855	DD	YES	5.6	YES

Comments: Background 5 minute count. Source count 1 minute.

APPENDIX A-15-2

Ludlum Model 2360 Alpha-Beta Scaler/Rate Meter with Model 43-68 100 cm^2 Gas Proportional Alpha-Beta Detector Serial Nos. 185779 (meter) and PR126794 (detector)

3/25

Certificate of Calibration

Ratemeter Certificate of Calibration

ERG
Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Manufacturer: Ludlum Model: 2360 Serial No.: 185779

All Ranges Calibrated Electronically; Ludlum Pulser Generator S.N. 97743

Reset ☑ Audio ☑ Mechanical ☑ Battery ☑

High Voltage 500v ☑ 1000v ☑ 1500v ☑

Instrument found within tolerance (+/- 10%) Yes ☑ No ☐

Alpha Threshold Setting: 120 mV

Beta Threshold Setting: 5.5 mV Beta Window: 50 mV

Reference Setting	Ratemeter	Instrument "As found reading"
400 Kcpm	400Kcpm	+/-10%
100 Kcpm	100Kcpm	
40 Kcpm	40Kcpm	
10 Kcpm	10 Kcpm	
4 Kcpm	4 Kcpm	
1 Kcpm	1 Kcpm	
400 cpm	400cpm	
100 cpm	100cpm	

Reference Setting	Integrated Counts (1-minute count)	Instrument "As found reading"
400 Kcpm	399278	+/-10%
40 Kcpm	39896	
4 Kcpm	3989	
400 cpm	398	

Calibrated By: [signature] Calibration Date: 01MAR05

Calibration Due: 01MAR06

Reviewed By: [signature] Date: 3/1/05

ZMS
3/25

Certificate of Calibration

Voltage Plateau Form

ERG
Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Detector Mfg.: Ludlum Model: 43-68 Serial No.: PR 126794

Counter Mfg.: Ludlum Model: 2360 Serial No.: 185779

Alpha Threshold Setting: 120 mV

Beta Threshold Setting: 3.5 mV Beta Window: 50 mV

Alpha Source : ☒ Th230 @ 13,500 dpm sn: 4098-03 ☐ Other: _____

Beta Source: ☑ Tc99 @ 18,100 dpm sn: 4099-03 ☐ Other: _____

Geometry / Distance to source: Contact

Count Time: 1 minute(s)

High Voltage	Alpha Source Counts		Beta Source Counts		Background Counts	
	Alpha	Beta	Alpha	Beta	Alpha	Beta
1300	168	1005	0	181	0	4
1400	1451	830	4	1762	2	40
1425	1711	872	1	2147	0	44
1450	1954	869	2	2712	1	75
1475	2059	954	5	3364	2	112
→ 1500	2161	1017	3	3968	3	152
1525	2326	1109	2	4440	1	195
1550	2572	1157	8	4540	3	273
1575	2578	1111	34	4291	4	339
1600	2761	984	186	3976	8	313

Recommended Operating Voltage: 1500 volts

Calibrated By: _____ Calibration Date: 01MAR05

Calibration Due: 01MAR06

Reviewed By: _____ Date: 3/1/05

Form HPM/M2-8-1
Daily Check Log for Ludlum Model 2360 with 43-68 Detector
Instrument 3 Alpha

Instrument/SN: Ludlum Model **2360** **185779**	*Check Source(s) Used:* Th-230, S/N 5053-03			*continuous purge*
Detector/SN: Model 43-68 /PR126794				
EFF %: α= 15.77 % 4π	*source check acceptance criteria*		α	
CALIB. SOURCE USED: Th-230	**Average (NCPM):**		1,808	
DATE OF CALIB.: **3/1/2005**	**+2 sigma:**		1,874	
CALIB. DUE DATE: **3/1/2006**	**-2 sigma:**		1,742	
PERFORMED BY: **Ludlum Measurements Inc.**	**+3 sigma:**		1,907	
	-3 sigma:		1,709	

TECHNICIAN'S NAME		ALPHA/ BETA	RESPONSE CHECK	DATE	TIME	60 min Bkgrd (cpm)	1 min gross (cpm)	1 min net (cpm)	within +/- 2 sigma	within +/- 3 sigma	<10% drop
DD	1	Alpha	SAT	4/27/2005	8:05	0.70	1,801	1,800	YES	YES	NA
DD	2	Alpha	SAT	4/27/2005	15:15	0.70	1,872	1,871	YES	YES	YES
DD	3	Alpha	SAT	4/28/2005	9:00	0.80	1,902	1,901	NO	YES	NA
DD	4	Alpha	SAT	4/28/2005	16:00	1.40	1,907	1,906	NO	YES	YES
DBW	5	Alpha	SAT	5/2/2005	12:23	0.85	1,806	1,805	YES	YES	NA
DD	6	Alpha	SAT	5/3/2005	8:42	0.80	1,783	1,782	YES	YES	NA
DD	7	Alpha	SAT	5/3/2005	11:00	0.90	1,894	1,893	NO	YES	YES
DD	8	Alpha	SAT	5/5/2005	10:45	1.10	1,771	1,770	YES	YES	NA
DD	9	Alpha	SAT	5/5/2005	16:30	1.20	1,882	1,881	NO	YES	YES

APPENDIX A-16

SURVEY UNIT KAISER-FSS-016

Appendix A-16, Table A-16-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-016
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-016	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	216521	PR226935	05/17/05 to 05/17/06	06/15/05 to 06/22/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-16-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 216521 (meter) and PR226935 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

jons 6/24

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER WAYPOINT TECHNOLOGY GROUP ORDER NO. 235778

Ludlum Measurements, Inc. Model 2221 Serial No. 216521

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR226935

Cal. Date 17-May-05 Cal Due Date 17-May-06 Cal. Interval 1 Year Meterface 202-159

heck mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 71 °F RH 42 % Alt 701.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

strument Volt Set Comments V Input Sens. Comment mV Det. Oper. Comments V at Comment mV Threshold Dial Ratio = mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 1998 V

COMMENTS:

	Peak settings	Gross Counts
High Voltage:	625v	950
Threshold dial:	642	100(10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
esolution for Cs137:	≈9.1 %	n/a

Model 2221 currently set for peaking.

High voltage set with detector connected.

Firmware:261072

mma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1K	400kcpm		400
X 1K	100kcpm		100
X 100	40kcpm		400
X 100	10kcpm		100
X 10	4kcpm		400
X 10	1kcpm		100
X 1	400cpm		400
X 1	100cpm		10

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm		40038 (0)
	40kcpm		4006(0)
	4kcpm		400 (0)
	400cpm		40 (0)
	40cpm		4 (0)

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Log Scale	500kcpm		475k
	50kcpm		50k
	5kcpm		5k
	500cpm		510
	50cpm		52

dium Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of her International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. e calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ☐ Beta S/N ☑ Other Am241~1.66uCi

☑ 500 S/N 38120 ☐ Oscilloscope S/N ☑ Multimeter S/N 78401030

Calibrated By: Lonnie Ortega Date 17-May-05

Reviewed By: Gloria Ortega Date 17 May 05

AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR 226935

Customer WAYPOINT TECHNOLOGY GROUP Order #. 235778

Counter 2221 Serial No. 216521 Counter Input Sensitivity 35 mV

Count Time 6 Second Distance Source to Detector ~2cm

Other

High Voltage	Background	Isotope Am241 Size ~1.66 uCi	Isotope Size	Isotope Size	Isotope Size
800	466	11281			
850	510	11728			
900	529	11637			
950	456	11958			
1000	530	11854			
1050	555	11730			
1100	601	11887			

Signature Jessica Ortega Date 17-May-05

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	287,854 + 2σ		293,373 + 3σ
	265,777 - 2σ		260,259 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	6:00	6/15/2005	9,318	279,823	270,505	DD	YES	6.0	YES
2	6:35	6/16/2005	9,225	288,902	279,677	DD	YES	5.9	YES
3	6:40	6/17/2005	9,374	290,596	281,222	DD	YES	5.8	YES
4	6:50	6/20/2005	8,775	289,659	280,884	DD	YES	5.8	YES
5	6:30	6/21/2005	9,220	285,237	276,017	DD	YES	5.8	YES
6	6:30	6/22/2005	9,074	289,986	280,912	DD	YES	5.8	YES

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

6 INCHES

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	9,617 + 2σ		9,747 + 3σ
	9,096 - 2σ		8,967 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	6:00	6/15/2005	9,318	18,648	9,330	DD	YES	6.0	YES
2	6:35	6/16/2005	9,225	18,692	9,467	DD	YES	5.8	YES
3	6:40	6/17/2005	9,374	18,932	9,558	DD	YES	5.8	YES
4	6:50	6/20/2005	8,775	18,399	9,624	DD	NO	5.8	YES
5	6:30	6/21/2005	9,220	18,723	9,503	DD	YES	5.8	YES
6	6:30	6/22/2005	9,074	18,701	9,627	DD	NO	5.8	YES

Comments: Background 5 minute count. Source check 1 minute count.

APPENDIX A-17

SURVEY UNIT KAISER-FSS-017

Appendix A-17, Table A-17-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-017
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-017	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	216521	PR226935	05/17/05 to 05/17/06	07/06/05 to 07/08/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-17-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 216521 (meter) and PR226935 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

Form 6/24

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER WAYPOINT TECHNOLOGY GROUP ORDER NO. 235778

Ludlum Measurements, Inc. Model 2221 Serial No. 216521

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR226935

Cal. Date 17-May-05 Cal Due Date 17-May-06 Cal. Interval 1 Year Meterface 202-159

heck mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 71 °F RH 42 % Alt 701.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

strument Volt Set Comments V Input Sens. Comment mV Det. Oper. Comments V at Comment mV Threshold Dial Ratio = mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 1998 V

COMMENTS:

	Peak settings	Gross Counts
High Voltage:	625v	950
Threshold dial:	642	100(10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
esolution for Cs137:	≈9.1 %	n/a

Model 2221 currently set for peaking.

High voltage set with detector connected.

Firmware:261072

mma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1K	400kcpm		400
X 1K	100kcpm		100
X 100	40kcpm		400
X 100	10kcpm		100
X 10	4kcpm		400
X 10	1kcpm		100
X 1	400cpm		400
X 1	100cpm		10

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
igital eadout	400kcpm		4003 (0)	Log Scale	500kcpm		475k
	40kcpm		4006 (0		50kcpm		50k
	4kcpm		400 (0)		5kcpm		5k
	400cpm		40 (0)		500cpm		590
	40cpm		4 (0)		50cpm		52

dium Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of her International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. e calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

Alpha S/N ☐ Beta S/N ☑ Other Am241~1.66uCi

☑ n 500 S/N 38120 ☐ Oscilloscope S/N ☑ Multimeter S/N 78401030

Calibrated By: Lonnie Ortega Date 17-May-05

Reviewed By: Gloria Ortega Date 17 May 05

AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR 226935

Customer WAYPOINT TECHNOLOGY GROUP Order #. 235778

Counter 2221 Serial No. 216521 Counter Input Sensitivity 35 mV

Count Time 6 Second Distance Source to Detector ~2cm

Other

High Voltage	Background	Isotope Am241 Size ~1.66 uCi	Isotope Size	Isotope Size	Isotope Size
800	466	11281			
850	510	11728			
900	529	11637			
950	456	11958			
1000	530	11854			
1050	555	11730			
1100	601	11887			

Signature Lenora Oakley Date 17-May-05

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

CONTACT

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	287,854 + 2σ
	265,777 - 2σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	6:05	7/6/2005	9,331	291,879	282,548	DD	Yes	5.7	Yes
2	6:55	7/7/2005	9,815	286,206	276,391	DD	Yes	5.6	Yes
3	7:40	7/8/2005	9,049	293,824	284,775	DD	Yes	5.6	Yes

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

6 INCHES

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	9,617 + 2σ		9,747 + 3σ
	9,096 - 2σ		8,967 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	6:05	7/6/2005	9,331	18,836	9,505	DD	Yes	5.7	Yes
2	6:55	7/7/2005	9,815	19,535	9,720	DD	No	5.4	Yes
3	7:40	7/8/2005	9,049	18,334	9,285	DD	Yes	5.6	Yes

Comments: Background 5 minute count. Source check 1 minute count.

APPENDIX A-18

SURVEY UNIT KAISER-FSS-018

Appendix A-18, Table A-18-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-018
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-018	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	216521	PR226935	05/17/05 to 05/17/06	08/8/05 to 08/19/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-18-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 216521 (meter) and PR226935 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

jones 6/24

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER WAYPOINT TECHNOLOGY GROUP ORDER NO. 235778

Ludlum Measurements, Inc. Model 2221 Serial No. 216521

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR226935

Cal. Date 17-May-05 Cal Due Date 17-May-06 Cal. Interval 1 Year Meterface 202-159

neck mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 71 °F RH 42 % Alt 701.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

strument Volt Set Comments V Input Sens. Comment mV Det. Oper. Comments V at Comment mV Threshold Dial Ratio ____ = ____ mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 1998 V

COMMENTS:

	Peak settings	Gross Counts
High Voltage:	625v	950
Threshold dial:	642	100(10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
tesolution for Cs137:	≈9.1 %	n/a

Model 2221 currently set for peaking.

High voltage set with detector connected.

Firmware:261072

amma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1K	400kcpm		400
X 1K	100kcpm		100
X 100	40kcpm		400
X 100	10kcpm		100
X 10	4kcpm		400
X 10	1kcpm		100
X 1	400cpm		400
X 1	100cpm		10

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm		40038 (0)
	40kcpm		4006 (0)
	4kcpm		400 (0)
	400cpm		40 (0)
	40cpm		4 (0)

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Log Scale	500kcpm		475k
	50kcpm		50k
	5kcpm		5k
	500cpm		510
	50cpm		52

dlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of her International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. e calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ____ ☐ Beta S/N ____ ☑ Other Am241~1.66μCi

☑ 500 S/N 38120 ☐ Oscilloscope S/N ____ ☑ Multimeter S/N 78401030

Calibrated By: Lemuel Ortega Date 17-May-05

Reviewed By: Gloria Ortega Date 17 May 05

AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR 226935

Customer WAYPOINT TECHNOLOGY GROUP Order #. 235778

Counter 2221 Serial No. 216521 Counter Input Sensitivity 35 mV

Count Time 6 second Distance Source to Detector ~2cm

Other

High Voltage	Background	Isotope Am241 Size ~1.66 µCi	Isotope Size	Isotope Size	Isotope Size
800	466	11281			
850	510	11728			
900	529	11637			
950	456	11958			
1000	530	11854			
1050	555	11730			
1100	601	11887			

Signature Jesus Ortiz Date 17-May-05

Form HPM/M-2-6-1
Daily Check Log for Ludlum 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	287,854 + 2σ		293,373 + 3σ
	265,777 - 2σ		260,259 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	6:25	8/8/2005	9,565	295,581	286,016	DD	YES	5.4	YES
2	6:30	8/9/2005	9,556	297,262	287,706	DD	YES	5.4	YES
3	6:30	8/10/2005	9,618	295,708	286,090	DD	YES	5.4	YES
4	6:35	8/11/2005	9,762	297,234	287,422	DD	YES	5.4	YES
5	6:25	8/12/2005	9,663	297,018	287,355	DD	YES	5.3	YES
6	6:30	8/17/2005	9,093	299,507	290,414	DD	NO	5.3	YES
7	6:35	8/18/2005	9,435	298,617	289,182	DD	NO	5.3	YES
8	6:30	8/19/2005	9,324	294,450	285,126	DD	YES	5.3	YES

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

6 INCHES

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	9,943 + 2σ		10,202 + 3σ
	8,908 - 2σ		8,648 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	6:25	8/8/2005	9,565	18,752	9,187	DD	YES	5.4	YES
2	6:30	8/9/2005	9,556	19,108	9,552	DD	YES	5.4	YES
3	6:30	8/10/2005	9,618	19,155	9,537	DD	YES	5.4	YES
4	6:35	8/11/2005	9,762	19,296	9,534	DD	YES	5.4	YES
5	6:25	8/12/2005	9,663	19,006	9,343	DD	YES	5.3	YES
6	6:30	8/17/2005	9,093	18,670	9,577	DD	YES	5.3	YES
7	6:35	8/18/2005	9,435	18,858	9,423	DD	YES	5.3	YES
8	6:30	8/19/2005	9,324	18,744	9,420	DD	YES	5.3	YES

Comments: Background 5 minute count. Source check 1 minute count.

APPENDIX A-19

SURVEY UNIT KAISER-FSS-019

Appendix A-19, Table A-19-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-019
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-019	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	216521	PR226935	05/17/05 to 05/17/06	08/8/05 to 08/25/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-19-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 216521 (meter) and PR226935 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER WAYPOINT TECHNOLOGY GROUP ORDER NO. 235778

Ludlum Measurements, Inc. Model 2221 Serial No. 216521

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR226935

Cal. Date 17-May-05 Cal Due Date 17-May-06 Cal. Interval 1 Year Meterface 202-159

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 71 °F RH 42 % Alt 701.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set Comments V Input Sens. Comment mV Det. Oper. Comments V at Comment mV Threshold Dial Ratio ____ = ____ mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 1998 V

COMMENTS:

	Peak settings	Gross Counts
High Voltage:	625v	950
Threshold dial:	642	100(10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
Resolution for Cs137:	≈9.1 %	n/a

Model 2221 currently set for peaking.

High voltage set with detector connected.

Firmware:261072

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1K	400kcpm		400
X 1K	100kcpm		100
X 100	40kcpm		400
X 100	10kcpm		100
X 10	4kcpm		400
X 10	1kcpm		100
X 1	400cpm		400
X 1	100cpm		10

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm		40038 (0)
	40kcpm		4006 (0)
	4kcpm		400 (0)
	400cpm		40 (0)
	40cpm		4 (0)

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Log Scale	500kcpm		475k
	50kcpm		50k
	5kcpm		5k
	500cpm		510
	50cpm		52

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ____ ☐ Beta S/N ____ ☑ Other Am241~1.66uCi

☑ Ludlum 500 S/N 38120 ☐ Oscilloscope S/N ____ ☑ Multimeter S/N 78401030

Calibrated By: Lemus Ortega Date 17-May-05

Reviewed By: Gloria Ortega Date 17 May 05

AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR 226935

Customer WAYPOINT TECHNOLOGY GROUP Order #. 235778

Counter 2221 Serial No. 216521 Counter Input Sensitivity 35 mV

Count Time 6 Second Distance Source to Detector ~2cm

Other

High Voltage	Background	Isotope Am241 Size ~1.66 uCi	Isotope Size	Isotope Size	Isotope Size
800	466	11281			
850	510	11728			
900	529	11637			
950	456	11958			
1000	530	11854			
1050	555	11730			
1100	601	11887			

Signature Steven Abbey Date 17-May-05

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	287,854 + 2σ		293,373 + 3σ
	265,777 - 2σ		260,259 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	6:25	8/8/2005	9,565	295,581	286,016	DD	YES	5.4	YES
2	6:30	8/9/2005	9,556	297,262	287,706	DD	YES	5.4	YES
3	6:30	8/10/2005	9,618	295,708	286,090	DD	YES	5.4	YES
4	6:35	8/11/2005	9,762	297,234	287,422	DD	YES	5.4	YES
5	6:25	8/12/2005	9,663	297,018	287,355	DD	YES	5.3	YES
6	6:30	8/17/2005	9,093	299,507	290,414	DD	NO	5.3	YES
7	6:35	8/18/2005	9,435	298,617	289,182	DD	NO	5.3	YES
8	6:30	8/19/2005	9,324	294,450	285,126	DD	YES	5.3	YES
9	6:30	8/22/2005	9,545	290,356	280,811	DD	YES	5.3	YES
10	6:40	8/23/2005	9,401	291,858	282,457	DD	YES	6.2	YES
11	6:30	8/24/2005	9,464	293,561	284,097	DD	YES	6.3	YES
12	6:40	8/25/2005	9,384	297,651	288,267	DD	NO	6.2	YES

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

6 INCHES

Source S/N:	Cs-137 sn: 547	
Source DPM:	N/A	
Radiation Detected:	gamma	
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	9,943 + 2σ	10,202 + 3σ
	8,908 - 2σ	8,648 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	6:25	8/8/2005	9,565	18,752	9,187	DD	YES	5.4	YES
2	6:30	8/9/2005	9,556	19,108	9,552	DD	YES	5.4	YES
3	6:30	8/10/2005	9,618	19,155	9,537	DD	YES	5.4	YES
4	6:35	8/11/2005	9,762	19,296	9,534	DD	YES	5.4	YES
5	6:25	8/12/2005	9,663	19,006	9,343	DD	YES	5.3	YES
6	6:30	8/17/2005	9,093	18,670	9,577	DD	YES	5.3	YES
7	6:35	8/18/2005	9,435	18,858	9,423	DD	YES	5.3	YES
8	6:30	8/19/2005	9,324	18,744	9,420	DD	YES	5.3	YES
9	6:30	8/22/2005	9,545	18,669	9,345	DD	YES	5.3	YES
10	6:40	8/23/2005	9,401	18,735	9,338	DD	YES	6.2	YES
11	6:30	8/24/2005	9,464	18,812	9,348	DD	YES	6.3	YES
12	6:40	8/25/2005	9,384	18,893	9,509	DD	YES	6.2	YES

Comments: Background 5 minute count. Source check 1 minute count.

APPENDIX A-20

SURVEY UNIT KAISER-FSS-020

Appendix A-20, Table A-20-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-020
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-020	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	157032	PR206809	02/14/05 to 02/14/06	09/30/05 to 10/06/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	216521	PR226935	05/17/05 to 05/17/06	09/30/05 to 10/07/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-20-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 157032 (meter) and PR206809 (detector)

CERTIFICATE OF CALIBRATION

ENERCON Services, Inc.
650-I Seco Road
Monroeville, PA 15146
Ph. 412-373-8455
Fax 412-373-5930

Customer: Enercon Services Inc. Order No.P.O.# PA-400-4072

Mfg.: Ludlum Model 2221 Serial No.:157032

Cal Date: 02/14/05 Cal Due Date: 02/14/06 Cal. Interval 12 mo.'s Meterface 202-159

Check mark ☑ applies to applicable instruments and/or detector. IAW Mfg. Spec. T 72.5 °F RH 26 % Alt. 1120 Ft.

☒ ~~New Instrument~~/ Instrument Received ☑ Within Toler +/-10% ☐ 0-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See Comment

☑ Mechanical Ck. ☑ Meter Zeroed ☐ Background Subtract ☒ Input Sens. Linearity

☑ F/S Resp. OK ☑ Reset Ck. ☒ Window Operation ☑ Geotropism

☒ Audio. Ck. ☐ Alarm Setting Ck. ☒ Batt. Ck. (Min. Volt) 6.1 VDC

☒ Calibrated in accordance with ECL 205-1 Rev. 0 1/23/03

Instrument Volt Set 1000 V Input Sens. 10 MV

Det. Oper. N/A V at N/A mV Threshold Dial Ratio 10 = 100

☒ HV Readout (2 points) Ref./Inst. 504 / 500 V Ref./Inst. 2000 / 1999

COMMENTS: Digital Calibration done using a 0.1 minute count time. Results reflect that count time.

Gamma Calibration: GM detectors positioned perpendicular to source except for M44-9 in which the front of probe faces source.

RANGE/ MULTIPLER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1K	400 Kcpm	400 Kcpm	400 Kcpm
X1K	200 Kcpm	200 Kcpm	200 Kcpm
X1K	100 Kcpm	90 Kcpm	90 Kcpm
X100	40 Kcpm	40 Kcpm	40 Kcpm
X100	20 Kcpm	20 Kcpm	20 Kcpm
X100	10 Kcpm	10 Kcpm	10 Kcpm
X10	4 Kcpm	4 Kcpm	4 Kcpm
X10	2 Kcpm	2 Kcpm	2 Kcpm
X10	1 Kcpm	1 Kcpm	1 Kcpm
X1	400 cpm	400 cpm	400 cpm
X1	200 cpm	200 cpm	200 cpm
X1	100 cpm	100 cpm	100 cpm

*Uncertainty within ±20%

	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING
Digital Readout	400 cpm	40 cpm		Log Scale	50 cpm	50 cpm	50 cpm
	400 Kcpm	39557 cpm			500 Kcpm	500 Kcpm	500 Kcpm
	40 Kcpm	3956 cpm			50 Kcpm	50 Kcpm	50 Kcpm
	4 Kcpm	395 cpm			5 Kcpm	5 Kcpm	5 Kcpm
	40 cpm	4 cpm			500 cpm	500 cpm	500 cpm

ENERCON Services, inc. certified that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology or to the calibration facility other International Standards Organization members, or have been derived from accepted values or natural physical constraints or have been derived by the ratio type of calibration technology. The calibration system conforms to the requirements of ANSI /NCSL Z540-1-1994 and ANSI N323-1978.

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 6205GF

☐ Alpha S/N _____ ☐ Beta S/N _____ ☐ Other _____

☒ M 500 S/N 187460 ☐ Oscilloscope S/N _____ ☐ Multimeter S/N 020513278

Calibrated By: R. Shank R. Shank Date: 02/14/05

Reviewed By: _____ Date: _____

AC Inst. ☐ Passed Dielectric (hi-Pot) and Continuity Only ☐ Failed

PLATEAU

Instrument :	Ludlum	**DATE:**	2/14/2005
Model No,	2221	**Source:**	Cs137
Serial No.	157032	**Serial No.**	03-95 2485
Probe:	44-10	**Strength:**	0.79uCi
Serial No.	PR206809		

	Background Count (cpm)	Source Count (cpm)	H.V.
1	2110	83144	700
2	2023	85332	725
3	2145	86609	750
4	2193	88120	775
5	2275	91113	800
6	2514	94549	825
7	2456	94875	850
8	2488	95566	875
9	2562	96575	900
10	2512	96942	925
11	2529	96763	950
12	2416	97113	975
13	2514	97531	1000
14			1025
15			1050
16			1075
17			1100
18			1150
19			1200
20			1250

P. Plant

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 5

Instrument Model:	2221
Instrument S/N:	157032
Detector Model:	44-10
Detector S/N:	PR206809
Calibration Due:	2/14/06

CONTACT

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	269,265 + 2σ
	262,026 - 2σ

									271,076 + 3σ
									260,216 - 3σ
	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:30	9/30/2005	9,061	275,150	266,089	DD	YES	5.7	YES
2	8:05	10/3/2005	9,137	279,165	270,028	DD	NO	5.6	YES
3	6:35	10/4/2005	9,090	278,669	269,579	DD	NO	5.6	YES
4	6:35	10/5/2005	8,989	277,334	268,345	DD	YES	5.6	YES
5	6:40	10/6/2005	9,026	276,471	267,445	DD	YES	5.5	YES

Comments: Background 5 minute count. Source count 1 minute.

Form HPM/M-2-6-1
Daily Check Log for Ludlum 2221 with 44-10 Detector
Instrument 5

	Instrument Model:	2221			Source S/N:	Cs-137 sn: 547			
	Instrument S/N:	157032			Source DPM:	N/A			
	Detector Model:	44-10			Radiation Detected:	gamma			
	Detector S/N:	PR206809			Acceptable Range:	10,768 + 2σ			11,378 + 3σ
	Calibration Due:	2/14/06	**6 INCHES**		(Refer to Penn E&R/HPM/M-2-1-1)	8,334 - 2σ			7,724 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:30	9/30/2005	9,061	18,732	9,671	DD	YES	5.7	YES
2	8:05	10/3/2005	9,137	18,499	9,362	DD	YES	5.6	YES
3	6:35	10/4/2005	9,090	18,845	9,755	DD	YES	5.6	YES
4	6:35	10/5/2005	8,989	18,754	9,765	DD	YES	5.6	YES
5	6:40	10/6/2005	9,026	18,556	9,530	DD	YES	5.5	YES

Comments: Background 5 minute count. Source count 1 minute

APPENDIX A-20-2

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 216521 (meter) and PR226935 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

JONES 6/24

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER WAYPOINT TECHNOLOGY GROUP ORDER NO. 235778

Ludlum Measurements, Inc. Model 2221 Serial No. 216521

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR226935

Cal. Date 17-May-05 Cal Due Date 17-May-06 Cal. Interval 1 Year Meterface 202-159

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 71 °F RH 42 % Alt 701.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set Comments V Input Sens. Comment mV Det. Oper. Comments V at Comment mV Threshold Dial Ratio ____ = ____ mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 1998 V

COMMENTS:

	Peak settings	Gross Counts
High Voltage:	625v	950
Threshold dial:	642	100(10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
Resolution for Cs137:	≈9.1 %	n/a

Model 2221 currently set for peaking.

High voltage set with detector connected.

Firmware:261072

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1K	400kcpm		400
X 1K	100kcpm		100
X 100	40kcpm		400
X 100	10kcpm		100
X 10	4kcpm		400
X 10	1kcpm		100
X 1	400cpm		400
X 1	100cpm		40

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm		40038 (0)
	40kcpm		4006 (9)
	4kcpm		400 (0)
	400cpm		40 (0)
	40cpm		4 (0)

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Log Scale	500kcpm		475k
	50kcpm		50k
	5kcpm		5k
	500cpm		510
	50cpm		52

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ____ ☐ Beta S/N ____ ☑ Other Am241-1.66uCi

☑ RM 500 S/N 38120 ☐ Oscilloscope S/N ____ ☑ Multimeter S/N 78401030

Calibrated By: Lenora Ortega Date 17-May-05

Reviewed By: Gloria Ortega Date 17 May 05

AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR 226935

Customer WAYPOINT TECHNOLOGY GROUP Order #. 235778

Counter 2221 Serial No. 216521 Counter Input Sensitivity 35 mV

Count Time 6 Second Distance Source to Detector ~2cm

Other

High Voltage	Background	Isotope Am241 Size ~1.66 uCi	Isotope Size	Isotope Size	Isotope Size
800	466	11281			
850	510	11728			
900	529	11637			
950	456	11958			
1000	530	11854			
1050	555	11730			
1100	601	11887			

Signature Jessica Ortega Date 17-May-05

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	287,854 + 2σ		293,373 + 3σ
	265,777 - 2σ		260,259 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:40	9/30/2005	9,411	296,240	286,829	DD	YES	5.6	YES
2	7:50	10/1/2005	9,989	299,420	289,431	DD	NO	5.6	YES
3	8:10	10/3/2005	9,541	298,881	289,340	DD	NO	5.6	YES
4	6:40	10/4/2005	9,419	295,267	285,848	DD	YES	5.6	YES
5	6:40	10/5/2005	9,477	298,173	288,696	DD	NO	5.6	YES
6	6:45	10/6/2005	9,420	297,912	288,492	DD	NO	5.6	YES
7	6:40	10/7/2005	9,412	296,026	286,614	DD	YES	5.4	YES

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

6 INCHES

Source S/N:	Cs-137 sn: 547	
Source DPM:	N/A	
Radiation Detected:	gamma	
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	9,943 + 2σ	10,202 + 3σ
	8,908 - 2σ	8,648 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:40	9/30/2005	9,411	18,949	9,538	DD	YES	5.6	YES
2	8:10	10/3/2005	9,541	18,830	9,289	DD	YES	5.6	YES
3	6:40	10/4/2005	9,419	18,789	9,370	DD	YES	5.6	YES
4	6:40	10/5/2005	9,477	18,884	9,407	DD	YES	5.6	YES
5	6:45	10/6/2005	9,420	18,804	9,384	DD	YES	5.6	YES
6	6:40	10/7/2005	9,412	18,851	9,439	DD	YES	5.4	YES

Comments: Background 5 minute count. Source check 1 minute count.

APPENDIX A-21

SURVEY UNIT KAISER-FSS-021

Appendix A-21, Table A-21-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-021
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-021	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	216521	PR226935	05/17/05 to 05/17/06	09/27/05 to 10/1/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-21-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 216521 (meter) and PR226935 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

Jones 6/24

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER WAYPOINT TECHNOLOGY GROUP ORDER NO. 235778

Ludlum Measurements, Inc. Model 2221 Serial No. 216521

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR226935

Cal. Date 17-May-05 Cal Due Date 17-May-06 Cal. Interval 1 Year Meterface 202-159

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 71 °F RH 42 % Alt 701.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set Comments V Input Sens. Comment mV Det. Oper. Comments V at Comment mV Threshold Dial Ratio ____ = ____ mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 1998 V

COMMENTS:

	Peak settings	Gross Counts
High Voltage:	625v	950
Threshold dial:	642	100(10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
Resolution for Cs137:	≈9.1 %	n/a

Model 2221 currently set for peaking.

High voltage set with detector connected.

Firmware:261072

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1K	400kcpm		400
X 1K	100kcpm		100
X 100	40kcpm		400
X 100	10kcpm		100
X 10	4kcpm		400
X 10	1kcpm		100
X 1	400cpm		400
X 1	100cpm		10

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm		40038 (0)
	40kcpm		4006 (0)
	4kcpm		400 (0)
	400cpm		40 (0)
	40cpm		4 (0)

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Log Scale	500kcpm		475k
	50kcpm		50k
	5kcpm		5k
	500cpm		510
	50cpm		52

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ____ ☐ Beta S/N ____ ☑ Other Am241~1.66uCi

☑ RO-20 S/N 38120 ☐ Oscilloscope S/N ____ ☑ Multimeter S/N 78401030

Calibrated By: Lemuel Ortega Date 17-May-05

Reviewed By: Gloria Ortega Date 17 May 05

AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR 226935

Customer WAYPOINT TECHNOLOGY GROUP Order #. 235778

Counter 2221 Serial No. 216521 Counter Input Sensitivity 35 mV

Count Time 60 second Distance Source to Detector ~2cm

Other

High Voltage	Background	Isotope Am241 Size ~1.66 uCi	Isotope Size	Isotope Size	Isotope Size
800	466	11281			
850	510	11728			
900	529	11637			
950	456	11958			
1000	530	11858			
1050	555	11730			
1100	601	11887			

Signature Jessica Ortega Date 17-May-05

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

CONTACT

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	287,854 + 2σ
	265,777 - 2σ

									293,373 + 3σ
									260,259 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	6:30	9/27/2005	9,616	297,218	287,602	DD	YES	5.7	YES
2	6:30	9/28/2005	9,558	296,575	287,017	DD	YES	5.6	YES
3	6:40	9/29/2005	9,576	295,800	286,224	DD	YES	5.6	YES
4	7:40	9/30/2005	9,411	296,240	286,829	DD	YES	5.6	YES
5	7:50	10/1/2005	9,989	299,420	289,431	DD	NO	5.6	YES

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

6 INCHES

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	9,943 + 2σ
	8,908 - 2σ

	Time	**Date**	**Background Count Rate**	**Source Count Rate**	**Net Source Count Rate**	**Technician**	**W/IN +/- 2σ**	**Batt check (volts)**	**W/IN +/- 3σ**
1	6:30	9/27/2005	9,616	18,831	9,215	DD	YES	5.7	YES
2	6:30	9/28/2005	9,558	19,024	9,466	DD	YES	5.6	YES
3	6:40	9/29/2005	9,576	19,268	9,692	DD	YES	5.6	YES
4	7:40	9/30/2005	9,411	18,949	9,538	DD	YES	5.6	YES

Comments: Background 5 minute count. Source check 1 minute count.

APPENDIX A-22

SURVEY UNIT KAISER-FSS-022

Appendix A-22, Table A-22-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-022
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-022	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	216521	PR226935	05/17/05 to 05/17/06	10/20/05 to 10/24/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.
Ludlum 2360 Alpha-Beta Scaler /Rate Meter with 43-68 100cm^2 Gas Proportional Alpha-Beta Detector	193686	PR190485	05/05/05 to 05/05/06	10/18/05	Simultaneous alpha-beta counting and discrimination - Instrument was used to survey embedded structures.

APPENDIX A-22-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 216521 (meter) and PR226935 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

Jones 6/24

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER WAYPOINT TECHNOLOGY GROUP ORDER NO. 235778

Ludlum Measurements, Inc. Model 2221 Serial No. 216521

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR226935

Cal. Date 17-May-05 Cal Due Date 17-May-06 Cal. Interval 1 Year Meterface 202-159

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 71 °F RH 42 % Alt 701.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set Comments V Input Sens. Comment mV Det. Oper. Comments V at Comment mV Threshold Dial Ratio ____ = ____ mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 1998 V

COMMENTS:

	Peak settings	Gross Counts
High Voltage:	625v	950
Threshold dial:	642	100(10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
Resolution for Cs137:	≈9.1 %	n/a

Model 2221 currently set for peaking.

High voltage set with detector connected.

Firmware:261072

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1K	400kcpm		400
X 1K	100kcpm		100
X 100	40kcpm		400
X 100	10kcpm		100
X 10	4kcpm		400
X 10	1kcpm		100
X 1	400cpm		400
X 1	100cpm		40

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm		40038 (0)
	40kcpm		4006 (0)
	4kcpm		400 (0)
	400cpm		40 (0)
	40cpm		4 (0)
Log Scale	500kcpm		475k
	50kcpm		50k
	5kcpm		5k
	500cpm		590
	50cpm		52

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ____ ☐ Beta S/N ____ ☑ Other Am241~1.66uCi

☑ M 500 S/N 38120 ☐ Oscilloscope S/N ____ ☑ Multimeter S/N 78401030

Calibrated By: Lonnie Ortega Date 17-May-05

Reviewed By: Gloria Ortega Date 17 May 05

AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR 226935

Customer WAYPOINT TECHNOLOGY GROUP Order #. 235778

Counter 2221 Serial No. 216521 Counter Input Sensitivity 35 mV

Count Time 6 Second Distance Source to Detector ~2cm

Other

High Voltage	Background	Isotope Am241 Size ~1.66 µCi	Isotope Size	Isotope Size	Isotope Size
800	466	11281			
850	510	11728			
900	529	11637			
950	456	11958			
1000	530	11854			
1050	555	11730			
1100	601	11887			

Signature Dennis Ables Date 17-May-05

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

CONTACT

Source S/N:	Cs-137 sn: 547	
Source DPM:	N/A	
Radiation Detected:	gamma	
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	287,854 + 2σ	293,373 + 3σ
	265,777 - 2σ	260,259 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:20	10/20/2005	9,525	298,513	288,988	DD	NO	5.4	YES
2	13:00	10/21/2005	9,294	296,779	287,485	DD	YES	5.3	YES
3	7:40	10/24/2005	9,420	290,208	280,788	DD	YES	5.3	YES

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

6 INCHES

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	9,943 + 2σ
	8,908 - 2σ

	Time	**Date**	**Background Count Rate**	**Source Count Rate**	**Net Source Count Rate**	**Technician**	**W/IN +/- 2σ**	**Batt check (volts)**	**W/IN +/- 3σ**
1	7:20	10/20/2005	9,525	18,551	9,026	DD	YES	5.4	YES
2	13:00	10/21/2005	9,294	18,921	9,627	DD	YES	5.3	YES
3	7:40	10/24/2005	9,420	18,681	9,261	DD	YES	5.3	YES

	10,202 + 3σ
	8,648 - 3σ

Comments: Background 5 minute count. Source check 1 minute count.

APPENDIX A-22-2

Ludlum Model 2360 Alpha-Beta Scaler/Rate Meter with Model 43-68 100 cm^2 Gas Proportional Alpha-Beta Detector Serial Nos. 193686 (meter) and PR190485 (detector)

5 mR
10/26

Certificate of Calibration

Ratemeter Certificate of Calibration

ERG
Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Manufacturer: Ludlum Model: 2360 Serial No.: 193686

All Ranges Calibrated Electronically; Ludlum Pulser Generator S.N. 97743

Reset ☑ Audio ☑ Mechanical ☑ Battery ☑

High Voltage 500v ☑ 1000v ☑ 1500v ☑

Instrument found within tolerance (+/- 10%) Yes ☑ No ☐

Alpha Threshold Setting: 120 mV

Beta Threshold Setting: 3.5 mV Beta Window: 50 mV

Reference Setting	Ratemeter	Instrument "As found reading"
400 Kcpm	400Kcpm	+/- 10%
100 Kcpm	100Kcpm	
40 Kcpm	40Kcpm	
10 Kcpm	10Kcpm	
4 Kcpm	4Kcpm	
1 Kcpm	1Kcpm	
400 cpm	400cpm	
100 cpm	100cpm	

Reference Setting	Integrated Counts (1-minute count)	Instrument "As found reading"
400 Kcpm	400123cpm	+/- 10%
40 Kcpm	39742cpm	
4 Kcpm	3965 cpm	
400 cpm	399cpm	

Calibrated By: [signature] Calibration Date: 05/05/05

Calibration Due: 05/05/06

Reviewed By: [signature] Date: 5/5/05

Certificate of Calibration

Voltage Plateau Form

ERG
Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

Detector Mfg.: Ludlum Model: 43-68 Serial No.: PR 190485

Counter Mfg.: Ludlum Model: 2360 Serial No.: 193686

Alpha Threshold Setting: 120 mV

Beta Threshold Setting: 3.5 mV Beta Window: 50 mV

Alpha Source : ☑ [redacted] ☐ Other:

Beta Source: ☑ [redacted] ☐ Other:

Geometry / Distance to source: CONTACT

Count Time: 1 minute(s)

High Voltage	Alpha Source Counts		Beta Source Counts		Background Counts	
	Alpha	Beta	Alpha	Beta	Alpha	Beta
1425	1286	371	3	906	0	23
1450	1747	801	3	2297	2	52
1475	2038	954	3	2927	3	76
→ 1500	2219	964	1	3685	3	110
1525	2476	1079	6	4525	5	194
1550	2663	1108	15	4573	3	272
1575	2792	1058	48	4225	7	333

Recommended Operating Voltage: 1500 volts

Calibrated By: [signature] Calibration Date: 05/05/05

Calibration Due: 05/05/06

Reviewed By: [signature] Date: 5/5/05

Form HPM/M-2-8-1
Daily Check Log for Ludlum Model 2360 with 43-68 Detector
Instrument 4 Alpha

Instrument/SN: Ludlum Model **2360** **193686**	*Check Source(s) Used: Th-230, S/N 5053-03*		
Detector/SN: Model 43-68/PR 190485			
EFF %: α=16.8% 4π	*source check acceptance criteria*		α
CALIB. SOURCE USED: Th-230	**Average (NCPM):**		1,919
DATE OF CALIB.: **5/5/2005**	**+2 sigma:**		2,019
CALIB. DUE DATE: **5/5/2006**	**-2 sigma:**		1,819
PERFORMED BY: **ERG**	**+3 sigma:**		2,069
	-3 sigma:		1,769

TECHNICIAN'S NAME		ALPHA/ BETA	RESPONSE CHECK	DATE	TIME	60 min Bkgrd (cpm)	1 min gross (cpm)	1 min net (cpm)	within +/- 2 sigma	within +/- 3 sigma	<10% drop
DD	1	Alpha	SAT	10/18/2005	8:55	1.10	1,798	1,797	NO	YES	NA
DD	2	Alpha	SAT	10/18/2005	12:50	1.30	1,779	1,778	NO	YES	YES

APPENDIX A-23

SURVEY UNIT KAISER-FSS-023

Appendix A-23, Table A-23-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-023
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-023	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	216521	PR226935	05/17/05 to 05/17/06	11/30/05 to 12/02/05	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-23-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 216521 (meter) and PR226935 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

Jones 6/24

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER WAYPOINT TECHNOLOGY GROUP ORDER NO. 235778

Ludlum Measurements, Inc. Model 2221 Serial No. 216521

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR226935

Cal. Date 17-May-05 Cal Due Date 17-May-06 Cal. Interval 1 Year Meterface 202-159

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 71 °F RH 42 % Alt 701.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set Comments V Input Sens. Comment mV Det. Oper. Comments V at Comment mV Threshold Dial Ratio ____ = ____ mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 1998 V

COMMENTS:

	Peak settings	Gross Counts
High Voltage:	625v	950
Threshold dial:	642	100(10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
Resolution for Cs137:	~9.1 %	n/a

Model 2221 currently set for peaking.

High voltage set with detector connected.

Firmware:261072

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1K	400kcpm		400
X 1K	100kcpm		100
X 100	40kcpm		400
X 100	10kcpm		100
X 10	4kcpm		400
X 10	1kcpm		100
X 1	400cpm		400
X 1	100cpm		10

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm		40038 (0)
	40kcpm		4006 (0)
	4kcpm		400 (0)
	400cpm		40 (0)
	40cpm		4 (0)

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Log Scale	500kcpm		475k
	50kcpm		50k
	5kcpm		5k
	500cpm		510
	50cpm		52

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ____ ☐ Beta S/N ____ ☑ Other Am241-1.66uCi

LV Ion 500 S/N 38120 ☐ Oscilloscope S/N ____ ☑ Multimeter S/N 78401030

Calibrated By: Lonnie Ortiz Date 17-May-05

Reviewed By: Gloria Ortiz Date 17 May 05

AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR 226935

Customer WAYPOINT TECHNOLOGY GROUP Order #. 235778

Counter 2221 Serial No. 216521 Counter Input Sensitivity 35 mV

Count Time 6 Second Distance Source to Detector ~2cm

Other

High Voltage	Background	Isotope Am241 Size ~1.66 μCi	Isotope Size	Isotope Size	Isotope Size
800	466	11281			
850	510	11728			
900	529	11637			
950	456	11958			
1000	530	11854			
1050	555	11730			
1100	601	11887			

Signature Jessica Ashley Date 17-May-05

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	287,854 + 2σ		293,373 + 3σ
	265,777 - 2σ		260,259 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:30	11/30/2005	9,090	297,058	287,968	DD	NO	5.6	YES
2	6:40	12/1/2005	9,231	288,855	279,624	DD	YES	5.6	YES
3	6:35	12/2/2005	9,172	288,074	278,902	DD	YES	5.6	YES

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

6 INCHES

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	9,943 + 2σ
	8,908 - 2σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:30	11/30/2005	9,090	18,775	9,685	DD	YES	5.6	YES
2	6:40	12/1/2005	9,231	18,613	9,382	DD	YES	5.6	YES
3	6:35	12/2/2005	9,172	18,562	9,390	DD	YES	5.6	YES

Comments: Background 5 minute count. Source check 1 minute count.

	10,202 + 3σ
	8,648 - 3σ

APPENDIX A-24

SURVEY UNIT KAISER-FSS-024

Appendix A-24, Table A-24-1
Final Status Survey Instrument Summary
Survey Unit Kaiser-FSS-024
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Instrument Model and Detector Model/Type	Instrument Serial Number	Detector Serial Number	Calibration Period	In-Service Period Survey Unit Kaiser-FSS-024	Usage
Ludlum 2221 Scaler/ Rate Meter with 44-10 2" X 2" NaI Scintillation Gamma Detector	216521	PR226935	05/17/05 to 05/17/06	1/24/2006	Field analysis, high-energy gamma detection - Instrument was used to evaluate remediation progress and scan land areas for the Final Status Survey.

APPENDIX A-24-1

Ludlum Model 2221 Scaler/Rate Meter
With Model 44-10 2-inch x 2-inch NaI Scintillation Gamma Detector
Serial Nos. 216521 (meter) and PR226935 (detector)

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER WAYPOINT TECHNOLOGY GROUP ORDER NO. 235778

Ludlum Measurements, Inc. Model 2221 Serial No. 216521

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR226935

Cal. Date 17-May-05 Cal Due Date 17-May-06 Cal. Interval 1 Year Meterface 202-159

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 71 °F RH 42 % Alt 701.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set Comments V Input Sens. Comment mV Det. Oper. Comments V at Comment mV Threshold Dial Ratio ____ = ____ mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 1998 V

COMMENTS:

	Peak settings	Gross Counts
High Voltage:	625v	950
Threshold dial:	642	100(10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
Resolution for Cs137:	~9.1 %	n/a

Model 2221 currently set for peaking.

High voltage set with detector connected.

Firmware:261072

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1K	400kcpm		400
X 1K	100kcpm		100
X 100	40kcpm		400
X 100	10kcpm		100
X 10	4kcpm		400
X 10	1kcpm		100
X 1	400cpm		400
X 1	100cpm		40

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm		40038 (0)
	40kcpm		4006 (9)
	4kcpm		400 (0)
	400cpm		40 (0)
	40cpm		4 (0)

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Log Scale	500kcpm		475k
	50kcpm		50k
	5kcpm		5k
	500cpm		510
	50cpm		52

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ____ ☐ Beta S/N ____ ☑ Other Am241~1.66uCi

☐ Ion 500 S/N 38120 ☐ Oscilloscope S/N ____ ☑ Multimeter S/N 78401030

Calibrated By: Lonnie Ashley Date 17-May-05

Reviewed By: Gloria Orozco Date 17 May 05

☐ AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR 226935

Customer WAYPOINT TECHNOLOGY GROUP Order #. 235778

Counter 2221 Serial No. 216521 Counter Input Sensitivity 35 mV

Count Time 6 Seconds Distance Source to Detector ~2cm

Other

High Voltage	Background	Isotope Am241 Size ~1.66 µCi	Isotope Size	Isotope Size	Isotope Size
800	466	11281			
850	510	11728			
900	529	11637			
950	456	11958			
1000	530	11854			
1050	555	11730			
1100	601	11887			

Signature Steven Abbey Date 17-May-05

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

CONTACT

Source S/N:	Cs-137 sn: 547		
Source DPM:	N/A		
Radiation Detected:	gamma		
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	287,854 + 2σ		293,373 + 3σ
	265,777 - 2σ		260,259 - 3σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:50	1/24/2006	9,198	296,856	287,658	DD	YES	5.4	YES

Comments: Background 5 minute count. Source check 1 minute count.

Form HPM/M-2-6-1
Daily Check Log for Ludlum Model 2221 with 44-10 Detector
Instrument 7

Instrument Model:	2221
Instrument S/N:	216521
Detector Model:	44-10
Detector S/N:	PR226935
Calibration Due:	5/17/06

6 INCHES

Source S/N:	Cs-137 sn: 547
Source DPM:	N/A
Radiation Detected:	gamma
Acceptable Range: (Refer to Penn E&R/HPM/M-2-1-1)	9,943 + 2σ
	8,908 - 2σ

	Time	Date	Background Count Rate	Source Count Rate	Net Source Count Rate	Technician	W/IN +/- 2σ	Batt check (volts)	W/IN +/- 3σ
1	7:50	1/24/2006	9,198	18,666	9,468	DD	YES	5.4	YES

10,202 + 3σ	
8,648 - 3σ	

Comments: Background 5 minute count. Source check 1 minute count.

APPENDIX B

DECOMMISSIONING PLAN CHAPTER 14.0

Table of Contents

14.0 Facility Radiation Surveys

This chapter presents the general framework for facility radiation surveys relative to the decommissioning of the Tulsa facility. The chapter focuses on the 14-acre Pond Parcel area. Supplemental information relative to facility radiation surveys for the "former operational area" of the facility is provided in Chapter 14.0 of the May 2002 DPA (Revised May 2003).

14.1 Release Criteria

The site will be remediated in accordance with decommissioning criteria of Subpart E, Radiological Criteria for License Termination of 10 CFR Part 20, Standards of Protection Against Radiation. Specifically, Subpart E, 10 CFR 20.1402, Radiological Criteria for Unrestricted Use, allows release of a site for unrestricted use if the residual radioactivity distinguishable from background results in a TEDE to an average member of the critical group that does not exceed 25 mrem/yr and the residual radioactivity has been reduced to levels that are ALARA.

Dose modeling is used to estimate the TEDE to the average member of the critical group (that group reasonably expected to receive the greatest exposure to residual radioactivity for any applicable circumstances). The concentration of residual radioactivity (per radionuclide) distinguishable from background that, if distributed uniformly throughout a survey unit, results in a TEDE of 25 mrem in 1 year to an average member of the critical group is the single-radionuclide $DCGL_W$. Preliminary $DCGL_W$ values for the radionuclides of concern at the Kaiser site have been calculated using the guidance provided in NUREG-1549, Decision Methods for Dose Assessment to Comply With Radiological Criteria for License Termination. In order to account for the presence of multiple radionuclides, the Unity Rule was applied, and $DCGL_W$ values adjusted as shown in Table 14-1.

Table 14-1
$DCGL_W$ Values

Radionuclide	Single Radionuclide $DCGL_W$ (pCi/g)	Ratio to Th-232 Assuming Equilibration	Average Concentration with Th-232 at Single Rad $DCGL_W$ (pCi/g)	Adjusted $DCGL_W$ to Meet Unity Rule (pCi/g)
Pb-210	1.751	0.043	0.15	0.12
Ra-226	5.9	0.082	0.28	0.24
Ra-228	4.3	1	3.4	3
Th-228	3.4	1	3.4	3
Th-230	102	3.5	12	10
Th-232	3.4	1	3.4	3

In developing the remedial action plan, a derived cutoff concentration level (DCCL) of 31.1 pCi/g Th-232 has been determined. This value represents the dividing line concentration between material which must be exported to an off-site disposal facility and material which can remain on site under an unrestricted release scenario. Based upon kriging analyses (Appendix A), on average, material above the DCCL is exempt. Moreover, the kriging volume estimates together with the dose assessment presented in Chapter 5.0 demonstrate that unrestricted release dose levels can be achieved when material below the DCCL is returned to the excavation as described in Chapter 8.0. The average concentration of below-criteria material remaining on site is termed herein as the Average Derived Concentration Level (ADCL). Based upon dose evaluations, the ADCL, rounded to 7 pCi/g Th-232, results in a postremediation TEDE well below 1 mrem/yr.

The three important threshold concentration criteria and their significance are summarized below in Table 14-2.

Table 14-2
Threshold Concentration Criteria

Parameter	Value (pCi/g Th-232)	Application
$DCGL_W$	3.0	Release criterion for soil stockpile/processing area
DCCL	31.1	Dividing line for off-site disposal of material
ADCL	7.0	Estimated average concentration of material left on site as backfill

Table 14-3 presents area factors (based upon MARSSIM guidance) to be used for elevated measurement comparisons (EMC) and to determine sampling requirements in situations where the scan instrument's minimum detectable concentration is greater than the $DCGL_W$ or DCCL depending on the survey area. The $DCGL_{EMC}$ values applicable to the stockpile/processing area are calculated by multiplying the $DCGL_W$ by the area factors presented in Table 14-3. $DCGL_{EMC}$ values are presented in Table 14-4.

$$DCGL_{EMC} = \text{Area Factor} * DCGL_W$$

For the segregated material below 31.1 pCi/g of Th-232 left onsite as backfill, the ADCL value was multiplied by the area factors presented in Table 14-3 and the results are presented in Table 14-5.

$ADCL_{EMC}$ = Area Factor * ADCL

However, since the material used as backfill is material below 31.1 pCi/g of Th-232, the elevated measurement comparison is only applicable to concentrations exceeding 31.1 pCi/g of Th-232. The ADCL value of 7 pCi/g of Th-232 was conservatively used to establish elevated measurement criteria for the backfill material greater than 31.1 pCi/g of Th-232, to maintain the average concentration of the backfill material ALARA.

Table 14-3
Area Factors

	Area Factors								
Radio-nuclide	1 m^2 (11 ft^2)	3 m^2 (32 ft^2)	10 m^2 (108 ft^2)	30 m^2 (323 ft^2)	100 m^2 (1,076 ft^2)	300 m^2 (3,229 ft^2)	1,000 m^2 (10,764 ft^2)	3,000 m^2 (32,292 ft^2)	10,000 m^2 (107,639 ft^2)
Th-232	12.5	6.2	3.2	2.3	1.8	1.5	1.1	1.0	1.0

Table 14-4
$DCGL_{EMC}$ Values for Processing Area

	$DCGL_{EMC}$ (pCi/g)								
Radio-nuclide	1 m^2 (11 ft^2)	3 m^2 (32 ft^2)	10 m^2 (108 ft^2)	30 m^2 (323 ft^2)	100 m^2 (1,076 ft^2)	300 m^2 (3,229 ft^2)	1,000 m^2 (10,764 ft^2)	3,000 m^2 (32,292 ft^2)	10,000 m^2 (107,639 ft^2)
Th-232	37.5	18.6	9.6	6.9	5.4	4.5	3.3	3.0	3.0

Table 14-5
$ADCL_{EMC}$ Values for Excavation Areas

	$ADCL_{EMC}$ (pCi/g)								
Radio-nuclide	1 m^2 (11 ft^2)	3 m^2 (32 ft^2)	10 m^2 (108 ft^2)	30 m^2 (323 ft^2)	100 m^2 (1,076 ft^2)	300 m^2 (3,229 ft^2)	1,000 m^2 (10,764 ft^2)	3,000 m^2 (32,292 ft^2)	10,000 m^2 (107,639 ft^2)
Th-232	87.5	43.4	22.4	16.1	12.6	10.5	7.7	7.0	7.0

14.2 Characterization Surveys

A series of radiological characterization surveys of the site have been performed from 1994 to 2001. A summary of each survey is provided.

14.2.1 ADA 1994

In February of 1994, the site was divided into eight sections and a gamma walk-over survey was performed. Measurements were taken at 1 m above the ground every 15 feet. A Ludlum Model 3-97 Survey Meter (internal 1-inch-by-1-inch NaI [Tl] scintillator detector) calibrated to read micro-Roentgen per hour (μR/hr) was used. Background was established as 10 μR/hr, and readings of greater than twice background were observed in all eight sections of the site including a maximum of 400 μR/hr. Five 18-inch core boring samples, one background core boring, and four additional soil samples from test digs were taken. The samples were oven dried at approximately 50°C for 12 hours and then counted for a minimum of 100 minutes using an ORTEC Multichannel Analyzer connected to a Canberra High Purity Intrinsic Germanium Detector. Analytical results confirmed the presence of Th-228 in secular equilibrium with Th-232. Th-230 (from the natural uranium decay chain) also was identified. The Th-230 was 2.4 to 3.4 times the Th-232 activity.

14.2.2 ARS 1995

In October of 1994, a more extensive characterization of the site was performed. Two hundred and fifty samples were systematically collected from 90 borehole locations. Samples were collected in 500-ml Marinelli containers, weighed to the nearest 0.1 g, and counted for 10 minutes with a shielded 2-inch-by-2-inch NaI (Tl) scintillator detector. The instrument was a Bicron LabTech Dual Channel Analyzer.

Sixty 200-ml subsamples were taken from the 250 field samples. Subsamples were analyzed using a density compensating gamma spectroscopy system (Nuclear Fuel Systems, Inc.) for U-234, U-235, U-238, and Th-232. Referred to as the At Line Solution Assay System (ALSAS), it provided density corrected pCi/g values. A correlation coefficient (r) of 0.990 relating the total counts of the field 2-inch-by-2-inch NaI (Tl) detector field count to the analytical results (pCi/g) of the same sample was completed. Linear regression was used to determine an equation to calculate pCi/g values from counts. The results of the survey were total thorium (Th-232 + Th-228) pCi/g values ranging from below the MDA of 1 pCi/g to 425.6 pCi/g.

Alpha spectroscopy was performed on 11 of the samples and confirmed the previously established ratio of Th-232 to Th-230 in dross of between 1:2.4 and 1:3.4. The 11 samples were selected from 60 sample results that fell in the 1 to 50 pCi/g total thorium range. The 11 samples represented 3 of the 4 main areas surveyed including the Retention Pond, the Reserve Pond, and the land area between the railroad and the Retention Pond. The ratios calculated from these data ranged from 1:0.62 to 1:3.15. Data were consistent

with previous characterization survey results and were used to estimate volumes of contaminated material and to map contamination at depth.

Surface water from the Retention Pond (two samples) and from Fulton Creek (one sample) were collected and analyzed by gamma spectroscopy. Results were below the MDA value of approximately 1.0 pCi/l Th-232.

14.2.3 Adjacent Land Remediation Plan Appendix A

In 1999, 24 samples were selected (on site) to confirm the Th-232 to Th-230 ratio in the dross. The samples were selected based on geographical distribution and included both the Retention and Reserve ponds and a range of depths. The data approximate the ratio to be 1:3.5. This ratio was used to calculate the Th-230 activity based on the measured Th-232 activity during Phase I remediation of adjacent (to Kaiser property) land.

14.2.4 Summary

NUREG-1575 (MARSSIM) defines areas that have no reasonable potential for residual contamination as "nonimpacted." These areas have no radiological impact from site operations. Areas with some potential for residual contamination are defined as "impacted." Impacted areas are further divided into Class 1, 2, or 3 areas based on the potential for contamination.

The former Freshwater Pond area is nonimpacted. Results of characterization surveys indicate that the remainder of the pond parcel east of the former Freshwater Pond area is impacted. The land areas have been classified in accordance with MARSSIM based on the existing characterization survey data. The classification is provided in the Final Status Survey Design section below. In addition, part of the adjacent land was impacted and was remediated in 2000-2001. The adjacent land area was surveyed under NUREG/CR-5849 and the unrestricted release approved by the NRC in 2002. Therefore, the entire area adjacent to the site as delineated by grids in Figure 2-4, is not addressed in this phase of decommissioning.

In addition to the characterization events detailed in Sections 14.2.1, 14.2.2, and 14.2.3, composite samples of characterization core samples and final status samples were taken during adjacent land remediation surveys. The composite samples were analyzed by alpha spectroscopy to further evaluate the Th-232 to Th-230 activity ratio. The results yielded Th-232 to Th-230 ratios from 1:0.32 to 1:2.95. A summary of soil sample analyses performed to calculate the ratio of Th-232 to Th-230 activity is presented in the table below. A compilation of the analytical data used to calculate the ratio of Th-232 to

Th-230 is presented in Appendix E. The established ratio of Th-232 to Th-230 of 1:3.5 will continue to be used during Phase II of the decommissioning of the site because this is the most conservative (protective) approach. A summary of sample result Th-232 to Th-230 activity ratios for the Kaiser site is provided in Table 14-6 below.

Table 14-6

Measured Th-232 to Th-230 Ratios

Reference	Number of Samples	Minimum Ratio of Th-232:Th-230	Maximum Ratio of Th-232:Th-230	Average Ratio of Th-232:Th-230
ADA 1994	3	1:2.4	1:3.4	NA
ARS 1995	11	1:0.6	1:3.1	1:1.7
Kaiser 1999	24	1:1.5	1:6.4	1:3.4
ES 2002	14	1:0.32	1:3.0	1:2.1

Characterization activities concerning water sample analysis have also shown that the contaminated material is not soluble.

The characterization of the site is complete. Extensive characterization surveys and sample analysis have been reviewed to provide the initial classification of the site open land areas and structural surfaces. The majority of the land area is impacted and classified as Class 1. The only nonimpacted area is the Freshwater Pond parcel based on site history and the adjacent land based on final status survey results. The only identified subsurface structural surface is the spillway. The spillway is classified as impacted Class 1. All additional subsurface structures discovered during excavation in Class 1 open land areas will be classified as Class 1. Reclassification of any areas would be based on final status survey measurements secured as detailed in the following parts of Section 14.0.

14.3 Remedial Action Support Surveys

Segregation of impacted soil during remediation may be aided by an automated system equipped with NaI (or equivalent) gamma detectors. Alternatively, HPTs may segregate impacted soil using portable survey instruments equipped with NaI detectors. Both detection methods have the sensitivity to detect Th-232 (surrogate radionuclide) below the most restrictive threshold value of 3 pCi/g above background. Th-232 is an alpha emitter but is in secular equilibrium with several progeny that emit high-energy photons. Detection of Th-232 is based on the detection of these high-energy photons. Table 14-7 provides MDC values calculated using the guidance provided in NUREG-1575, MARSSIM, for increasing background values. The calculation of MDC is based on the detection of high-energy emitting Th-232 progeny.

Table 14-7
MARSSIM Calculated Minimum Detectable Concentration Values
For Increasing Background (2-inch-by-2-inch NaI Detectors)

Background (cpm)	Minimum Detectable Count Rate (ncpm)	Scan Minimum Detectable Concentration (μR/hr)	Scan Minimum Detectable Concentration (pCi/g Th-232)
3,000	585	1.00	1.0
5,000	756	1.29	1.3
7,000	894	1.52	1.5
9,000	1,014	1.73	1.7
11,000	1,121	1.91	1.9
13,000	1,219	2.08	2.1
15,000	1,309	2.23	2.2
16,000	1,352	2.30	2.3
17,000	1,394	2.37	2.3
18,000	1,434	2.44	2.4
19,000	1,473	2.51	2.5
20,000	1,512	2.58	2.5
21,000	1,549	2.64	2.6

Remedial action support surveys will be performed while remediation is being conducted and will guide the remedial action in a real-time mode. These surveys will be used to determine when a survey unit is ready for the final status survey. The remedial action surveys will rely principally on direct radiation measurement using gamma-sensitive instrumentation. Scan MDC will be determined for remediation survey instrumentation using the same protocol as final status surveys. The determination of a survey unit's readiness for a final status survey will rely on the on-site knowledge of the area (i.e., kriging information and area classification) and the results from the survey instrumentation.

During remediation, excavated material will be characterized into one of the following four categories based on physical description and/or radiological survey:

- Contaminated Soil (or soil-like material) – Soil above the $DCGL_W$ or DCCL value for the processing and Retention Pond areas respectively.
- Acceptable Backfill Soil (or soil-like material) – Soil containing radioactivity above the $DCGL_W$ but below the DCCL value.
- Suspect Contaminated Soil (or soil like material) – Soil which requires additional characterization for the determination of whether it is below the $DCGL_W$ or DCCL value.

- Debris (Structural Surface Survey Material) – Nonsoil material that is oversized (e.g., concrete fragments, bricks, and construction debris). Surveys of debris consist of surveys of structural surfaces for total (fixed) and removable contamination in units of disintegrations per minute per one hundred centimeters squared (dpm/100 cm^2).

Debris is subdivided into two categories: 1) removable debris that can be easily removed from an excavation and 2) permanent structures such as the concrete spillway contained beneath Characterization Grids 1-4 (ALRP). Removable debris will be segregated from soil to the extent practical by visual inspection. Debris buried within the dross and soil mixture will be evaluated in accordance with NRC Fuel Cycle Policy and Guidance Directive FC 83-23 to determine whether they are potential candidates for clearance surveys considering such factors as volumetric contamination and accessibility of surfaces for survey. Clearance surveys may be performed if large, nonporous, solid debris with only surface contamination are uncovered during residue excavation. In this case, clearance surveys for total and loose alpha will be performed on the debris to ensure that released items are released in accordance with NRC Fuel Cycle Policy and Guidance Directive FC 83-23. Otherwise, debris material will be packaged to meet the applicable disposal facility waste acceptance criteria. Permanent structures will be surveyed for unrestricted release in accordance with the guidance provided in the May 2002 DPA and the May 2005 Technical Addendum for structural surface surveys.

The area containing the Characterization Grids 1-4 (ALRP) is known to contain a concrete spillway. As shown in Figure 4-1, the spillway starts slightly west of Characterization Grid 1 and runs from west to east. The spillway turns north at Characterization Grid 4 and proceeds toward the Retention Pond. The spillway is considered a permanent structure and will be surveyed as a Class 1 structure.

Additional subsurface structures may be encountered during excavation. The structures will first be categorized as permanent or removable. If the structures are permanent, a final status survey of structural surfaces will be performed. Since thorium is highly insoluble, it is not anticipated that structures will be volumetrically contaminated. However, subsurface culverts and/or piping may be encountered. Structures with internal surfaces will receive final status surveys of both external and internal surfaces. Consideration will be given to nonaccessible surfaces. Residues, sediments, and/or liquids encountered will be collected and held for sampling. Based on the results of the sample analysis, the material will be dispositioned accordingly. Gas proportional detectors will be used to survey structural surfaces when possible. The final and clearance survey protocols for structures are detailed in subsequent parts of Chapter 14.0. Soil and/or soil like material surrounding structures will be segregated in accordance with this plan.

Based on survey instrument DCCL, $DCGL_W$, and ADCL values, survey instrumentation threshold values will be determined. The lower bound threshold is the value below which surveyed soil is acceptable backfill soil. The upper bound threshold is the value above which surveyed soil is contaminated soil. The two threshold values will be conservatively set based on empirical data (e.g., the lower bound threshold value will be set at the average net counts per minute [ncpm] value corresponding to the $DCGL_W$ less one standard deviation and the upper bound threshold will be set at the average plus one standard deviation) to ensure that soil is acceptable backfill or that soil is contaminated. The average ncpm value will be derived from empirical data and will be continually checked as survey and analytical data are collected. Soil surveyed with results between the two threshold values will be stockpiled as suspect contaminated soil and will be sampled for laboratory analysis to determine if the soil is acceptable backfill or contaminated.

14.4 Final Status Survey Design

14.4.1 Survey Objective

The objective of this survey is to demonstrate that residual radioactivity levels meet the site release criteria.

14.4.2 Basic Design

14.4.2.1 MARSSIM's Wilcoxon Rank Sum Test

The final status survey will use systematic grid sampling to determine the average radionuclide concentration in a survey unit and gross gamma scans to screen for elevated areas. At least the minimum number of samples (N/2) will be taken in each survey unit. Since the radionuclides of interest occur naturally in background, the minimum number of samples (N/2) from the reference background area will also be used to complete the Wilcoxon Rank Sum (WRS) Test.

Minimum Number of Samples (N/2)

When using the WRS test, the minimum number of samples (N/2) is the number of samples required in the survey unit and in the reference background area. Hence "N" is the total number of samples required to complete the WRS test. Paramount to determining the minimum number of samples is the determination of the relative shift, delta over sigma (Δ/σ). Delta is equal to the DCGL minus the lower bound gray region (LBGR) value. The LBGR value is arbitrarily set at one-half the DCGL value to start

the determination. Sigma is an estimate of the variability in a set of sample analysis results from a survey unit. The estimate of sigma used is based on the standard deviations in Th-232 activity measured in survey units during the final status sampling of the adjacent land remediation final survey (0.42). Sigma may be increased if the spatial variability of contaminants within a given survey unit is expected to be greater than 0.42. Since the Th-232 activity concentration of 3.0 pCi/g will be used as the surrogate DCGLw, Δ is equal to 3.0 – 1.5, or 1.5. Delta divided by the sigma of 0.42 results in a relative shift of 3.57 which is rounded to 3.5 for the purpose of determining the required number of samples. The number of samples can be calculated using the following formula or looked up in Table 5.3 of MARSSIM:

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{3(P_r - 0.5)^2}$$

where:

$Z_{1-\alpha}$ = percentile represented by selected value of α, Table 5.2 of MARSSIM
$Z_{1-\beta}$ = percentile represented by selected value of β, Table 5.2 of MARSSIM
P_r = value obtained from Table 5.1 of MARSSIM

Based on a relative shift of 3.5, the following number of samples are required to meet the DQOs:

Size of Survey Unit	Class	DQOs for α and β	Number of Sampling Locations
≥ 10 m^2 <2,000 m^2	1	0.05, 0.05	9
$\geq$ 2,000 m^2 and <10,000 m^2	2	0.05, 0.05	9
$\geq$ 10,000 m^2	3	0.05, 0.05	9

Likewise for surveys of the backfill material the number of samples is 9 corresponding to a relative shift of 3.5, based on the DCCL value of 31.1, the LBGR of 15.6 and a sigma estimate of 4.4 pCi/g.

The number of samples in the above table includes a factor to increase the number of required samples by 20 percent, as recommended by MARSSIM, to allow for lost or unusable data. The number of required samples may be further increased to increase the power level of the statistical tests. Additional sampling locations may also be necessary if characterization data and remedial action surveys and sampling indicate that there is greater than expected spatial variability (σ)of sample results within specific survey units.

14.4.2.2 Discrete Soil Sampling

The results of discrete soil sampling will be used to verify that the average soil concentration is less than the appropriate $DCGL_W$ or DCCL values. Regardless of the survey unit classification (Class 1, Class 2,

or Class 3), a predetermined minimum number of samples will be collected in each survey unit. A random-start triangular grid pattern will be used in Class 1 and Class 2 survey units. This sampling pattern is generally the most efficient means of identifying small areas of elevated activity. The distance between the grid nodes (L) will be determined by

$$L = [A/(0.866 \times n)]\ ½$$

where A is the survey unit area to be covered by the grid pattern and n is the number of samples.

The random start point will be selected by use of readily available random point generators such as provided by the spreadsheet Excel. Sample points will be located by use of a global positioning system (GPS) or equivalent survey equipment.

14.4.2.3 Scanning

Scanning surveys will be used to identify small areas of elevated activity. The percentage of the survey unit to be covered by scans will be based upon the survey unit classification in accordance with the following table.

Table 14-8

Survey Unit Classification	Scanning Coverage
Class 1	100 percent coverage
Class 2	10 to 100 percent Systematic and Judgmental
Class 3	Judgmental

One hundred percent coverage means that the entire surface area of the survey unit has been covered by the field of view of the detector. The scanning coverage for Class 1 areas will be 100 percent. The scanning coverage for Class 2 areas will be adjusted based on the level of confidence supplied by existing data. Whenever less than 100 percent of the survey unit is scanned, the Data Manager will determine the degree of scan coverage and which areas are to be scanned based on the information available at the time of survey. For example, if the potential for contamination in a section of the survey unit is higher than the rest, i.e., the section that borders a Class 1 survey unit, this section may receive 100 percent coverage, while the remaining section may receive 50 percent systematic coverage. If the survey unit has an equally unlikely potential for contamination, e.g., isolated with no previous history of contamination, a systematic coverage at 25 percent coverage may be appropriate.

14.4.2.4 Null Hypothesis

The null hypothesis (H_o) to be tested is that the residual contamination exceeds the remedial objective (release criteria are not met) and the alternative hypothesis (H_A) is that the residual contamination meets the remedial objective (release criteria is met).

14.4.2.5 Decision Error Rates

There are two types of decision errors as shown below:

		DECISION/OUTCOME OF STATISTICAL TEST	
		Reject H_o	Accept H_o
TRUE CONDITION OF SURVEY UNIT	Meets remedial objective (below $DCGL_W$)	No decision error (probability = 1 -α)	Incorrectly fail to release survey unit Type II error (probability = β)
	Exceeds remedial objective (exceeds $DCGL_W$)	Incorrectly release survey unit Type I error (probability = α)	No decision error (probability = 1 - β)

Examination of this table highlights the importance of limiting the Type I error rate (or α) in terms of protection of human health and the environment. The DQO selected for α is 0.05. The DQO selected for β is 0.05.

14.5 Use of a Surrogate Radionuclide

Characterization activities have verified that the primary radionuclides of concern are isotopes of thorium. Th-232 and Th-228 are part of the natural thorium decay chain and have been verified to be in secular equilibrium (i.e., the activity of Th-228 is equal to that of Th-232). Another isotope of thorium, Th-230, has been identified as a primary radionuclide of concern. Although Th-230 is part of the natural uranium decay chain, no uranium has been identified. However, in the estimated 55 years since Th-230 was separated from the uranium decay chain, some Ra-226, a member of the decay chain below Th-230, has grown in. The relationship of Th-230 activity to that of Th-232 has been established in previous characterization of the site. The relationship of Th-230 activity is 3.5 times Th-232 activity. Not all of the radionuclides present can be identified by real-time gamma surveys or by gamma spectroscopy of soil samples--the most efficient and cost-effective measurements. In addition, each of the radionuclides contributes to the total dose to varying degrees of magnitude. In order to save both time and resources, it is

desirable to select a surrogate radionuclide to demonstrate compliance for all the radionuclides and to guide remediation activities. Th-232 has been selected as the surrogate radionuclide.

14.6 Establishing Background

Appendix F contains the reference area, surface soil, and background data consisting of two different reference areas located approximately 1 mile apart. The results of 30 different sampling locations in each reference area presented in the *Adjacent Land Characterization*, Kaiser Aluminum Specialty Products, Appendix A, Estimate of Volume of Off-Site Contaminated Soil, Adjacent Land Characterization Report, ADA, March 1999. These data were also used for the background determination during the Kaiser Adjacent Land Area Remediation Project. Based on a review of the data in both reference areas, there appears to be no significant variability between the two reference areas that were sampled. The mean Th-232 concentration in the reference area located on the nonimpacted northwest Kaiser property is 0.94 +/- 0.11 pCi/g at the 95 percent confidence level, and mean Th-232 concentration in a reference area located approximately 1 mile away is 1.06 +/- 0.10 pCi/g at the 95 percent confidence level. The reference area data standard deviations were 0.30 and 0.28 respectively. According to NUREG 1727, "When there may be significant difference in backgrounds between different areas, a Kruskal-Wallis test...can be used to determine whether there are, in fact, significant differences in mean background concentrations among potential reference areas." Based on the agreement between the mean of both reference areas, it is not necessary to conduct a Kruskal-Wallis test on the reference area data, because there is no significant variability between the two reference areas that have been sampled. The established background value was 1.1 pCi/g Th-232.

14.7 Area Classifications

All of the areas have undergone either a characterization study or historical site assessment that is used as the basis for the initial determination of the area classification established in this section. The former Freshwater Pond area currently is not impacted. However, DPs call for use of this area (after closure) as a material processing area. Therefore, all areas in the Pond Parcel with the exception of the clean backfill cover have been designated as impacted for purposes of classification and survey. In addition, gamma surveys will be performed in areas adjacent to the dross pond to confirm that elevated gamma levels measured during the ALRP were due to gamma contribution from the pond.

Definitions

Class	Definition	Survey Unit Size
1 Land Areas	Areas known or expected to have radionuclide concentrations above the $DCGL_W$	Up to 2,000 m^2
2 Land Areas	Areas known or expected to have radionuclide concentrations above normal background concentrations but that are not expected to be above the $DCGL_W$	2,000 to 10,000 m^2
3 Land Areas	Areas that are not expected to have radionuclide concentrations detectable above normal background concentrations	No limit
1 Structural Surfaces	Areas known or expected to have radionuclide concentrations above the $DCGL_W$	Up to 100 m2 of floor area
2 Structural Surfaces	Areas known or expected to have radionuclide concentrations above normal background concentrations but that are not expected to be above the $DCGL_W$	100 to 1,000 m2
3 Structural Surfaces	Areas that are not expected to have radionuclide concentrations detectable above normal background concentrations	No limit

NUREG-1575, MARSSIM, recommends a maximum Class 1 survey unit area of 2,000 m^2 to ensure each survey unit is assigned an adequate number of sample points. For areas larger than 2.000 m^2 with uniform conditions, initial classification and exposure pathway modeling assumptions, the survey unit area may be increased providing the data quality objectives, specifically the sample point density is maintained. If it is determined during site remedial operations that site conditions warrant a survey unit to be greater than 2,000 m^2 in size, Kaiser will design the survey to comply with the data quality objectives of MARSSIM.

(Sept. 2005 Revision)

Initial Area Classifications

Area	Description	Classification
Processing Area (Fresh Water Pond)	Area currently occupied by a Freshwater Pond which will be used for processing/stockpiling excavated materials (≈9 survey units).	1
Former Retention Pond Area Bottom	Area formerly occupied by the dross Retention Pond and Reserve Pond, post excavation of dross (≈21 survey units).	1
Former Retention Pond Area	Area formerly occupied by the dross Retention Pond and Reserve Pond, backfilled with below-criteria material in 2-foot survey lifts (≈21 survey units per lift).	1
Former Operational Area	The triangular parcel of land north of 41st Street and south of the Union Pacific Railroad right-of-way in which plant processes and operations occurred.	1
Spillway/Other Permanent Structures	Structures (such as the spillway) located where thoriated material is known to exist. The total area of these structures cannot be determined until uncovered by excavation.	1

14.7.1 Process for Reassignment of Area Classifications

All areas will not have the same potential for residual contamination and, accordingly, will not need the same level of survey coverage to achieve the established release criteria. The initial area classifications are based on a combination of characterization data and historical information. Additional information obtained during the remediation process may lead to the determination that the initial classifications established should be revised to be consistent with the definitions given.

14.7.2 Classification Upgrades

Any area classification may be upgraded (e.g., from Class 2 to Class 1) by the Data Manager based on the receipt of additional survey or measurement information that justifies the need for such action.

14.7.3 Classification Downgrades

Any area classification may be downgraded (e.g., from Class 1 to Class 2) by the Data Manager based on the receipt of additional survey or measurement information that justifies the lower classification provided that the approval of the Kaiser RSO and the NRC is obtained.

14.7.4 Documentation of Classification Changes

All changes to the initial area classifications will be documented and included in the final soil remediation documentation.

14.8 Selection of Survey Units

Each impacted area will be divided into a number of survey units based on the classification defined above. Selection of the survey units will be based on areas having similar operational history or similar potential for residual radioactivity to the extent practical. Survey units also will have relatively compact shapes unless an unusual shape is appropriate for the site operational history or site conditions.

14.9 Field Instrumentation

The gamma-emitting progeny of the surrogate radionuclide Th-232 emit high-energy photons and are easily detected using survey instruments equipped with NaI scintillation crystal detectors. Scanning for gross gamma activity will be used to guide remediation activities and as part of the final status survey when remediation is complete. The following survey instruments (or equivalents) as appropriate will be used to scan soil:

Manufacturer and Meter	Manufacturer and Detector Model	Detector Type	Use
Ludlum 2221	Ludlum 44-10 2"-x-2" NaI scintillator	Sodium Iodide (unshielded)	Scans for Gamma-Emitting Radionuclides

Use of these field instruments or acceptable equivalents are evaluated against the goal of achieving MDCs of less than 75 percent of the $DCGL_W$ for direct measurements and/or scanning measurements. MDCs were calculated for scanning instruments using the method provided in MARSSIM for calculating MDCs that control both Type I and Type II errors (i.e., elimination of false negatives and false positives) as follows:

$$\text{Scan MDCR}_{\text{surveyor}} = \frac{\text{MDCR}}{\sqrt{p \in_i}}$$

Where MDCR is the minimum detectable count rate in counts per minute (cpm), $\in_i$ is the instrument efficiency (cpm/μR/hour), and p is the surveyor efficiency. The value of p has been estimated to be between 0.5 and 0.75. The value of 0.5 is conservative. In addition:

$$\text{MDCR} = s_i \times (60/i)$$

$$s_i = d' \sqrt{b_i}$$

where si is the minimal number of net source counts required for a specified level of performance for the interval i, in seconds; d′ is the value selected from MARSSIM Table 6.5 based on the required true positive and false positive rates; and bi is the number of background counts in the intervali. The value of d′ used to calculate the detector sensitivity values is 1.38, corresponding to an alpha of 0.05 and beta of 0.40. This value of d′ will result in less than 5 percent false negatives and about 40 percent false positives. Typical scan MDCs using the MARSSIM two stage scan methodology for survey instruments equipped with 2-inch-by-2-inch NaI detectors are summarized in Table 14-7 for increasing background count rates. Static and scan MDCs for surface contamination detectors are presented in Chapter 14.0 and Appendix D of the May 2002 DPA.

For surface contamination scanning and static measurements, the radionuclides of concern and/or their progeny emit alpha and/or beta particles that are easily detected using survey instruments equipped with gas proportional detectors and scalers. Scanning for gross alpha or gross beta activity will be used as part of status surveys of structural surface survey units to ensure elevated areas of activity are not missed. In addition, static counts of structural surfaces at predetermined sample points are used to assess total contamination of structural surfaces. The following survey instruments (or equivalents) will be used to scan structural surfaces:

Manufacturer and Meter	Manufacturer and Detector Model	Detector Type	Use
Ludlum 2224	Ludlum 43-89 Dual Phosphor Alpha/Beta Detector	Zinc Sulfide Scintillator	Scans and Static Counts for Alpha and Beta Emitting Radionuclides
Ludlum 2221	Ludlum 43-68 Gas Proportional	Gas Proportional	Scans and Static Counts for Alpha and Beta Emitting Radionuclides

Use of these field instruments or acceptable equivalents are evaluated against the goal of achieving MDCs of less than the $DCGL_w$s for direct measurements and/or scanning measurements. MDCs will be calculated for scanning instruments using the method provided in MARSSIM for calculating MDC that controls both Type I and Type II errors (i.e., elimination of false negatives and false positives) as follows:

Alpha Scan

There are two equations based on the MARSSIM two-stage scan methodology used to determine the alpha scanning MDC depending on the background level. For a typical alpha background level of less than 3 cpm, the probability of detecting a single count while passing over the contaminated area is:

$$P(n \geq 1) = 1 - e^{\frac{-GEd}{60v}}$$

where:

$P(n \geq 1)$ = probability of observing a single count,
G = activity (dpm),
E = 4π detector efficiency (cpd),
d = width of detector in direction of scan (cm), and
v = scan speed (cm/s).

Increase the value of G until the corresponding probability equals the desired confidence level, e.g., 95 percent. For a background level of 3 cpm to about 10 cpm, the probability of detecting two or more counts while passing over the contaminated area is:

$$P(n \geq 2) = 1 - \left(1 + \frac{(GE+B)d}{60v}\right)\left(e^{\frac{(GE+B)d}{60v}}\right)$$

where:

$P(n \geq 2)$ = probability of observing two or more counts,
G = activity (dpm),
E = 4π detector efficiency (cpd),
B = background count rate (cpm),
d = width of detector in direction of scan (cm), and

v = scan speed (cm/s).

Increase the value of G until the corresponding probability equals the desired confidence level, e.g., 95 percent.

Beta Scan

Based on the MARSSIM two-stage scan methodology, the beta scanning MDC at a 95 percent confidence level is calculated using the following equation which is a combination of MARSSIM Equations 6-8, 6-9, and 6-10:

$$MDC_{scan} = \frac{d' \sqrt{b_i}\left(\frac{60}{i}\right)}{\sqrt{p} \cdot E_{tot} \cdot \frac{A}{100 cm^2}}$$

where:

MDC_{scan} = MDC level in dpm/100 cm^2,
d' = desired performance variable (usually 1.38 corresponding to alpha and beta errors of 0.05),
b_i = background counts during the residence interval,
i = residence interval in seconds,
ρ = surveyor efficiency (0.5 – 0.75, 0.5 is conservative),
A = detector probe physical (active) area in cm^2, and
E_{tot} = total detector efficiency for radionuclide emission of
= $E_i \times E_s$,
where:
E_i = 2π instrument efficiency in counts per disintegration (cpd) and
E_s = source (or surface contamination) efficiency.

Note: Es values can be determined or the default values provided in NUREG-1507 can be used as follows: 0.25 for all alpha energies and beta maximum energies between 0.15 and 0.4 MeV, 0.5 for all beta maximum energies greater than 0.4 MeV.

Alpha or Beta Static Counts

Minimum counting times for static counts of total and removable contamination will be chosen to provide a MDC that is a fraction (25 – 75 percent) of the survey unit-specific acceptance criteria. MARSSIM equations have been modified to convert to units of dpm/100 cm^2. Count times are determined using the following equation. Static counting MDCs at a 95 percent confidence level are calculated using the following equation which is an expansion of NUREG-1507, Equation 6-7 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E_{tot} \cdot \frac{A}{100}}$$

where:

MDC_{static} = minimum detectable concentration level in dpm/100 cm^2,
B_R = background count rate in counts per minute,
t_B = background count time in minutes,
t_S = sample count time in minutes,
A = detector probe physical (active) area in cm^2, and
E_{tot} = total detector efficiency for radionuclide emission of
= $E_i \times E_s$,
where:
E_i = 2π instrument efficiency in counts per disintegration (cpd) and
E_s = source (or surface contamination) efficiency.

Note: Es values can be determined or the default values provided in NUREG-1507 can be used as follows: 0.25 for all alpha energies and beta maximum energies between 0.15 and 0.4 MeV, 0.5 for all beta maximum energies greater than 0.4 MeV.

14.10 Laboratory Analysis

With the exception of radiation badge service, laboratory analytical services are expected to be provided by Outreach of Broken Arrow, Oklahoma. In the event that Outreach is not available, Kaiser will select another qualified analytical laboratory.

Soil samples will be analyzed by gamma spectroscopy. The MDC value required for each gamma spectroscopy analysis is 25 percent of the release criteria for Th-232. Characterization survey results confirm that Th-232 is in secular equilibrium with its short-lived progeny Ac-228 and Th-228. Th-232 activity will be identified based on the Ac-228 activity (primary gamma energy of 911.1 keV). The Th-228 activity will be calculated by multiplying the Th-232 activity by 1. The Th-230 activity will be calculated by multiplying the Th-232 activity by 3.5.

A minimum of five of the QC samples taken as part of the final status survey will also be analyzed by alpha spectroscopy for Th-232, Th-230, and Th-228. The data will be used to confirm the activity ratio of Th-232 to Th-230 of 1:3.5. The required MDC for the alpha spectroscopy analysis will be 0.5 pCi/g.

14.11 Sampling and Measurement Technique

A combination of the following techniques may be used to achieve the desired survey requirements for an area.

14.11.1 Surface Scans

Depending on the area classification (Class 1, Class 2, or Class 3), scanning coverage will range in accordance with Table 14-8, Section 14.4.2.3. When scanning soil, the detector is held close to the ground (1 to 2 inches) and moved in a serpentine pattern. A scan rate of 0.5 m per second will be used. In the scanning mode, the audio response will be used to prevent lack of detection of an elevated area due to meter response time. The "two-stage" scan methodology will be utilized.

14.11.2 On Site Gamma Spectrometry

An on-site gamma-ray spectroscopy system may be utilized to provide qualitative and quantitative analysis of the Th-232 content in waste samples and final status survey screening samples.

14.11.3 Soil Sampling

14.11.3.1 Surface Sampling

Surface soil sampling will be conducted to evaluate the average remaining activity concentration of excavation bottom survey units prior to backfill activity. Surface samples will be collected from the top 15 cm (6 inches) of soil that correspond to the soil mixing or plow depth in several environmental pathway models. Grass, rocks, sticks, and foreign objects will be removed from the soil samples to the degree practical at the time of sampling. If there is reason to believe these materials contain activity, they will be retained as separate samples.

14.11.3.2 Core Sampling

Core samples will be collected after backfilling of below-release criteria material is complete. For purposes of a final status survey, the entire backfilled retention pond area will be considered as a unit and divided into survey units based on m2, i.e., Class 1 survey units of less than 2,000 m^2. A random start, triangular grid pattern will be used to take the required number of samples (N/2) in each survey unit. The sample will consist of a core sample through the approximate 3-meter layer of placed material. The entire core will be scanned using a 2-inch-by-2-inch NaI detector in a low background area sufficient to achieve a scan-MDC of less than 3 pCi/g Th-232. The 3 meters will be subdivided into three consecutive 1-meter segments in accordance with Appendix E of the NMSS Decommissioning Standard Review Plan. Each

1-meter segment will be mixed and containerized. All three segments will be analyzed by gamma spectroscopy for Th-232. The MDC required will be 3 pCi/g.

14.12 Final Status Survey Implementation

The final status survey will be used to select/verify survey unit classification and to demonstrate that the objectives have been achieved. Two situations that require final status surveys are detailed in this section. The first involves the final status survey of remediated areas (e.g., the Retention/Reserve Pond Area), and the second involves the final status survey of the processing area. The surveys will be performed using gamma-sensitive instrumentation and analytical analyses described above.

14.12.1 Postremediation Surveys

The final status survey units will be defined and marked. When remediation activities in a survey unit are completed, the following will be performed.

14.12.1.1 Gamma Scans

A gamma scan as defined by classification will be performed in accordance with the area classification. For the Retention Pond area, each 2-foot-thick lift that is placed in an excavation will receive a 100 percent scan to ensure that there are no areas that exceed the elevated measurement comparison.

14.12.1.2 Grids

The sample grid and starting location will be established.

14.12.1.3 Sample Number

The required number of samples will be taken and analyzed as described above.

14.12.1.4 Data Evaluation

The data will be evaluated as described below.

14.12.2 Postremediation Surveys for Returned Overburden Material

When remediation activities in a survey unit that required the excavation of substantial overburden soil are completed, the following will be performed:

- The bottom of the excavation will be surveyed as detailed in 14.12.1.1 above.
- The sample grid and starting location will be established,
- The number of surface samples required will be taken and analyzed.
- A 2-foot layer of acceptable (below 31.1 pCi/g) backfill material will be placed in the excavation.
- A gamma scan as defined by classification will be performed.
- The sequence of 2-foot layers of acceptable backfill and subsequent survey will be repeated as necessary to fill excavation (prior to placement of off-site backfill).

Once the excavation is filled with below-criteria material:

- the sample grid and starting location will be established,
- the number of core samples required will be taken and analyzed, and
- the data will be evaluated as described below.

14.13 Data Evaluation

Data will be reviewed by the Data Manager to ensure that the requirements are implemented as prescribed and that the results of the data collection activities support the objectives of the survey, or permit a determination that these objectives should be modified.

14.13.1 Preliminary Data Review

The Data Manager will review QA and QC reports, prepare graphs of the data, and calculate basic statistical quantities to analyze the structure of the data and identify patterns, relationships, or potential anomalies. The survey data shall be reviewed as it is collected. The preliminary data examination includes the following:

- Evaluation of data completeness.
- Verification of instrument calibration.
- Verification of sample identification and traceability back to sampling location.
- Measurement of precision using duplicates, replicates, or split samples.
- Measurement of bias using reference materials or spikes examination of blanks for contamination.

- Assessment of adherence to method specifications and QC limits.
- Evaluation of method performance in the sample matrix.
- Applicability and validation of analytical procedures for site-specific measurements.
- Assessment of external QC measurement results and QA assessments, including the results of analytical laboratory QA/QC reports related to the analysis of final status survey samples.

14.13.2 Data Evaluation and Conversion

For comparison of survey data to $DCGL_W$s or DCCLs, the survey data from field and laboratory measurements will be converted to $DCGL_W$ or DCCL units. The Data Manager will ensure data measurements retain traceability to NIST and conversion factors are appropriate for the radiation quantity. The preliminary data reports will be reviewed to ensure adequate measurement sensitivity is being achieved and to resolve any detector sensitivity problems. Analytical reports will be reviewed for proper MDC values. The results of analytical results will be reported whether the result is above or below the reported MDC value so that the MDC value is not used in the data assessment. Preliminary scan data will also be reviewed against the percent coverage requirement of the survey unit.

An evaluation will be made to determine that the data are consistent with the underlying assumptions made for survey plan statistical procedures. The basic statistical quantities that will be calculated for the survey unit are the following:

- Mean
- Standard deviation
- Median
- Minimum
- Maximum

The parameter of interest is the mean concentration in the survey unit. The two-sample statistical test (WRS Test) will be used. The two-sample WRS Test will evaluate whether the median of the data is above or below the $DCGL_W$ or DCCL.

Summary of Statistical Tests

Survey Result	Conclusion
Difference between maximum survey unit measurement and minimum reference area measurements is less than $DCGL_W$/DCCL	Survey unit meets release criterion
Difference of survey unit average and reference area average is greater than $DCGL_W$/DCCL	Survey unit does not meet release criterion
Difference between any survey unit measurement and any reference area measurement greater than $DCGL_W$/DCCL and the difference of survey unit average and reference area average is less than $DCGL_W$/ DCCL	Conduct WRS Test and elevated measurement comparison

The null hypothesis is assumed to be true unless the WRS test indicates that it should be rejected in favor of the alternative. The result of the hypothesis test determines whether or not the survey unit as a whole is deemed to meet the release criterion. The WRS test will be applied as outlined in the following steps.

1. Adjusted reference area measurements will be obtained by adding the $DCGL_W$ or DCCL to each reference area measurement.

2. The m adjusted reference area sample measurements and the n sample measurements from the survey unit will be pooled and ranked in order of increasing size from 1 to N, where N = m + n.

3. If measurements are tied in rank, each of the tied values will be assigned the same average rank of that group of tied measurements.

4. The ranks from the reference area will be summed as W_r.

5. The value of W_r will be compared with the critical value given in MARSSIM Table I.4 for the appropriate values of m and n at the required Type I error decision rate ($\alpha = 0.05$). If W_r is greater than the critical value, the null hypothesis that the survey unit exceeds the release criterion was rejected.

Both the measurements at discrete locations and the scans will be used to identify elevated areas within a survey unit. Analytical results of soil samples will be used to complete the elevated measurement comparison. If residual radioactivity is found in a localized area of elevated activity - in addition to the residual radioactivity distributed relatively uniformly across the survey unit - the unity rule discussed above will be used to ensure that the release criterion has been met as follows:

$$\frac{\delta}{DCGL} + \sum_{x+1}^{n} \frac{(\delta_{EMC} - \delta)}{DCGL_{EMC}} \leq 1$$

where:

δ = is the average concentration of Th-232 over the entire survey unit
δ_{EMC} = the average concentration of Th-232 over the elevated area x within the survey unit
DCGL = the $DCGL_w$ or DCCL for Th-232

$DCGL_{EMC}$ = (area factor for elevated area x) X (DCGL)
x = refers to one of the elevated areas within the survey unit
n = the total number of elevated areas within the survey unit

If there is more than one elevated area, a separate term will be included for each area. The result of the EMC will be used as a trigger for further investigation. The investigation may involve taking further measurements to determine that the area and level of the elevated residual radioactivity are such that the resulting dose or risk meets the release criterion. The investigation will provide adequate assurance, using the DQO process, that there are no other undiscovered areas of elevated residual radioactivity in the survey unit that might otherwise result in a dose or risk exceeding the release criterion. In some cases, this may lead to reclassifying a survey unit--unless the results of the investigation indicate that reclassification is not necessary.

14.13.3 Investigation Levels

The Data Manager will use radionuclide-specific investigation levels to indicate when additional investigations may be necessary. Investigation levels will also serve as a QC check to determine when a measurement process begins to get out of control. A measurement that exceeds the investigation level may indicate that the survey unit has been improperly classified or it may indicate a failing instrument. When an investigation level is exceeded, the first step will be to confirm that the initial measurement/sample actually exceeds the particular investigation level. This may involve taking further measurements to determine that the area and level of the elevated residual radioactivity are such that the resulting dose or risk meets the release criterion. Depending on the results of the investigation actions, the survey unit may require reclassification, remediation, and/or resurvey. The following table lists the investigation levels which will be used by the Data Manager.

Postremediation Survey Investigation Levels

Survey Unit Classification	Flag Direct Measurement or Sample Result When:	Flag Scanning Measurement Result When:
Class 1	>$DCGL_{EMC}$ / DCCL or > $DCGL_W$ / DCCL and the mean of the survey unit is greater than 0.75 of the $DCGL_W$ / DCCL	>$DCGL_{EMC}$ or >DCCL
Class 2	> $DCGL_W$	> $DCGL_W$ or >MDC
Class 3	> 0.5 of the $DCGL_W$ + background	> $DCGL_W$ or >MDC

If the data suggest that the survey unit was misclassified, the original DQOs will be redeveloped for the correct classification. The sampling design and data collection documentation will be reviewed for consistency with the DQOs.

14.14 Final Status Survey Report

A report will be prepared to document the final conditions of the site. The report will include information concerning the following:

- An overview of the results of the survey.
- A discussion of any changes that were made in the survey from what was proposed in the Soil Remediation Plan.
- A description of the method by which the number of samples was determined for each survey unit.
- A summary of the values used to determine the number of samples and justification for these values.

The survey results for each survey unit including the following:

- The number of samples taken for the survey unit.
- A map or drawing of the survey unit showing the reference system and random-start systematic sample locations.
- The measured sample concentrations.
- The statistical evaluation of measured concentrations.
- Judgmental and miscellaneous sample data sets reported separately from those samples collected for performing the statistical evaluation.
- A discussion of anomalous data including any areas of elevated direct radiation detected during scanning that exceeded the investigation level or measurement locations in excess of the $DCGL_W$ or DCCL.
- A statement that a given survey unit satisfied the $DCGL_W$ or DCCL and the elevated measurement comparison, if any sample points exceeded the $DCGL_W$ or DCCL.
- A description of any changes in initial survey unit assumptions relative to the extent of residual radioactivity.
- A discussion of a survey unit reclassification including applicable data.

References

1. ADA Consultants, Inc., April 1, 1994, Radiological Survey Report, Kaiser Aluminum & Chemical Corporation, Tulsa, Oklahoma.

2. Advanced Recovery Systems, 1995, Volume II, Plate 1, Field Characterization Report, Appendix F.

3. Advanced Recovery Systems/Nuclear Fuel Services, Inc., April 25, 1995, Kaiser Aluminum Specialty Products, Field Characterization Report, Tulsa, Oklahoma.

4. Earth Sciences Consultants, Inc., February 2002, Final Status Survey Report, Adjacent Land Area, Tulsa, Oklahoma Facility.

5. Earth Sciences Consultants, Inc., May 2002, Revised May 2003, Decommissioning Plan Addendum, Tulsa Facility, Tulsa, Oklahoma, Kaiser Aluminum & Chemical Corporation, Baton Rouge, Louisiana.

6. Kaiser, August 1998, Adjacent Land Remediation Plan for Kaiser Aluminum & Chemical Corporation, Tulsa, Oklahoma.

7. NMSS Decommissioning Standard Review Plan Appendix E – Rev 0, September 2000, Implementing the MARSSIM Approach for Conducting Final Radiological Survey.

8. Nuclear Regulatory Commission, July 1998, Draft NUREG-1549: Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination.

9. NUREG-1507, December 1997, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions.

10. NUREG/CR-1575, August 2000, MARSSIM, Rev. 1

APPENDIX C

WILCOXON RANK SUM TEST

APPENDIX C
Evaluation of Survey Unit Analytical Results
Wilcoxon Rank Sum Test
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

In accordance with the DP, final status survey activities included systematic grid sampling to determine the average radionuclide concentration in a survey unit and gross gamma scans to screen for elevated areas. At least the minimum number of samples required (N) was taken in each survey unit. Since the radionuclides of interest occur naturally in background, the minimum number of samples (N) from a survey unit and an appropriate reference background area was used to complete the Wilcoxon Rank Sum (WRS) Test.

Note: When the WRS Test is used, the minimum number of samples required in the survey unit and in the reference area is referred to as N/2 in MARSSIM so that the total number of samples required to complete the WRS test is N.

PROCEDURE

After N systematic samples have been taken within the survey unit, an equal number of samples results is randomly selected from the appropriate reference area data base. The random number function in Microsoft Excel is used to select the appropriate number of samples. The reference area databases are included in Appendix C as follows:

1. Appendix C, Table 1, Soil Reference Area Sample Results – The soil sample Th-232 activity concentration results (pCi/g) are from two sets of 30 core samples taken prior to the onset of decommissioning activities onsite. The first set of 30 cores was taken in a non-impacted area of the site. The second set of 30 cores was taken approximately one mile offsite. Each 6-inch segment of each core was analyzed for Th-232. There is no significant variability between the two sets of results. A discussion of the results and the data can be found in Chapter 14 and Appendix F of the DP.

2. Appendix C, Table 2, Concrete Structural Surface Reference Area Total Alpha Contamination Results – The total alpha contamination results (dpm/100cm^2) from the concrete floor of the Flux Building (Survey Unit FB-001) final survey were used as the concrete structural surface reference area. The results of the Flux Building survey were indistinguishable from background in accordance with the State of Oklahoma's criteria for allowing the concrete to be disposed of offsite in the State of Oklahoma.

3. Appendix C, Table 3, Cinderblock Structural Surface Reference Area Total Alpha Contamination Results – The total alpha contamination results (dpm/100cm^2) from the cinderblock wall of Flux Building (Survey Unit FB-001) final survey were used as the cinderblock structural surface reference area. The results of the Flux Building survey were indistinguishable from background in accordance with the State of Oklahoma's criteria for allowing the cinderblock to be disposed of offsite in the State of Oklahoma.

Once the reference area results are selected, the survey unit and reference area results are then complied in a table with the average, standard deviation, minimum, maximum, and median values for both sets of data being calculated. The results are evaluated using the following table.

Survey Result	Conclusion
If the difference between the maximum survey unit sample result and the minimum reference area sample result is less than the appropriate release criteria (DCGL$_W$/DCCL/DCGL-GA) then:	The survey unit meets release criterion.
If the difference of the survey unit sample results average and the reference area sample results average is greater than the appropriate release criteria (DCGL$_W$ /DCCL/DCGL-GA), then:	The survey unit does not meet release criterion.
If the difference between any survey unit sample result and any reference area sample result is greater than the appropriate release criteria (DCGL$_W$/DCCL/DCGL-GA), and the difference of the survey unit average and reference area average is less than the appropriate release criteria, then:	Conduct the Wilcoxon Rank Sum Test and Elevated Measurement Comparison (EMC) if necessary, to determine if the unit meets release criterion.

The null hypothesis (the survey unit exceeds the release criteria) is assumed to be true unless the WRS Test indicates that it should be rejected in favor of the alternative. The result of the hypothesis test determines whether or not the survey unit as a whole is deemed to meet the release criterion. The WRS Test is applied as outlined in the following steps.

1. Adjusted reference area measurements are obtained by adding the appropriate release criteria (DCGL$_W$ /DCCL/DCGL-GA) to each reference area measurement.

2. The m adjusted reference area sample measurements and the n sample measurements from the survey unit are pooled and ranked in order of increasing size from 1 to N, where $N = m + n$.

3. If measurements are tied in rank, each of the tied values is assigned the same average rank of that group of tied measurements.

4. The ranks from the reference area are summed as W_r.

5. The value of W_r is compared with the critical value given in MARSSIM Table I.4 for the appropriate values of m and n at the required Type I error decision rate ($\alpha = 0.05$). (If the values of m and n exceed 20, the critical value is calculated using the formulas I.1 and/or I.2 of MARSSIM Appendix I.) If W_r is greater than the critical value, the null hypothesis that the survey unit exceeds the release criterion is rejected.

A copy of MARSSIM Table I-4 and MARSSIM Appendix I formulas I.1 and I.2 is included as part of this appendix.

APPENDIX C

Table 1 - Soil Reference Area Sample Results

Reference Group Sample No.	Core Location[1]	Core Length[2]	Below Surface Depth	Th-232 (pCi/g)
1	1	46"	0" - 6"	0.98
2	2	36"	0" - 6"	0.80
3	3	40"	0" - 6"	0.35
4	4	37"	0" - 6"	0.61
5	5	43"	0" - 6"	0.90
6	6	39"	0" - 6"	0.95
7	7	40"	0" - 6"	0.70
8	8	41"	0" - 6"	1.24
9	9	38"	0" - 6"	0.86
10	10	37"	0" - 6"	0.57
11	11	41"	0" - 6"	0.97
12	12	39"	0" - 6"	0.96
13	13	42"	0" - 6"	1.31
14	14	46"	0" - 6"	1.13
15	15	36"	0" - 6"	1.11
16	16	34"	0" - 6"	0.53
17	17	38"	0" - 6"	0.91
18	18	38"	0" - 6"	0.60
19	19	40"	0" - 6"	0.36
20	20	41"	0" - 6"	1.38
21	21	39"	0" - 6"	1.25
22	22	40"	0" - 6"	1.07
23	23	46"	0" - 6"	1.08
24	24	33"	0" - 6"	0.85
25	25	46"	0" - 6"	0.56
26	26	42"	0" - 6"	1.47
27	27	42"	0" - 6"	1.24
28	28	44"	0" - 6"	1.18
29	29	39"	0" - 6"	0.90
30	30	41"	0" - 6"	1.25
31	31	42"	0" - 6"	1.33
32	32	46"	0" - 6"	1.36
33	33	46"	0" - 6"	0.92
34	34	46"	0" - 6"	1.12
35	35	42"	0" - 6"	1.07
36	36	38"	0" - 6"	0.41
37	37	46"	0" - 6"	0.86

APPENDIX C
Table 1 - Soil Reference Area Sample Results

Reference Group Sample No.	Core Location[1]	Core Length[2]	Below Surface Depth	Th-232 (pCi/g)
38	38	39"	0" - 6"	1.02
39	39	46"	0" - 6"	0.70
40	40	46"	0" - 6"	1.13
41	41	41"	0" - 6"	0.92
42	42	33"	0" - 6"	0.90
43	43	46"	0" - 6"	0.96
44	44	34"	0" - 6"	1.29
45	45	46"	0" - 6"	1.23
46	46	36"	0" - 6"	0.58
47	47	39"	0" - 6"	0.63
48	48	40"	0" - 6"	1.10
49	49	28"	0" - 6"	0.99
50	50	26"	0" - 6"	0.97
51	51	46"	0" - 6"	1.72
52	52	46"	0" - 6"	1.63
53	53	46"	0" - 6"	1.29
54	54	46"	0" - 6"	1.24
55	55	46"	0" - 6"	1.31
56	56	46"	0" - 6"	1.17
57	57	46"	0" - 6"	0.96
58	58	46"	0" - 6"	1.04
59	59	46"	0" - 6"	0.96
60	60	46"	0" - 6"	1.00
61	1	46"	6" - 12"	0.92
62	2	36"	6" - 12"	1.34
63	3	40"	6" - 12"	0.66
64	4	37"	6" - 12"	1.06
65	5	43"	6" - 12"	0.94
66	6	39"	6" - 12"	0.84
67	7	40"	6" - 12"	1.18
68	8	41"	6" - 12"	1.33
69	9	38"	6" - 12"	0.82
70	10	37"	6" - 12"	0.47
71	11	41"	6" - 12"	1.07
72	12	39"	6" - 12"	1.21
73	13	42"	6" - 12"	1.09
74	14	46"	6" - 12"	0.87

APPENDIX C
Table 1 - Soil Reference Area Sample Results

Reference Group Sample No.	Core Location[1]	Core Length[2]	Below Surface Depth	Th-232 (pCi/g)
75	15	36"	6" - 12"	1.27
76	16	34"	6" - 12"	0.97
77	17	38"	6" - 12"	0.80
78	18	38"	6" - 12"	1.04
79	19	40"	6" - 12"	0.57
80	20	41"	6" - 12"	1.25
81	21	39"	6" - 12"	1.25
82	22	40"	6" - 12"	1.43
83	23	46"	6" - 12"	1.22
84	24	33"	6" - 12"	0.79
85	25	46"	6" - 12"	1.18
86	26	42"	6" - 12"	0.88
87	27	42"	6" - 12"	0.98
88	28	44"	6" - 12"	1.46
89	29	39"	6" - 12"	0.87
90	30	41"	6" - 12"	1.37
91	31	42"	6" - 12"	0.97
92	32	46"	6" - 12"	1.37
93	33	46"	6" - 12"	0.67
94	34	46"	6" - 12"	1.17
95	35	42"	6" - 12"	0.89
96	36	38"	6" - 12"	0.57
97	37	46"	6" - 12"	1.09
98	38	39"	6" - 12"	1.39
99	39	46"	6" - 12"	1.37
100	40	46"	6" - 12"	1.01
101	41	41"	6" - 12"	0.91
102	42	33"	6" - 12"	1.04
103	43	46"	6" - 12"	1.12
104	44	34"	6" - 12"	1.45
105	45	46"	6" - 12"	0.95
106	46	36"	6" - 12"	0.98
107	47	39"	6" - 12"	1.00
108	48	40"	6" - 12"	1.01
109	49	28"	6" - 12"	1.27
110	50	26"	6" - 12"	1.26
111	51	46"	6" - 12"	1.16

APPENDIX C
Table 1 - Soil Reference Area Sample Results

Reference Group Sample No.	Core Location[1]	Core Length[2]	Below Surface Depth	Th-232 (pCi/g)
112	52	46"	6" - 12"	1.50
113	53	46"	6" - 12"	1.28
114	54	46"	6" - 12"	0.82
115	55	46"	6" - 12"	1.29
116	56	46"	6" - 12"	0.65
117	57	46"	6" - 12"	1.10
118	58	46"	6" - 12"	1.20
119	59	46"	6" - 12"	1.32
120	60	46"	6" - 12"	1.08
121	1	46"	12" - 18"	1.47
122	2	36"	12" - 18"	1.24
123	3	40"	12" - 18"	0.57
124	4	37"	12" - 18"	1.07
125	5	43"	12" - 18"	0.81
126	6	39"	12" - 18"	1.29
127	7	40"	12" - 18"	1.26
128	8	41"	12" - 18"	1.07
129	9	38"	12" - 18"	0.93
130	10	37"	12" - 18"	0.94
131	11	41"	12" - 18"	1.26
132	12	39"	12" - 18"	1.48
133	13	42"	12" - 18"	1.43
134	14	46"	12" - 18"	0.75
135	15	36"	12" - 18"	0.99
136	16	34"	12" - 18"	1.25
137	17	38"	12" - 18"	1.22
138	18	38"	12" - 18"	0.86
139	19	40"	12" - 18"	0.70
140	20	41"	12" - 18"	1.42
141	21	39"	12" - 18"	0.97
142	22	40"	12" - 18"	1.36
143	23	46"	12" - 18"	1.03
144	24	33"	12" - 18"	1.28
145	25	46"	12" - 18"	0.86
146	26	42"	12" - 18"	1.23
147	27	42"	12" - 18"	1.06
148	28	44"	12" - 18"	1.37

APPENDIX C
Table 1 - Soil Reference Area Sample Results

Reference Group Sample No.	Core Location[1]	Core Length[2]	Below Surface Depth	Th-232 (pCi/g)
149	29	39"	12" - 18"	0.98
150	30	41"	12" - 18"	1.50
151	31	42"	12" - 18"	1.52
152	32	46"	12" - 18"	1.27
153	33	46"	12" - 18"	0.85
154	34	46"	12" - 18"	1.06
155	35	42"	12" - 18"	1.04
156	36	38"	12" - 18"	0.96
157	37	46"	12" - 18"	0.91
158	38	39"	12" - 18"	1.22
159	39	46"	12" - 18"	1.46
160	40	46"	12" - 18"	1.20
161	41	41"	12" - 18"	1.20
162	42	33"	12" - 18"	1.00
163	43	46"	12" - 18"	1.09
164	44	34"	12" - 18"	1.88
165	45	46"	12" - 18"	0.54
166	46	36"	12" - 18"	1.32
167	47	39"	12" - 18"	1.45
168	48	40"	12" - 18"	1.30
169	49	28"	12" - 18"	1.19
170	50	26"	12" - 18"	1.20
171	51	46"	12" - 18"	1.16
172	52	46"	12" - 18"	1.07
173	53	46"	12" - 18"	0.86
174	54	46"	12" - 18"	0.78
175	55	46"	12" - 18"	1.12
176	56	46"	12" - 18"	0.92
177	57	46"	12" - 18"	0.64
178	58	46"	12" - 18"	0.71
179	59	46"	12" - 18"	1.24
180	60	46"	12" - 18"	0.96
181	1	46"	18" - 24"	1.35
182	2	36"	18" - 24"	1.16
183	3	40"	18" - 24"	0.81
184	4	37"	18" - 24"	1.08
185	5	43"	18" - 24"	0.90

APPENDIX C
Table 1 - Soil Reference Area Sample Results

Reference Group Sample No.	Core Location[1]	Core Length[2]	Below Surface Depth	Th-232 (pCi/g)
186	6	39"	18" - 24"	1.36
187	7	40"	18" - 24"	1.30
188	8	41"	18" - 24"	1.25
189	9	38"	18" - 24"	1.03
190	10	37"	18" - 24"	0.49
191	11	41"	18" - 24"	1.47
192	12	39"	18" - 24"	1.32
193	13	42"	18" - 24"	1.16
194	14	46"	18" - 24"	0.89
195	15	36"	18" - 24"	1.48
196	16	34"	18" - 24"	0.91
197	17	38"	18" - 24"	1.52
198	18	38"	18" - 24"	0.92
199	19	40"	18" - 24"	0.66
200	20	41"	18" - 24"	1.41
201	21	39"	18" - 24"	1.03
202	22	40"	18" - 24"	1.51
203	23	46"	18" - 24"	1.43
204	24	33"	18" - 24"	1.35
205	25	46"	18" - 24"	1.05
206	26	42"	18" - 24"	1.02
207	27	42"	18" - 24"	1.56
208	28	44"	18" - 24"	0.79
209	29	39"	18" - 24"	0.90
210	30	41"	18" - 24"	1.22
211	31	42"	18" - 24"	1.62
212	32	46"	18" - 24"	1.29
213	33	46"	18" - 24"	0.94
214	34	46"	18" - 24"	1.45
215	35	42"	18" - 24"	1.13
216	36	38"	18" - 24"	0.64
217	37	46"	18" - 24"	1.28
218	38	39"	18" - 24"	1.32
219	39	46"	18" - 24"	1.01
220	40	46"	18" - 24"	0.86
221	41	41"	18" - 24"	1.19
222	42	33"	18" - 24"	1.19

APPENDIX C
Table 1 - Soil Reference Area Sample Results

Reference Group Sample No.	Core Location[1]	Core Length[2]	Below Surface Depth	Th-232 (pCi/g)
223	43	46"	18" - 24"	1.02
224	44	34"	18" - 24"	1.59
225	45	46"	18" - 24"	0.73
226	46	36"	18" - 24"	0.99
227	47	39"	18" - 24"	2.25
228	48	40"	18" - 24"	1.62
229	49	28"	18" - 24"	1.22
230	50	26"	18" - 24"	1.31
231	51	46"	18" - 24"	1.38
232	52	46"	18" - 24"	1.25
233	53	46"	18" - 24"	1.20
234	54	46"	18" - 24"	0.57
235	55	46"	18" - 24"	1.18
236	56	46"	18" - 24"	1.14
237	57	46"	18" - 24"	0.70
238	58	46"	18" - 24"	0.60
239	59	46"	18" - 24"	1.29
240	60	46"	18" - 24"	1.08
241	1	46"	24" - 30"	1.49
242	2	36"	24" - 30"	1.01
243	3	40"	24" - 30"	0.77
244	4	37"	24" - 30"	1.50
245	5	43"	24" - 30"	1.11
246	6	39"	24" - 30"	1.46
247	7	40"	24" - 30"	1.33
248	8	41"	24" - 30"	1.63
249	9	38"	24" - 30"	1.27
250	10	37"	24" - 30"	1.18
251	11	41"	24" - 30"	1.32
252	12	39"	24" - 30"	1.63
253	13	42"	24" - 30"	1.27
254	14	46"	24" - 30"	1.16
255	15	36"	24" - 30"	1.42
256	16	34"	24" - 30"	1.49
257	17	38"	24" - 30"	1.31
258	18	38"	24" - 30"	0.81
259	19	40"	24" - 30"	0.60

APPENDIX C
Table 1 - Soil Reference Area Sample Results

Reference Group Sample No.	Core Location[1]	Core Length[2]	Below Surface Depth	Th-232 (pCi/g)
260	20	41"	24" - 30"	2.06
261	21	39"	24" - 30"	1.30
262	22	40"	24" - 30"	1.63
263	23	46"	24" - 30"	1.54
264	24	33"	24" - 30"	1.41
265	25	46"	24" - 30"	1.18
266	26	42"	24" - 30"	1.62
267	27	42"	24" - 30"	1.37
268	28	44"	24" - 30"	2.32
269	29	39"	24" - 30"	0.97
270	30	41"	24" - 30"	1.46
271	31	42"	24" - 30"	1.49
272	32	46"	24" - 30"	1.43
273	33	46"	24" - 30"	0.84
274	34	46"	24" - 30"	1.37
275	35	42"	24" - 30"	1.25
276	36	38"	24" - 30"	0.70
277	37	46"	24" - 30"	1.12
278	38	39"	24" - 30"	1.25
279	39	46"	24" - 30"	1.03
280	40	46"	24" - 30"	1.17
281	41	41"	24" - 30"	1.39
282	42	33"	24" - 30"	0.87
283	43	46"	24" - 30"	1.18
284	44	34"	24" - 30"	1.20
285	45	46"	24" - 30"	0.64
286	46	36"	24" - 30"	1.13
287	47	39"	24" - 30"	1.02
288	48	40"	24" - 30"	1.37
289	51	46"	24" - 30"	1.19
290	52	46"	24" - 30"	1.31
291	53	46"	24" - 30"	1.29
292	54	46"	24" - 30"	0.93
293	55	46"	24" - 30"	0.89
294	56	46"	24" - 30"	0.96
295	57	46"	24" - 30"	1.26
296	58	46"	24" - 30"	0.79

APPENDIX C
Table 1 - Soil Reference Area Sample Results

Reference Group Sample No.	Core Location[1]	Core Length[2]	Below Surface Depth	Th-232 (pCi/g)
297	59	46"	24" - 30"	0.85
298	60	46"	24" - 30"	1.38
299	1	46"	30" - 36"	1.24
300	2	36"	30" - 36"	0.67
301	3	40"	30" - 36"	0.76
302	4	37"	30" - 36"	1.16
303	5	43"	30" - 36"	0.98
304	6	39"	30" - 36"	0.99
305	7	40"	30" - 36"	1.50
306	8	41"	30" - 36"	1.41
307	9	38"	30" - 36"	1.02
308	10	37"	30" - 36"	0.38
309	11	41"	30" - 36"	2.04
310	12	39"	30" - 36"	1.42
311	13	42"	30" - 36"	1.42
312	14	46"	30" - 36"	1.26
313	15	36"	30" - 36"	0.56
314	17	38"	30" - 36"	1.16
315	19	40"	30" - 36"	0.84
316	20	41"	30" - 36"	1.13
317	21	39"	30" - 36"	1.21
318	22	40"	30" - 36"	1.47
319	23	46"	30" - 36"	1.31
320	25	46"	30" - 36"	0.93
321	26	42"	30" - 36"	1.03
322	27	42"	30" - 36"	1.38
323	28	44"	30" - 36"	0.87
324	29	39"	30" - 36"	1.12
325	30	41"	30" - 36"	1.50
326	31	42"	30" - 36"	1.72
327	32	46"	30" - 36"	1.32
328	33	46"	30" - 36"	1.25
329	34	46"	30" - 36"	1.21
330	35	42"	30" - 36"	1.22
331	36	38"	30" - 36"	0.55
332	37	46"	30" - 36"	0.95
333	38	39"	30" - 36"	0.89

APPENDIX C

Table 1 - Soil Reference Area Sample Results

Reference Group Sample No.	Core Location[1]	Core Length[2]	Below Surface Depth	Th-232 (pCi/g)
334	39	46"	30" - 36"	0.82
335	40	46"	30" - 36"	1.11
336	41	41"	30" - 36"	1.36
337	43	46"	30" - 36"	1.21
338	45	46"	30" - 36"	1.04
339	46	36"	30" - 36"	0.46
340	47	39"	30" - 36"	1.10
341	48	40"	30" - 36"	1.61
342	51	46"	30" - 36"	1.26
343	52	46"	30" - 36"	1.14
344	53	46"	30" - 36"	1.61
345	54	46"	30" - 36"	0.86
346	55	46"	30" - 36"	0.84
347	56	46"	30" - 36"	0.90
348	57	46"	30" - 36"	0.87
349	58	46"	30" - 36"	0.82
350	59	46"	30" - 36"	1.16
351	60	46"	30" - 36"	1.07
352	1	46"	36" - 42"	1.09
353	5	43"	36" - 42"	0.79
354	13	42"	36" - 42"	0.96
355	14	46"	36" - 42"	0.96
356	23	46"	36" - 42"	1.45
357	25	46"	36" - 42"	0.94
358	26	42"	36" - 42"	0.74
359	27	42"	36" - 42"	0.74
360	28	44"	36" - 42"	1.08
361	31	42"	36" - 42"	0.47
362	32	46"	36" - 42"	1.18
363	33	46"	36" - 42"	0.97
364	34	46"	36" - 42"	1.31
365	35	42"	36" - 42"	0.74
366	37	46"	36" - 42"	0.99
367	39	46"	36" - 42"	1.02
368	40	46"	36" - 42"	1.26
369	43	46"	36" - 42"	1.21
370	45	46"	36" - 42"	0.79

APPENDIX C

Table 1 - Soil Reference Area Sample Results

Reference Group Sample No.	Core Location[1]	Core Length[2]	Below Surface Depth	Th-232 (pCi/g)
371	51	46"	36" - 42"	0.84
372	52	46"	36" - 42"	1.06
373	53	46"	36" - 42"	1.32
374	54	46"	36" - 42"	0.95
375	55	46"	36" - 42"	0.99
376	56	46"	36" - 42"	0.96
377	57	46"	36" - 42"	0.99
378	58	46"	36" - 42"	0.77
379	59	46"	36" - 42"	1.02
380	60	46"	36" - 42"	1.20
			Average:	1.10
			Stdev.:	0.30
			Minimum:	0.35
			Maximum:	2.32
			Median:	1.11
			Count:	380

Notes:

[1]Numbers 1 through 30 taken on-site in an non-impacted area. Numbers 31 through 60 taken 1 mile offsite.

[2]Length is the actual length of the recovered core from a 4-foot increment.

APPENDIX C

Table 2 - Concrete Structural Surface Reference Area Sample Results

Reference Group Sample No.	Flux Building Survey Unit	Location	Grid	Total Alpha Contamination (dpm/100cm^2)
1	FB-001	Concrete Floor	A3	90.6
2	FB-001	Concrete Floor	A4	53.0
3	FB-001	Concrete Floor	A5	92.3
4	FB-001	Concrete Floor	A6	33.4
5	FB-001	Concrete Floor	A7	43.2
6	FB-001	Concrete Floor	B3	102
7	FB-001	Concrete Floor	B4	60.4
8	FB-001	Concrete Floor	B5	60.4
9	FB-001	Concrete Floor	B6	50.3
10	FB-001	Concrete Floor	B7	60.4
11	FB-001	Concrete Floor	C3	171
12	FB-001	Concrete Floor	C4	50.3
13	FB-001	Concrete Floor	C5	141
14	FB-001	Concrete Floor	C6	161
15	FB-001	Concrete Floor	C7	62.9
16	FB-001	Concrete Floor	D3	70.5
17	FB-001	Concrete Floor	D4	102
18	FB-001	Concrete Floor	D5	72.7
19	FB-001	Concrete Floor	D6	72.7
20	FB-001	Concrete Floor	D7	92.3
21	FB-001	Concrete Floor	E3	80.5
22	FB-001	Concrete Floor	E4	82.5
23	FB-001	Concrete Floor	E5	72.7
24	FB-001	Concrete Floor	E6	82.5
25	FB-001	Concrete Floor	E7	72.7
26	FB-001	Concrete Floor	F3	111
27	FB-001	Concrete Floor	F4	141
28	FB-001	Concrete Floor	F5	161
29	FB-001	Concrete Floor	F6	269
30	FB-001	Concrete Floor	F7	92.3
31	FB-001	Concrete Floor	G3	-10.1
32	FB-001	Concrete Floor	G4	82.5
33	FB-001	Concrete Floor	G5	122
34	FB-001	Concrete Floor	G6	43.2
35	FB-001	Concrete Floor	G7	43.2
36	FB-001	Concrete Floor	H3	101
37	FB-001	Concrete Floor	H4	33.4

APPENDIX C

Table 2 - Concrete Structural Surface Reference Area Sample Results

Reference Group Sample No.	Flux Building Survey Unit	Location	Grid	Total Alpha Contamination (dpm/100cm^2)
38	FB-001	Concrete Floor	H5	72.7
39	FB-001	Concrete Floor	H6	33.4
40	FB-001	Concrete Floor	H7	72.7
41	FB-001	Concrete Floor	I3	80.5
42	FB-001	Concrete Floor	I4	92.3
43	FB-001	Concrete Floor	I5	72.7
44	FB-001	Concrete Floor	I6	102
45	FB-001	Concrete Floor	I7	62.9
46	FB-001	Concrete Floor	J3	151
47	FB-001	Concrete Floor	J4	141
48	FB-001	Concrete Floor	J5	102
49	FB-001	Concrete Floor	J6	102
50	FB-001	Concrete Floor	J7	33.4
51	FB-002	Concrete Floor	FSS-002	107
52	FB-002	Concrete Floor	FSS-004	56.4
53	FB-002	Concrete Floor	FSS-006	66.4
54	FB-002	Concrete Floor	FSS-008	66.4
55	FB-002	Concrete Floor	FSS-010	16.1
56	FB-002	Concrete Floor	FSS-012	36.2
57	FB-002	Concrete Floor	FSS-014	66.4
58	FB-002	Concrete Floor	FSS-016	127
59	FB-003	Concrete Floor	FSS-001	50.3
60	FB-003	Concrete Floor	FSS-002	30.2
61	FB-003	Concrete Floor	FSS-004	50.3
62	FB-003	Concrete Floor	FSS-005	80.5
63	FB-003	Concrete Floor	FSS-008	40.3
64	FB-003	Concrete Floor	FSS-009	40.3
65	FB-003	Concrete Floor	FSS-012	30.2
66	FB-003	Concrete Floor	FSS-013	80.5
67	FB-003	Concrete Floor	FSS-016	151
68	FB-003	Concrete Floor	FSS-017	60.4
69	FB-003	Concrete Floor	FSS-003	102
70	FB-003	Concrete Floor	FSS-006	43.2
71	FB-003	Concrete Floor	FSS-007	72.7
72	FB-003	Concrete Floor	FSS-010	62.9
73	FB-003	Concrete Floor	FSS-011	112
74	FB-003	Concrete Floor	FSS-014	13.8

APPENDIX C

Table 2 - Concrete Structural Surface Reference Area Sample Results

Reference Group Sample No.	Flux Building Survey Unit	Location	Grid	Total Alpha Contamination (dpm/100cm^2)
75	FB-003	Concrete Floor	FSS-015	62.9
76	FB-007	Concrete Floor	FSS-004	72.5
77	FB-007	Concrete Floor	FSS-006	82.5
78	FB-007	Concrete Floor	FSS-009	123
79	FB-007	Concrete Floor	FSS-010	52.3
			Average:	79.7
			Stdev.:	42.5
			Minimum:	-10.1
			Maximum:	269
			Median:	72.7
			Count:	79

APPENDIX C

Table 3 - Cinderblock Structural Surface Reference Area Sample Results

Reference Group Sample No.	Flux Building Survey Unit	Location	Grid	Total Alpha Contamination (dpm/100cm^2)
1	FB-001	Painted Cinderblock Wall	A1	10.1
2	FB-001	Painted Cinderblock Wall	A2	20.1
3	FB-001	Painted Cinderblock Wall	B1	13.8
4	FB-001	Painted Cinderblock Wall	B2	13.8
5	FB-001	Painted Cinderblock Wall	C1	30.2
6	FB-001	Painted Cinderblock Wall	C2	111
7	FB-001	Painted Cinderblock Wall	D1	60.4
8	FB-001	Painted Cinderblock Wall	D2	30.2
9	FB-001	Painted Cinderblock Wall	E1	-10.1
10	FB-001	Painted Cinderblock Wall	E2	0.0
11	FB-001	Painted Cinderblock Wall	F1	0.0
12	FB-001	Painted Cinderblock Wall	F2	30.2
13	FB-001	Painted Cinderblock Wall	G1	40.3
14	FB-001	Painted Cinderblock Wall	G2	-10.1
15	FB-001	Painted Cinderblock Wall	H1	20.1
16	FB-001	Painted Cinderblock Wall	H2	80.5
17	FB-001	Painted Cinderblock Wall	I1	40.3
18	FB-001	Painted Cinderblock Wall	I2	20.1
19	FB-001	Painted Cinderblock Wall	J1	0.0
20	FB-001	Painted Cinderblock Wall	J2	40.3
21	FB-001	Painted Cinderblock Wall	K3	10.1
22	FB-001	Painted Cinderblock Wall	K4	33.4
23	FB-001	Painted Cinderblock Wall	K5	23.6
24	FB-001	Painted Cinderblock Wall	K6	20.1
25	FB-001	Painted Cinderblock Wall	K7	40.3
26	FB-001	Painted Cinderblock Wall	L3	30.2
27	FB-001	Painted Cinderblock Wall	L4	10.1
28	FB-001	Painted Cinderblock Wall	L5	10.1
29	FB-001	Painted Cinderblock Wall	L6	10.1
30	FB-001	Painted Cinderblock Wall	L7	20.1
31	FB-002	Painted Cinderblock Wall	FSS-001	5.89
32	FB-002	Painted Cinderblock Wall	FSS-003	15.7
33	FB-002	Painted Cinderblock Wall	FSS-005	25.5
34	FB-002	Painted Cinderblock Wall	FSS-007	15.7

APPENDIX C

Table 3 - Cinderblock Structural Surface Reference Area Sample Results

Reference Group Sample No.	Flux Building Survey Unit	Location	Grid	Total Alpha Contamination (dpm/100cm^2)
1	FB-001	Painted Cinderblock Wall	A1	10.1
35	FB-002	Painted Cinderblock Wall	FSS-009	5.89
36	FB-002	Painted Cinderblock Wall	FSS-011	5.89
37	FB-002	Painted Cinderblock Wall	FSS-013	15.7
38	FB-002	Painted Cinderblock Wall	FSS-015	45.2
39	FB-002	Painted Cinderblock Wall	FSS-017	45.2
40	FB-004	Painted Cinderblock Wall	3	20.1
41	FB-004	Painted Cinderblock Wall	7	0.0
42	FB-004	Painted Cinderblock Wall	9	40.3
43	FB-004	Painted Cinderblock Wall	11	-10.1
44	FB-004	Painted Cinderblock Wall	13	10.1
45	FB-004	Painted Cinderblock Wall	2	3.93
46	FB-004	Painted Cinderblock Wall	6	3.93
47	FB-004	Painted Cinderblock Wall	8	62.9
48	FB-004	Painted Cinderblock Wall	10	43.2
49	FB-004	Painted Cinderblock Wall	12	33.4
50	FB-004	Painted Cinderblock Wall	14	3.93
51	FB-006	Painted Cinderblock Wall	FSS-011	78.6
52	FB-006	Painted Cinderblock Wall	FSS-012	29.5
53	FB-006	Painted Cinderblock Wall	FSS-013	88.4
54	FB-006	Painted Cinderblock Wall	FSS-014	68.8
55	FB-007	Painted Cinderblock Wall	FSS-001	12.1
56	FB-007	Painted Cinderblock Wall	FSS-002	2.01
57	FB-007	Painted Cinderblock Wall	FSS-005	32.2
58	FB-007	Painted Cinderblock Wall	FSS-007	2.01
59	FB-007	Painted Cinderblock Wall	FSS-008	22.1
60	FB-007	Painted Cinderblock Wall	FSS-011	2.01
61	FB-007	Painted Cinderblock Wall	FSS-012	12.1
62	FB-007	Painted Cinderblock Wall	FSS-014	12.1
63	FB-008	Painted Cinderblock Wall	FSS-001	6.04
64	FB-008	Painted Cinderblock Wall	FSS-002	-4.03
65	FB-008	Painted Cinderblock Wall	FSS-003	26.2
66	FB-008	Painted Cinderblock Wall	FSS-005	26.2
67	FB-008	Painted Cinderblock Wall	FSS-007	26.2

APPENDIX C

Table 3 - Cinderblock Structural Surface Reference Area Sample Results

Reference Group Sample No.	Flux Building Survey Unit	Location	Grid	Total Alpha Contamination (dpm/100cm^2)
1	FB-001	Painted Cinderblock Wall	A1	10.1
68	FB-008	Painted Cinderblock Wall	FSS-008	36.2
69	FB-008	Painted Cinderblock Wall	FSS-011	26.2
70	FB-008	Painted Cinderblock Wall	FSS-012	16.1
71	FB-008	Painted Cinderblock Wall	FSS-013	6.04
72	FB-008	Painted Cinderblock Wall	FSS-014	16.1
			Average:	23.4
			Stdev.:	23.4
			Minimum:	-10.1
			Maximum:	111
			Median:	20.1
			Count:	72

I.4 Critical Values for the WRS Test

Table I.4 Critical Values for the WRS test

m is the number of reference area samples and n is the number of survey unit samples.

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m=2	α=0.001	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43
	α=0.005	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	40	42
	α=0.01	7	9	11	13	15	17	19	21	23	25	27	28	30	32	34	36	38	39	41
	α=0.025	7	9	11	13	15	17	18	20	22	23	25	27	29	31	33	34	36	38	40
	α=0.05	7	9	11	12	14	16	17	19	21	23	24	26	27	29	31	33	34	36	38
	α=0.1	7	8	10	11	13	15	16	18	19	21	22	24	26	27	29	30	32	33	35

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m=3	α=0.001	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	56	59	62	65
	α=0.005	12	15	18	21	24	27	30	32	35	38	40	43	46	48	51	54	57	59	62
	α=0.01	12	15	18	21	24	26	29	31	34	37	39	42	45	47	50	52	55	58	60
	α=0.025	12	15	18	20	22	25	27	30	32	35	37	40	42	45	47	50	52	55	57
	α=0.05	12	14	17	19	21	24	26	28	31	33	36	38	40	43	45	47	50	52	54
	α=0.1	11	13	16	18	20	22	24	27	29	31	33	35	37	40	42	44	46	48	50

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m=4	α=0.001	18	22	26	30	34	38	42	46	49	53	57	60	64	68	71	75	78	82	86
	α=0.005	18	22	26	30	33	37	40	44	47	51	54	58	61	64	68	71	75	78	81
	α=0.01	18	22	26	29	32	36	39	42	46	49	52	56	59	62	66	69	72	76	79
	α=0.025	18	22	25	28	31	34	37	41	44	47	50	53	56	59	62	66	69	72	75
	α=0.05	18	21	24	27	30	33	36	39	42	45	48	51	54	57	59	62	65	68	71
	α=0.1	17	20	22	25	28	31	34	36	39	42	45	48	50	53	56	59	61	64	67

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m=5	α=0.001	25	30	35	40	45	50	54	58	63	67	72	76	81	85	89	94	98	102	107
	α=0.005	25	30	35	39	43	48	52	56	60	64	68	72	77	81	85	89	93	97	101
	α=0.01	25	30	34	38	42	46	50	54	58	62	66	70	74	78	82	86	90	94	98
	α=0.025	25	29	33	37	41	44	48	52	56	60	63	67	71	75	79	82	86	90	94
	α=0.05	24	28	32	35	39	43	46	50	53	57	61	64	68	71	75	79	82	86	89
	α=0.1	23	27	30	34	37	41	44	47	51	54	57	61	64	67	71	74	77	81	84

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m=6	α=0.001	33	39	45	51	57	63	67	72	77	82	88	93	98	103	108	113	118	123	128
	α=0.005	33	39	44	49	54	59	64	69	74	79	83	88	93	98	103	107	112	117	122
	α=0.01	33	39	43	48	53	58	62	67	72	77	81	86	91	95	100	104	109	114	118
	α=0.025	33	37	42	47	51	56	60	64	69	73	78	82	87	91	95	100	104	109	113
	α=0.05	32	36	41	45	49	54	58	62	66	70	75	79	83	87	91	96	100	104	108
	α=0.1	31	35	39	43	47	51	55	59	63	67	71	75	79	83	87	91	94	98	102

Table I.4 Critical Values for the WRS Test (continued)

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 7	α=0.001	42	49	56	63	69	75	81	87	92	98	104	110	116	122	128	133	139	145	151
	α=0.005	42	49	55	61	66	72	77	83	88	94	99	105	110	116	121	127	132	138	143
	α=0.01	42	48	54	59	65	70	76	81	86	92	97	102	108	113	118	123	129	134	139
	α=0.025	42	47	52	57	63	68	73	78	83	88	93	98	103	108	113	118	123	128	133
	α=0.05	41	46	51	56	61	65	70	75	80	85	90	94	99	104	109	113	118	123	128
	α=0.1	40	44	49	54	58	63	67	72	76	81	85	90	94	99	103	108	112	117	121

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 8	α=0.001	52	60	68	75	82	89	95	102	109	115	122	128	135	141	148	154	161	167	174
	α=0.005	52	60	66	73	79	85	92	98	104	110	116	122	129	135	141	147	153	159	165
	α=0.01	52	59	65	71	77	84	90	96	102	108	114	120	125	131	137	143	149	155	161
	α=0.025	51	57	63	69	75	81	86	92	98	104	109	115	121	126	132	137	143	149	154
	α=0.05	50	56	62	67	73	78	84	89	95	100	105	111	116	122	127	132	138	143	148
	α=0.1	49	54	60	65	70	75	80	85	91	96	101	106	111	116	121	126	131	136	141

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 9	α=0.001	63	72	81	88	96	104	111	118	126	133	140	147	155	162	169	176	183	190	198
	α=0.005	63	71	79	86	93	100	107	114	121	127	134	141	148	155	161	168	175	182	188
	α=0.01	63	70	77	84	91	98	105	111	118	125	131	138	144	151	157	164	170	177	184
	α=0.025	62	69	76	82	88	95	101	108	114	120	126	133	139	145	151	158	164	170	176
	α=0.05	61	67	74	80	86	92	98	104	110	116	122	128	134	140	146	152	158	164	170
	α=0.1	60	66	71	77	83	89	94	100	106	112	117	123	129	134	140	145	151	157	162

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 10	α=0.001	75	85	94	103	111	119	128	136	144	152	160	167	175	183	191	199	207	215	222
	α=0.005	75	84	92	100	108	115	123	131	138	146	153	160	168	175	183	190	197	205	212
	α=0.01	75	83	91	98	106	113	121	128	135	142	150	157	164	171	178	186	193	200	207
	α=0.025	74	81	89	96	103	110	117	124	131	138	145	151	158	165	172	179	186	192	199
	α=0.05	73	80	87	93	100	107	114	120	127	133	140	147	153	160	166	173	179	186	192
	α=0.1	71	78	84	91	97	103	110	116	122	128	135	141	147	153	160	166	172	178	184

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 11	α=0.001	88	99	109	118	127	136	145	154	163	171	180	188	197	206	214	223	231	240	248
	α=0.005	88	98	107	115	124	132	140	148	157	165	173	181	189	197	205	213	221	229	237
	α=0.01	88	97	105	113	122	130	138	146	153	161	169	177	185	193	200	208	216	224	232
	α=0.025	87	95	103	111	118	126	134	141	149	156	164	171	179	186	194	201	208	216	223
	α=0.05	86	93	101	108	115	123	130	137	144	152	159	166	173	180	187	195	202	209	216
	α=0.1	84	91	98	105	112	119	126	133	139	146	153	160	167	173	180	187	194	201	207

Table I.4 Critical Values for the WRS Test (continued)

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 12	α=0.001	102	114	125	135	145	154	164	173	183	192	202	210	220	230	238	247	256	266	275
	α=0.005	102	112	122	131	140	149	158	167	176	185	194	202	211	220	228	237	246	254	263
	α=0.01	102	111	120	129	138	147	156	164	173	181	190	198	207	215	223	232	240	249	257
	α=0.025	100	109	118	126	135	143	151	159	168	176	184	192	200	208	216	224	232	240	248
	α=0.05	99	108	116	124	132	140	147	155	165	171	179	186	194	202	209	217	225	233	240
	α=0.1	97	105	113	120	128	135	143	150	158	165	172	180	187	194	202	209	216	224	231

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 13	α=0.001	117	130	141	152	163	173	183	193	203	213	223	233	243	253	263	273	282	292	302
	α=0.005	117	128	139	148	158	168	177	187	196	206	215	225	234	243	253	262	271	280	290
	α=0.01	116	127	137	146	156	165	174	184	193	202	211	220	229	238	247	256	265	274	283
	α=0.025	115	125	134	143	152	161	170	179	187	196	205	214	222	231	239	248	257	265	274
	α=0.05	114	123	132	140	149	157	166	174	183	191	199	208	216	224	233	241	249	257	266
	α=0.1	112	120	129	137	145	153	161	169	177	185	193	201	209	217	224	232	240	248	256

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 14	α=0.001	133	147	159	171	182	193	204	215	225	236	247	257	268	278	289	299	310	320	330
	α=0.005	133	145	156	167	177	187	198	208	218	228	238	248	258	268	278	288	298	307	317
	α=0.01	132	144	154	164	175	185	194	204	214	224	234	243	253	263	272	282	291	301	311
	α=0.025	131	141	151	161	171	180	190	199	208	218	227	236	245	255	264	273	282	292	301
	α=0.05	129	139	149	158	167	176	185	194	203	212	221	230	239	248	257	265	274	283	292
	α=0.1	128	136	145	154	163	171	180	189	197	206	214	223	231	240	248	257	265	273	282

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 15	α=0.001	150	165	178	190	202	212	225	237	248	260	271	282	293	304	316	327	338	349	360
	α=0.005	150	162	174	186	197	208	219	230	240	251	262	272	283	293	304	314	325	335	346
	α=0.01	149	161	172	183	194	205	215	226	236	247	257	267	278	288	298	308	319	329	339
	α=0.025	148	159	169	180	190	200	210	220	230	240	250	260	270	280	289	299	309	319	329
	α=0.05	146	157	167	176	186	196	206	215	225	234	244	253	263	272	282	291	301	310	319
	α=0.1	144	154	163	172	182	191	200	209	218	227	236	246	255	264	273	282	291	300	309

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 16	α=0.001	168	184	197	210	223	236	248	260	272	284	296	308	320	332	343	355	367	379	390
	α=0.005	168	181	194	206	218	229	241	252	264	275	286	298	309	320	331	342	353	365	376
	α=0.01	167	180	192	203	215	226	237	248	259	270	281	292	303	314	325	336	347	357	368
	α=0.025	166	177	188	200	210	221	232	242	253	264	274	284	295	305	316	326	337	347	357
	α=0.05	164	175	185	196	206	217	227	237	247	257	267	278	288	298	308	318	328	338	348
	α=0.1	162	172	182	192	202	211	221	231	241	250	260	269	279	289	298	308	317	327	336

Table I.4 Critical Values for the WRS Test (continued)

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 17	α=0.001	187	203	218	232	245	258	271	284	297	310	322	335	347	360	372	384	397	409	422
	α=0.005	187	201	214	227	239	252	264	276	288	300	312	324	336	347	359	371	383	394	406
	α=0.01	186	199	212	224	236	248	260	272	284	295	307	318	330	341	353	364	376	387	399
	α=0.025	184	197	209	220	232	243	254	266	277	288	299	310	321	332	343	354	365	376	387
	α=0.05	183	194	205	217	228	238	249	260	271	282	292	303	313	324	335	345	356	366	377
	α=0.1	180	191	202	212	223	233	243	253	264	274	284	294	305	315	325	335	345	355	365

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 18	α=0.001	207	224	239	254	268	282	296	309	323	336	349	362	376	389	402	415	428	441	454
	α=0.005	207	222	236	249	262	275	288	301	313	326	339	351	364	376	388	401	413	425	438
	α=0.01	206	220	233	246	259	272	284	296	309	321	333	345	357	370	382	394	406	418	430
	α=0.025	204	217	230	242	254	266	278	290	302	313	325	337	348	360	372	383	395	406	418
	α=0.05	202	215	226	238	250	261	273	284	295	307	318	329	340	352	363	374	385	396	407
	α=0.1	200	211	222	233	244	255	266	277	288	299	309	320	331	342	352	363	374	384	395

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 19	α=0.001	228	246	262	277	292	307	321	335	350	364	377	391	405	419	433	446	460	473	487
	α=0.005	227	243	258	272	286	300	313	327	340	353	366	379	392	405	419	431	444	457	470
	α=0.01	226	242	256	269	283	296	309	322	335	348	361	373	386	399	411	424	437	449	462
	α=0.025	225	239	252	265	278	290	303	315	327	340	352	364	377	389	401	413	425	437	450
	α=0.05	223	236	248	261	273	285	297	309	321	333	345	356	368	380	392	403	415	427	439
	α=0.1	220	232	244	256	267	279	290	302	313	325	336	347	358	370	381	392	403	415	426

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 20	α=0.001	250	269	286	302	317	333	348	363	377	392	407	421	435	450	464	479	493	507	521
	α=0.005	249	266	281	296	311	325	339	353	367	381	395	409	422	436	450	463	477	490	504
	α=0.01	248	264	279	293	307	321	335	349	362	376	389	402	416	429	442	456	469	482	495
	α=0.025	247	261	275	289	302	315	329	341	354	367	380	393	406	419	431	444	457	470	482
	α=0.05	245	258	271	284	297	310	322	335	347	360	372	385	397	409	422	434	446	459	471
	α=0.1	242	254	267	279	291	303	315	327	339	351	363	375	387	399	410	422	434	446	458

Reject the null hypothesis if the test statistic (W_r) is greater than the table (critical) value. For n or m greater than 20, the table (critical) value can be calculated from:

$$m(n+m+1)/2 + z\sqrt{nm(n+m+1)/12} \quad \text{(I.1)}$$

if there are few or no ties, and from

$$m(n+m+1)/2 + z\sqrt{\frac{nm}{12}[(n+m+1) - \sum_{j=1}^{g} \frac{t_j(t_j^2-1)}{(n+m)(n+m-1)}]} \quad \text{(I.2)}$$

if there are many ties, where g is the number of groups of tied measurements and t_j is the number of tied measurements in the jth group. z is the (1-α) percentile of a standard normal distribution, which can be found in the following table:

α	z
0.001	3.09
0.005	2.575
0.01	2.326
0.025	1.960
0.05	1.645
0.1	1.282

Other values can be found in Table I-1.

APPENDIX D

CAVE COUNTER CALIBRATION AND SOIL SAMPLE RESULTS

Appendix D
On-Site Cave Counter
Final Status Survey Report
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corporation

Certain soil samples collected as part of the final status survey process are screened for Th-232 activity concentration using an on-site cave counter (counter). The on-site cave counter for the Thorium Remediation Project consists of a 2-inch by 2-inch NaI Ludlum Model 44-10 detector coupled with a Ludlum Model 2221 Scaler/Ratemeter instrument, mounted inside a shielded box with room for a standard soil sample container to be placed on the face (bottom, non-wire connecting end) of the detector. Five detectors (numbered NaI #1, NaI # 2, NaI # 3, NaI # 4 and NaI#8) have been used as part of the counter during the project. The detectors were all calibrated annually off-site by a qualified vendor to verify their response to high energy photons. The detectors, including their use as part of the counter, are utilized to obtain gross gamma readings from soil samples in units of counts per minute (cpm). The detector response is checked daily when in use to a Cs-137 source.

In addition to the off site calibration, two of the detectors (NaI #4 and NaI #5) have been calibrated on-site to verify the response of the detector to soil (or soil like material) containing Th-232 in equilibrium with all progeny. A well characterized sample of material used to calibrate another on-site counter system (the SMCM system) was used to calibrate both detectors. The documentation of the calibrations is included in this appendix.

The result of the on-site calibration is a detector specific calibration factor (CF) in units of pico-Curies of Th-232 per net counts per minute (pCi/cpm). The inverse of the CF is referred to as the instrument efficiency in units of cpm/pCi and is used to convert the gross gamma response of the detector in cpm to pCi/g of Th-232 within a standard soil sample as follows:

1. A standard soil sample of background soil is counted. Usually for 5 minutes each day the counter is used. The result is documented as "BKG Count Rate".
2. A standard soil sample is weighed in units of grams (g) and recorded as "Sample Weight". A standard empty soil container is also weighed. The sample weight is the net of the soil sample less the empty container weight.
3. The sample is placed inside the lead shielded box (standard repeatable counting geometry) and the NaI detector is placed on top of the container. Usually, a one minute count is performed and recorded as "Gross Count Rate Top".
4. The sample is re-placed in the standard counting geometry upside down. Another 1 minute count is performed and recorded as "Gross Count Rate Bottom".
5. The background count rate is subtracted from the average of the top and bottom sample count rates and recorded as "Net Count Rate Average".

6. The net count rate is then converted to pCi/g of Th-232 by dividing the net count rate average by the instrument efficiency (cpm/pCi) and the sample weight (g) and recorded as "Th-232". The instrument efficiency is equal to 1 / CF (in units of pCi/cpm).
7. The standard error for the count is then calculated and recorded as "95% CL Uncertainty" as follows:

$$Unc_{95\%cl} = \frac{1.96\sqrt{\left(\frac{CR_{sb}}{t_{sb}} + \frac{CR_{st}}{t_{st}} + \frac{CR_b}{t_b}\right)}}{\cdot E \cdot W}$$

where:

$Unc_{95\%cl}$ = 95% confidence level (2 sigma) uncertainty in pCi/g,
CR_{sb} = sample bottom count rate in counts per minute,
t_{sb} = sample bottom count time in minutes,
CR_{st} = sample top count rate in counts per minute,
t_{st} = sample top count time in minutes,
CR_b = background count rate in counts per minute,
t_b = background count time in minutes,
W = sample weight in g, and
E = detector efficiency (= 1/CF) in cpm/pCi

8. The minimum detectable concentration is calculated and recorded as "MDC" as follows:

$$MDC = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot \left(1 + \frac{t_s}{t_b}\right)}}{t_s \cdot E \cdot W}$$

where:

MDC = minimum detectable concentration in pCi/g,
B_R = background count rate in counts per minute,
t_B = background count time in minutes,
t_S = sample count time in minutes,
W = sample weight in g, and
E = detector efficiency in cpm/pCi

A summary of the two instrument/detectors used for cave counts is presented below in **Table D-1.**

The conversion of count data to a result in pCi/g of Th-232, the 95% confidence uncertainty (standard 2 sigma error) and the Minimum Detectable Concentration (MDC)

for the count, all in units of pCi/g, for various samples (not analyzed by Outreach) are presented in the attached **Appendix D, Table D-2.**

Table D-1 – Cave Counter Detector Summary

Number	Instrument Serial #:	Detector Serial #:	On-Site Calibration Date	Calibration Factor (cpm/pCi/g)	Efficiency = 1/CF (pCi/g/cpm)
4	172053	PR206815	12/03/04	4.41	0.227
8	216513	PR230093	11/03/05	4.46	0.224

Appendix D, Table D-2
Cave Counter Data
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corportion

Count Date	Det. #:	Detector Efficiency (cpm / pCi/g)	Sample No.	Sample Type	Survey Unit	Sample Count Time (min)	Sample Weight (g)	Gross Count Rate Top (cpm)	Gross Count Rate Bottom (cpm)	BKG Count Time (min)	BKG Counts	BKG Sample Weight (g)	Net Count Rate Average (cpm)	Th-232 (pCi/g)	95% CL Unc. (pCi/g)	MDC (pCi/g)
1/12/05	4	0.227	K-466	Biased	FOA-001	1	752	3,059	3,192	5	14,476	570	230	1.35	0.950	1.52
1/12/05	4	0.227	K-467	Biased	FOA-001	1	715	2,817	3,143	5	14,476	570	85	0.523	0.978	1.52
1/12/05	4	0.227	K-468	Biased	FOA-001	1	822	3,014	3,330	5	14,476	570	277	1.49	0.875	1.52
1/12/05	4	0.227	K-469	Biased	FOA-001	1	817	3,107	3,257	5	14,476	570	287	1.55	0.882	1.52
1/17/05	4	0.227	K-471	Biased	FOA-001	1	846	3,028	3,440	5	15,127	570	209	1.09	0.859	1.56
5/16/05	4	0.227	K-658	Biased	FOA-005	1	568	2,880	2,952	5	15,215	570	-127	-0.986	1.22	1.56
5/16/05	4	0.227	K-659	Biased	FOA-005	1	576	2,861	3,028	5	15,215	570	-99	-0.754	1.21	1.56
5/16/05	4	0.227	K-660	Biased	FOA-005	1	666	3,262	3,098	5	15,215	570	137	0.907	1.08	1.56
5/16/05	4	0.227	K-661	Biased	FOA-005	1	682	3,066	3,252	5	15,215	570	116	0.750	1.05	1.56
6/1/05	4	0.227	K-710	Biased	FOA-005	1	732	3,542	3,562	5	15,360	570	480	2.89	1.04	1.57
5/31/05	4	0.227	K-711	Biased	FOA-005	1	718	3,353	3,343	5	15,165	570	315	1.93	1.03	1.56
5/31/05	4	0.227	K-712	Biased	FOA-005	1	648	3,142	3,433	5	15,165	570	255	1.73	1.13	1.56
6/28/05	4	0.227	K-755	Biased	FOA-006	1	775	2,745	2,882	5	14,865	570	-160	-0.908	0.880	1.54
6/28/05	4	0.227	K-759	Biased	FOA-006	1	805	3,359	3,331	5	14,865	570	372	2.04	0.916	1.54
6/28/05	4	0.227	K-772	Biased	FOA-006	1	645	3,074	3,141	5	14,865	570	135	0.920	1.11	1.54
6/27/05	4	0.227	K-773	Biased	FOA-006	1	653	3,215	3,419	5	15,105	570	296	2.00	1.13	1.56
2/14/05	4	0.227	K-524	Biased	FSS-013	1	712	3,573	3,436	5	14,534	570	598	3.70	1.06	1.53

Appendix D, Table D-2
Cave Counter Data
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corportion

Count Date	Det. #:	Detector Efficiency (cpm / pCi/g)	Sample No.	Sample Type	Survey Unit	Sample Count Time (min)	Sample Weight (g)	Gross Count Rate Top (cpm)	Gross Count Rate Bottom (cpm)	BKG Count Time (min)	BKG Counts	BKG Sample Weight (g)	Net Count Rate Average (cpm)	Th-232 (pCi/g)	95% CL Unc. (pCi/g)	MDC (pCi/g)
12/6/05	8	0.224	K-552	Biased	FSS-014	10	696	26,779	28,659	10	28,220	570	-50	-0.321	0.363	0.614
4/14/05	4	0.227	K-570	Biased	FSS-015	1	836	3,427	3,105	5	14,870	570	292	1.54	0.873	1.54
4/14/05	4	0.227	K-571	Biased	FSS-015	1	838	3,279	3,311	5	14,870	570	321	1.69	0.874	1.54
4/14/05	4	0.227	K-572	Biased	FSS-015	1	706	3,122	3,113	5	14,870	570	144	0.896	1.01	1.54
4/18/05	4	0.227	K-574	Biased	FSS-015	1	734	3,218	3,273	5	14,703	570	305	1.83	0.991	1.54
4/18/05	4	0.227	K-575	Biased	FSS-015	1	616	2,996	3,126	5	14,703	570	121	0.863	1.15	1.54
4/18/05	4	0.227	K-576	Biased	FSS-015	1	635	3,132	3,073	5	14,703	570	162	1.13	1.12	1.54
12/6/05	8	0.224	K-625	Biased	FSS-015	10	673	28,765	29,472	10	28,220	570	90	0.595	0.382	0.614
4/26/05	4	0.227	K-626	Biased	FSS-015	1	581	3,359	3,397	5	16,175	570	143	1.09	1.28	1.61
12/6/05	8	0.224	K-627	Biased	FSS-015	10	539	26,779	28,659	10	28,220	570	-50	-0.415	0.469	0.614
4/26/05	4	0.227	K-630	Biased	FSS-015	1	224	3,317	3,225	5	16,175	570	36	0.709	3.27	1.61
6/15/05	4	0.227	K-716	Biased	FSS-016	1	825	3,883	3,624	5	15,310	570	692	3.70	0.944	1.57
6/15/05	4	0.227	K-718	Biased	FSS-016	1	777	4,169	3,884	5	15,310	570	965	5.47	1.04	1.57
6/15/05	4	0.227	K-720	Biased	FSS-016	1	635	3,598	3,886	5	15,310	570	680	4.72	1.22	1.57
6/15/05	4	0.227	K-721	Biased	FSS-016	1	644	3,823	3,675	5	15,310	570	687	4.70	1.21	1.57
11/29/05	8	0.224	K-751	Biased	FSS-016	1	849	2,789	2,811	5	13,695	570	61	0.320	0.807	1.50
11/29/05	8	0.224	K-753	Biased	FSS-016	1	785	2,702	2,889	5	13,695	570	57	0.321	0.872	1.50

Appendix D, Table D-2
Cave Counter Data
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corportion

Count Date	Det. #:	Detector Efficiency (cpm / pCi/g)	Sample No.	Sample Type	Survey Unit	Sample Count Time (min)	Sample Weight (g)	Gross Count Rate Top (cpm)	Gross Count Rate Bottom (cpm)	BKG Count Time (min)	BKG Counts	BKG Sample Weight (g)	Net Count Rate Average (cpm)	Th-232 (pCi/g)	95% CL Unc. (pCi/g)	MDC (pCi/g)
11/29/05	8	0.224	K-754	Biased	FSS-016	1	883	2,707	2,918	5	13,695	570	74	0.371	0.778	1.50
11/29/05	8	0.224	K-762	Biased	FSS-016	1	624	2,696	2,862	5	13,695	570	40	0.286	1.09	1.50
11/29/05	8	0.224	K-763	Biased	FSS-016	1	568	2,974	2,766	5	13,695	570	131	1.03	1.22	1.50
11/29/05	8	0.224	K-764	Biased	FSS-016	1	570	2,613	2,976	5	13,695	570	56	0.434	1.20	1.50
11/29/05	8	0.224	K-765	Biased	FSS-016	1	571	2,689	2,880	5	13,695	570	46	0.355	1.20	1.50
11/29/05	8	0.224	K-766	Biased	FSS-016	1	685	2,559	2,809	5	13,695	570	-55	-0.358	0.982	1.50
11/29/05	8	0.224	K-767	Biased	FSS-016	1	721	3,000	2,976	5	13,695	570	249	1.54	0.979	1.50
12/6/05	8	0.224	K-799	Biased	FSS-017	10	665	29,213	28,894	10	28,220	570	83	0.559	0.386	0.614
12/6/05	8	0.224	K-800	Biased	FSS-017	10	677	27,951	29,213	10	28,220	570	36	0.238	0.377	0.614
12/6/05	8	0.224	K-801	Biased	FSS-017	10	623	28,764	29,627	10	28,220	570	98	0.698	0.413	0.614
12/6/05	8	0.224	K-945	Biased	FSS-018	10	694	28,008	29,067	10	28,220	570	32	0.204	0.368	0.614
12/6/05	8	0.224	K-946	Biased	FSS-018	10	703	29,244	29,137	10	28,220	570	97	0.616	0.366	0.614
8/8/05	4	0.227	K-941	Biased	FSS-019	1	653	3,255	3,085	5	15,130	570	144	0.972	1.10	1.56
8/8/05	4	0.227	K-942	Biased	FSS-019	1	917	3,527	3,235	5	15,130	570	355	1.71	0.809	1.56
8/8/05	4	0.227	K-943	Biased	FSS-019	1	738	3,008	3,196	5	15,130	570	76	0.454	0.966	1.56
8/8/05	4	0.227	K-944	Biased	FSS-019	1	657	2,930	3,146	5	15,130	570	12	0.081	1.08	1.56
9/29/05	4	0.227	K-1058	Biased	FSS-020	1	892	3,632	3,555	5	15,160	570	562	2.78	0.855	1.56

Appendix D, Table D-2
Cave Counter Data
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corportion

Count Date	Det. #:	Detector Efficiency (cpm / pCi/g)	Sample No.	Sample Type	Survey Unit	Sample Count Time (min)	Sample Weight (g)	Gross Count Rate Top (cpm)	Gross Count Rate Bottom (cpm)	BKG Count Time (min)	BKG Counts	BKG Sample Weight (g)	Net Count Rate Average (cpm)	Th-232 (pCi/g)	95% CL Unc. (pCi/g)	MDC (pCi/g)
9/29/05	4	0.227	K-1059	Biased	FSS-020	1	827	3,513	3,256	5	15,160	570	353	1.88	0.898	1.56
10/8/05	8	0.224	K-1163	Biased	FSS-020	1	665	2,948	3,121	5	14,550	570	125	0.835	1.07	1.54
10/8/05	8	0.224	K-1164	Biased	FSS-020	1	603	2,911	2,919	5	14,550	570	5	0.037	1.16	1.54
9/30/05	8	0.224	K-1203	Biased	FSS-020	1	612	3,422	3,141	5	15,110	570	260	1.89	1.21	1.57
9/30/05	8	0.224	K-1204	Biased	FSS-020	1	604	3,339	3,159	5	15,110	570	227	1.68	1.22	1.57
10/3/05	8	0.224	K-1205	Biased	FSS-020	1	668	3,104	2,983	5	14,975	570	49	0.324	1.07	1.57
10/4/05	8	0.224	K-1206	Biased	FSS-020	1	616	3,285	2,982	5	14,875	570	159	1.148	1.18	1.56
10/4/05	8	0.224	K-1207	Biased	FSS-020	1	612	2,995	3,026	5	14,875	570	36	0.259	1.16	1.56
10/4/05	8	0.224	K-1208	Biased	FSS-020	1	918	3,072	3,222	5	14,875	570	172	0.836	0.790	1.56
10/4/05	8	0.224	K-1209	Biased	FSS-020	1	719	3,032	3,288	5	14,875	570	185	1.15	1.01	1.56
10/4/05	8	0.224	K-1210	Biased	FSS-020	1	698	3,343	3,147	5	14,875	570	270	1.73	1.05	1.56
9/29/05	4	0.227	K-1057	Biased	FSS-021	1	660	3,269	3,221	5	14,945	570	256	1.71	1.10	1.55
9/29/05	4	0.227	K-1061	Biased	FSS-021	1	627	3,239	3,393	5	14,945	570	327	2.30	1.17	1.55
9/29/05	4	0.227	K-1062	Biased	FSS-021	1	598	3,319	3,340	5	14,945	570	341	2.51	1.23	1.55
9/29/05	4	0.227	K-1063	Biased	FSS-021	1	648	3,389	3,190	5	14,945	570	301	2.05	1.13	1.55
10/20/05	4	0.227	K-1238	Biased	FSS-022	1	623	3,325	3,187	5	15,400	570	176	1.25	1.17	1.57
10/20/05	4	0.227	K-1239	Biased	FSS-022	1	886	3,466	3,723	5	15,400	570	515	2.56	0.862	1.57

Appendix D, Table D-2
Cave Counter Data
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corportion

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10/20/05	4	0.227	K-1240	Biased	FSS-022	1	620	3,528	3,304	5	15,400	570	336	2.39	1.20	1.57
10/20/05	4	0.227	K-1241	Biased	FSS-022	1	609	3,402	3,232	5	15,400	570	237	1.72	1.21	1.57
10/20/05	4	0.227	K-1242	Biased	FSS-022	1	562	3,184	3,420	5	15,400	570	222	1.74	1.31	1.57
10/20/05	4	0.227	K-1243	Biased	FSS-022	1	573	3,247	3,413	5	15,035	570	323	2.49	1.29	1.55
10/20/05	4	0.227	K-1244	Biased	FSS-022	1	540	2,952	3,207	5	15,035	570	73	0.592	1.32	1.55
12/1/05	8	0.224	K-1340	Biased	FSS-023	1	726	3,030	2,954	5	13,785	570	235	1.44	0.973	1.50
12/1/05	8	0.224	K-1341	Biased	FSS-023	1	667	2,923	3,122	5	13,785	570	266	1.78	1.06	1.50
12/1/05	8	0.224	K-1342	Biased	FSS-023	1	695	3,099	3,118	5	13,785	570	352	2.26	1.03	1.50
12/1/05	8	0.224	K-1343	Biased	FSS-023	1	601	2,949	3,077	5	13,785	570	256	1.90	1.18	1.50
12/1/05	8	0.224	K-1344	Biased	FSS-023	1	837	3,291	3,231	5	13,785	570	504	2.69	0.878	1.50
12/1/05	8	0.224	K-1345	Biased	FSS-023	1	967	3,148	3,188	5	13,785	570	411	1.90	0.750	1.50
1/24/06	8	0.224	K-1408	Biased	FSS-024	1	833	2,993	3,098	5	13,920	570	262	1.40	0.856	1.51
1/24/06	8	0.224	K-1458	Biased	FSS-024	1	564	2,803	2,885	5	13,920	570	60	0.474	1.22	1.51
1/24/06	8	0.224	K-1459	Biased	FSS-024	1	788	3,094	3,141	5	13,920	570	334	1.89	0.914	1.51
3/28/05	4	0.227	K-565	Biased	FSSB-003	1	645	7,281	6,352	5	15,035	570	3,810	26.0	1.60	1.55
4/1/05	4	0.227	K-566	Biased	FSSB-003	1	645	8,266	6,922	5	15,336	570	4,527	31.0	1.68	1.57
4/13/05	4	0.227	K-568	Biased	FSSB-003	1	645	7,047	6,513	5	14,915	570	3,797	26.0	1.59	1.55

Appendix D, Table D-2
Cave Counter Data
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corportion

Count Date	Det. #:	Detector Efficiency (cpm / pCi/g)	Sample No.	Sample Type	Survey Unit	Sample Count Time (min)	Sample Weight (g)	Gross Count Rate Top (cpm)	Gross Count Rate Bottom (cpm)	BKG Count Time (min)	BKG Counts	BKG Sample Weight (g)	Net Count Rate Average (cpm)	Th-232 (pCi/g)	95% CL Unc. (pCi/g)	MDC (pCi/g)
4/13/05	4	0.227	K-569	Biased	FSSB-003	1	645	6,806	6,453	5	14,915	570	3,647	24.9	1.58	1.55
4/15/05	4	0.227	K-573	Biased	FSSB-003	1	645	6,897	6,112	5	14,885	570	3,528	24.1	1.56	1.54
4/20/05	4	0.227	K-577	Biased	FSSB-003	1	645	5,693	5,095	5	14,890	570	2,416	16.5	1.43	1.54
5/10/05	4	0.227	K-635	Biased	FSSB-004	1	593	5,492	5,067	5	14,915	570	2,297	17.1	1.54	1.55
5/10/05	4	0.227	K-636	Biased	FSSB-004	1	737	7,984	6,028	5	14,915	570	4,023	24.1	1.42	1.55
5/11/05	4	0.227	K-637	Biased	FSSB-004	1	682	7,031	5,437	5	15,210	570	3,192	20.6	1.45	1.56
5/17/05	4	0.227	K-662	Biased	FSSB-004	1	520	5,847	5,423	5	15,050	570	2,625	22.3	1.81	1.55
5/17/05	4	0.227	K-663	Biased	FSSB-004	1	576	6,812	6,520	5	15,050	570	3,656	28.0	1.77	1.55
5/19/05	4	0.227	K-664	Biased	FSSB-004	1	564	5,496	5,566	5	15,770	570	2,377	18.6	1.66	1.59
5/19/05	4	0.227	K-665	Biased	FSSB-004	1	594	5,824	5,644	5	15,770	570	2,580	19.2	1.60	1.59
5/19/05	4	0.227	K-666	Biased	FSSB-004	1	590	5,671	5,683	5	15,770	570	2,523	18.9	1.60	1.59
5/19/05	4	0.227	K-667	Biased	FSSB-004	1	738	5,581	4,696	5	15,770	570	1,985	11.9	1.22	1.59
5/19/05	4	0.227	K-668	Biased	FSSB-004	1	606	5,830	5,710	5	15,770	570	2,616	19.0	1.57	1.59
5/19/05	4	0.227	K-669	Biased	FSSB-004	1	531	5,855	5,044	5	15,770	570	2,296	19.1	1.75	1.59
5/19/05	4	0.227	K-670	Biased	FSSB-004	1	549	5,849	5,383	5	15,770	570	2,462	19.8	1.71	1.59
5/19/05	4	0.227	K-671	Biased	FSSB-004	1	564	5,353	5,264	5	15,770	570	2,155	16.8	1.63	1.59
5/20/05	4	0.227	K-672	Biased	FSSB-004	1	598	5,957	5,499	5	14,990	570	2,730	20.1	1.59	1.55

Appendix D, Table D-2
Cave Counter Data
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corportion

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5/20/05	4	0.227	K-673	Biased	FSSB-004	1	569	6,395	5,999	5	14,990	570	3,199	24.8	1.73	1.55
5/23/05	4	0.227	K-674	Biased	FSSB-004	1	639	7,146	5,853	5	15,290	570	3,442	23.8	1.58	1.57
5/24/05	4	0.227	K-725	Biased	FSSB-004	1	559	6,576	6,250	5	14,835	570	3,446	27.2	1.79	1.54
5/24/05	4	0.227	K-726	Biased	FSSB-004	1	622	6,256	5,758	5	14,835	570	3,040	21.6	1.56	1.54
5/24/05	4	0.227	K-727	Biased	FSSB-004	1	571	5,873	5,682	5	14,835	570	2,811	21.7	1.67	1.54
7/7/05	4	0.227	K-791	Biased	FSSB-005	1	699	6,794	5,816	5	14,855	570	3,334	21.0	1.42	1.54
7/9/05	4	0.227	K-802	Biased	FSSB-005	1	500	6,520	5,748	5	15,030	570	3,128	27.6	1.96	1.55
7/12/05	4	0.227	K-803	Biased	FSSB-005	1	586	6,663	5,995	5	16,210	570	3,087	23.2	1.70	1.61
7/15/05	4	0.227	K-807	Biased	FSSB-005	1	523	6,251	5,548	5	15,250	570	2,850	24.0	1.84	1.56
7/21/05	4	0.227	K-862	Biased	FSSB-006	1	588	5,638	5,582	5	14,825	570	2,645	19.8	1.60	1.54
8/1/05	4	0.227	K-863	Biased	FSSB-006	1	571	7,193	6,697	5	15,245	570	3,896	30.1	1.82	1.56
8/1/05	4	0.227	K-864	Biased	FSSB-006	1	551	6,243	5,306	5	15,245	570	2,726	21.8	1.73	1.56
8/1/05	4	0.227	K-865	Biased	FSSB-006	1	564	6,251	5,522	5	15,245	570	2,838	22.2	1.71	1.56
8/1/05	4	0.227	K-866	Biased	FSSB-006	1	618	6,936	6,660	5	15,245	570	3,749	26.8	1.67	1.56
8/1/05	4	0.227	K-867	Biased	FSSB-006	1	662	7,303	6,939	5	15,245	570	4,072	27.1	1.59	1.56
8/3/05	4	0.227	K-947	Biased	FSSB-006	1	548	6,614	6,420	5	15,155	570	3,486	28.1	1.84	1.56
8/3/05	4	0.227	K-948	Biased	FSSB-006	1	576	6,910	6,150	5	15,155	570	3,499	26.8	1.75	1.56

Appendix D, Table D-2
Cave Counter Data
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corportion

Count Date	Det. #:	Detector Efficiency (cpm / pCi/g)	Sample No.	Sample Type	Survey Unit	Sample Count Time (min)	Sample Weight (g)	Gross Count Rate Top (cpm)	Gross Count Rate Bottom (cpm)	BKG Count Time (min)	BKG Counts	BKG Sample Weight (g)	Net Count Rate Average (cpm)	Th-232 (pCi/g)	95% CL Unc. (pCi/g)	MDC (pCi/g)
8/3/05	4	0.227	K-949	Biased	FSSB-006	1	553	6,600	5,766	5	15,155	570	3,152	25.1	1.78	1.56
8/3/05	4	0.227	K-950	Biased	FSSB-006	1	588	6,701	6,098	5	15,155	570	3,369	25.3	1.70	1.56
8/5/05	4	0.227	K-951	Biased	FSSB-006	1	547	5,983	5,555	5	15,130	570	2,743	22.1	1.74	1.56
8/5/05	4	0.227	K-952	Biased	FSSB-006	1	630	6,472	5,644	5	15,130	570	3,032	21.2	1.55	1.56
8/10/05	4	0.227	K-953	Biased	FSSB-006	1	597	6,447	6,187	5	15,135	570	3,290	24.3	1.67	1.56
8/10/05	4	0.227	K-954	Biased	FSSB-006	1	581	6,603	6,378	5	15,135	570	3,464	26.3	1.73	1.56
8/10/05	4	0.227	K-955	Biased	FSSB-006	1	516	6,225	6,301	5	15,135	570	3,236	27.7	1.92	1.56
8/10/05	4	0.227	K-956	Biased	FSSB-006	1	562	6,307	5,808	5	15,135	570	3,031	23.8	1.73	1.56
8/10/05	4	0.227	K-957	Biased	FSSB-006	1	551	6,220	5,795	5	15,135	570	2,981	23.9	1.76	1.56
8/10/05	4	0.227	K-958	Biased	FSSB-006	1	593	6,466	6,012	5	15,135	570	3,212	23.9	1.67	1.56
8/31/05	4	0.227	K-1002	Biased	FSSB-007	1	597	6,914	6,104	5	14,775	570	3,554	26.3	1.69	1.54
8/31/05	4	0.227	K-1003	Biased	FSSB-007	1	566	6,316	6,040	5	14,775	570	3,223	25.1	1.74	1.54
8/31/05	4	0.227	K-1004	Biased	FSSB-007	1	542	6,767	5,752	5	14,775	570	3,305	26.9	1.83	1.54
9/6/05	4	0.227	K-1008	Biased	FSSB-007	1	585	6,793	6,152	5	14,775	570	3,518	26.5	1.72	1.54
9/6/05	4	0.227	K-1009	Biased	FSSB-007	1	570	5,941	6,199	5	14,775	570	3,115	24.1	1.71	1.54
9/6/05	4	0.227	K-1010	Biased	FSSB-007	1	591	6,608	6,350	5	14,775	570	3,524	26.3	1.70	1.54
9/6/05	4	0.227	K-1011	Biased	FSSB-007	1	572	6,732	6,295	5	14,775	570	3,559	27.4	1.76	1.54

Appendix D, Table D-2
Cave Counter Data
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corportion

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9/8/05	4	0.227	K-1015	Biased	FSSB-007	1	635	5,072	4,990	5	14,875	570	2,056	14.3	1.41	1.54
9/8/05	4	0.227	K-1016	Biased	FSSB-007	1	586	6,268	6,056	5	14,875	570	3,187	24.0	1.68	1.54
9/8/05	4	0.227	K-1017	Biased	FSSB-007	1	596	7,080	6,496	5	14,875	570	3,813	28.2	1.73	1.54
9/8/05	4	0.227	K-1018	Biased	FSSB-007	1	578	6,442	5,912	5	14,875	570	3,202	24.4	1.70	1.54
9/20/05	4	0.227	K-1029	Biased	FSSB-007	1	549	6,664	6,002	5	14,750	570	3,383	27.2	1.81	1.54
9/20/05	4	0.227	K-1030	Biased	FSSB-007	1	509	6,324	5,598	5	14,750	570	3,011	26.1	1.90	1.54
9/20/05	4	0.227	K-1031	Biased	FSSB-007	1	596	6,689	6,294	5	14,750	570	3,542	26.2	1.69	1.54
9/23/05	4	0.227	K-1037	Biased	FSSB-007	1	630	6,771	6,462	5	14,545	570	3,708	26.0	1.61	1.53
9/23/05	4	0.227	K-1038	Biased	FSSB-007	1	601	5,924	6,168	5	14,545	570	3,137	23.0	1.62	1.53
9/23/05	4	0.227	K-1039	Biased	FSSB-007	1	642	6,867	6,601	5	14,545	570	3,825	26.3	1.60	1.53
9/27/05	4	0.227	K-1192	Biased	FSSB-007	1	593	6,512	5,731	5	14,760	570	3,170	23.6	1.65	1.54
9/14/05	4	0.227	K-1193	Biased	FSSB-007	1	659	6,535	5,497	5	15,080	570	3,000	20.1	1.47	1.55
9/12/05	4	0.227	K-1195	Biased	FSSB-007	1	522	6,002	5,622	5	15,095	570	2,793	23.6	1.83	1.56
9/12/05	4	0.227	K-1196	Biased	FSSB-007	1	567	5,885	5,439	5	15,095	570	2,643	20.6	1.66	1.56
11/18/05	8	0.224	K-1291	Biased	FSSB-007	1	612	5,478	5,514	5	14,045	570	2,687	19.6	1.54	1.52
8/31/05	4	0.227	K-1005	Biased	FSSB-008	1	629	6,416	5,645	5	14,775	570	3,076	21.6	1.55	1.54
8/31/05	4	0.227	K-1006	Biased	FSSB-008	1	587	6,628	6,057	5	14,775	570	3,388	25.4	1.70	1.54

Appendix D, Table D-2
Cave Counter Data
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corportion

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8/31/05	4	0.227	K-1007	Biased	FSSB-008	1	559	6,301	5,537	5	14,775	570	2,964	23.4	1.72	1.54
9/6/05	4	0.227	K-1012	Biased	FSSB-008	1	577	6,356	6,335	5	14,775	570	3,391	25.9	1.73	1.54
9/6/05	4	0.227	K-1013	Biased	FSSB-008	1	573	6,308	5,707	5	14,775	570	3,053	23.5	1.69	1.54
9/6/05	4	0.227	K-1014	Biased	FSSB-008	1	602	6,931	5,708	5	14,775	570	3,365	24.6	1.65	1.54
9/20/05	4	0.227	K-1032	Biased	FSSB-008	1	585	6,866	5,991	5	14,750	570	3,479	26.2	1.71	1.54
9/20/05	4	0.227	K-1033	Biased	FSSB-008	1	575	6,571	6,474	5	14,750	570	3,573	27.4	1.76	1.54
9/20/05	4	0.227	K-1034	Biased	FSSB-008	1	586	7,202	6,529	5	14,750	570	3,916	29.5	1.77	1.54
9/20/05	4	0.227	K-1035	Biased	FSSB-008	1	605	7,037	6,364	5	14,750	570	3,751	27.3	1.69	1.54
9/20/05	4	0.227	K-1036	Biased	FSSB-008	1	628	7,040	6,722	5	14,750	570	3,931	27.6	1.65	1.54
9/23/05	4	0.227	K-1040	Biased	FSSB-008	1	604	4,837	4,993	5	14,545	570	2,006	14.6	1.46	1.53
9/23/05	4	0.227	K-1040	Biased	FSSB-008	1	604	4,837	4,993	5	14,545	570	2,006	14.6	1.46	1.53
9/27/05	4	0.227	K-1191	Biased	FSSB-008	1	619	5,226	5,146	5	14,760	570	2,234	15.9	1.46	1.54
9/14/05	4	0.227	K-1194	Biased	FSSB-008	1	778	5,307	5,034	5	15,080	570	2,155	12.2	1.16	1.55
9/12/05	4	0.227	K-1197	Biased	FSSB-008	1	582	5,586	5,308	5	15,095	570	2,428	18.4	1.59	1.56
9/12/05	4	0.227	K-1198	Biased	FSSB-008	1	591	5,389	5,338	5	15,095	570	2,345	17.5	1.56	1.56
9/8/05	4	0.227	K-1199	Biased	FSSB-008	1	591	6,971	6,072	5	14,875	570	3,547	26.5	1.71	1.54
9/8/05	4	0.227	K-1200	Biased	FSSB-008	1	632	6,391	5,772	5	14,875	570	3,107	21.7	1.54	1.54

Appendix D, Table D-2
Cave Counter Data
Final Status Survey
Thorium Remediation Project
Tulsa, Oklahoma Facility
Kaiser Aluminum & Chemical Corportion

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9/8/05	4	0.227	K-1201	Biased	FSSB-008	1	602	6,921	6,347	5	14,875	570	3,659	26.8	1.69	1.54
9/8/05	4	0.227	K-1202	Biased	FSSB-008	1	586	6,242	5,702	5	14,875	570	2,997	22.6	1.65	1.54
11/9/05	4	0.227	K-1268	Biased	FSSB-009	1	606	4,706	4,453	5	15,305	570	1,519	11.1	1.41	1.57
11/9/05	4	0.227	K-1269	Biased	FSSB-009	1	570	4,767	4,608	5	15,305	570	1,627	12.6	1.52	1.57
11/18/05	8	0.224	K-1270	Biased	FSSB-009	1	631	5,564	5,431	5	14,045	570	2,689	19.0	1.49	1.52
11/17/05	8	0.224	K-1292	Biased	FSSB-009	1	544	5,864	5,366	5	13,825	570	2,850	23.4	1.74	1.51
11/17/05	8	0.224	K-1292	Biased	FSSB-009	1	544	5,864	5,366	5	13,825	570	2,850	23.4	1.74	1.51
11/17/05	8	0.224	K-1293	Biased	FSSB-009	1	648	5,192	4,691	5	13,825	570	2,177	15.0	1.38	1.51
11/17/05	8	0.224	K-1293	Biased	FSSB-009	1	648	5,192	4,691	5	13,825	570	2,177	15.0	1.38	1.51
11/21/05	8	0.224	K-1333	Biased	FSSB-009	1	664	6,323	6,234	5	14,005	570	3,478	23.4	1.51	1.52
11/21/05	8	0.224	K-1334	Biased	FSSB-009	1	652	5,875	5,648	5	14,005	570	2,961	20.3	1.47	1.52
11/21/05	8	0.224	K-1335	Biased	FSSB-009	1	681	4,150	4,251	5	14,005	570	1,400	9.17	1.22	1.52