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August 7, 2015 **Sent via Overnight Mail**

Mr. Ron C. Linton, Project Manager
Decommissioning & Uranium Recovery Licensing Directorate
Division of Waste Management & Environmental Protection
Office of Federal and State Materials & Environmental Management Programs
11545 Rockville Pike
Rockville, MD 20852-2738

Subject: Uranium One USA, Inc. Willow Creek Project, License SUA-1341
Irigaray Mine Units 1-9 Final Status Decommissioning Report

Dear Mr. Linton:

Please find the Final Status Decommissioning Report for Willow Creek Irigaray Mine Units 1-9 for Radioactive Materials License SUA-1341.

Uranium One appreciates the extension from August 3, 2015 to August 10, 2015 to allow for the incorporation of recently recovered data, rather than providing this data as a supplement to the Irigaray Mine Unit 1-9 Final Status Decommissioning Report.

Should you have any questions or need additional information in regards to this matter please contact me at (307) 234-8235 ext. 330 or email at scott.schierman@uranium1.com.

Sincerely,

Scott Schierman
HSE Manager

cc: Greg Kruse – Manager U.S. Operations
Rick Kukura – Willow Creek Mine Manager

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Final Status Decommissioning Report Supporting Release of Mine Units 1 through 9 And Two Associated Buildings at the Irigaray Site For Unrestricted Future Use

Willow Creek Project, Johnson County, Wyoming
NRC License No. SUA-1341

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Final Status Decommissioning Report Supporting Release of Mine Units 1 through 9 and Two Associated Buildings at the Irigaray ISR Site for Unrestricted Future Use

Willow Creek Project, Johnson County, Wyoming
NRC License No. SUA-1341

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August 2015

Contents

Figures

Overview

The Willow Creek Project is comprised of two distinct uranium recovery sites in Johnson and Campbell Counties, Wyoming. Formerly known separately as the Irigaray and Christensen Ranch sites, both now operate jointly under a single source materials license from the U.S. Nuclear Regulatory Commission (NRC License No. SUA-1341) for the Willow Creek Project. Currently owned and operated by Uranium One USA, Inc. (U1), these sites have historically used in-situ recovery (ISR) methods to extract uranium from subsurface ore resources.

The Christensen Ranch site is comprised of wellfields and a satellite ion exchange facility. Loaded ion exchange resin is transferred from Christensen Ranch to a central processing plant (CPP) at the Irigaray site (Site) for processing (Figure 1). The Irigaray CPP includes an elution circuit to extract uranium from ion exchange resin, a uranium precipitation circuit, a yellowcake filtering (dewatering) circuit, yellowcake storage tanks, and a yellowcake dryer and packing circuit. Historical ISR wellfield mine units at Irigaray (Mine Units 1 through 9) are permitted by the Wyoming Division of Environmental Quality (WDEQ) under Permit No. 478. This permit encompasses approximately 671 acres. The total acreage disturbed by historical Irigaray operations is approximately 133 acres.

Figure 1: Irigaray Site location.

Irigaray Mine Units 1-9 (Mine Units) are currently in the final stages of decommissioning. Prior to U1 acquiring the Site in 2010, much of the decommissioning work was performed by the former operator of the Site, COGEMA Mining, Inc. (COGEMA) under a NRC-approved Decommissioning Plan (COGEMA, 2001). Groundwater restoration has been completed (NRC approved the restoration in September 2006), but soils within these Mine Units require verification that radiological contamination if any, from historical ISR operations does not exceed approved cleanup levels before these areas can be released by the NRC for unrestricted use. Wellfield infrastructure has been removed, wells have been sealed and abandoned, and disturbed areas have been reclaimed.

In addition to soils as indicated above, there are two utility buildings at the Irigaray Site that U1 wishes to release from the NRC License for unrestricted use. These buildings, both unnamed, are a 60- by 60-ft steel and concrete structures used historically for the wellfield control building for Mine Units 1-5 and later used for wellfield restoration purposes and storage along with an associated shed. These utility buildings are located approximately 1,700 feet from the southeast corner of the CCP.

The purpose of these surveys was to provide sufficient information to the NRC to allow decisions regarding release of the Mine Units and buildings as indicated above from the license for unrestricted future use. The necessary final status radiological surveys have been conducted in general accordance with the approved Decommissioning Plan (COGEMA, 2001). This report documents the methods, results and conclusions of these surveys in two separate reports (Reports A and B) that follow.

Report A: Final Status Surveys for Soils

1. Introduction

Prior to the 2010 acquisition of the Irigaray Site by Uranium One USA, Inc. (U1), COGEMA Mining, Inc. (COGEMA) had conducted a comprehensive final status gamma radiation survey across the Site's largely decommissioned ISR Mine Units 1-9 (Mine Units). The Mine Units are depicted in Figure A1, along with the spatial extent of the gamma survey which included former ISR wellfields and a surrounding margin. Survey results (Figure A2) indicate that gamma radiation in the majority of surveyed locations is below the 25,000 count per minute (cpm) action level indicated in the Decommissioning Plan (COGEMA 2001), with the primary exceptions being two small localized areas of apparent soil impacts within Mine Unit 1.

Based in part on the gamma survey data, surface soil sampling was conducted in 2013 across a sampling grid in general accordance with the strategy specified in the Decommissioning Plan (COGEMA 2001). Some modification to this strategy was necessary because the electronic gamma survey database appears to have been lost (only color-coded maps of results are available). Verbal discussions between U1 and the NRC regarding this issue resulted in an agreement to slightly modify the soil sampling design in a manner that provides equally reliable evidence of compliance with applicable cleanup criteria. Cleanup criteria, soil sampling design, methods and results of final status soil sampling across the Mine Units are presented in the following Sections of this report.

2. Soil Cleanup Criteria

Established representative background concentrations of radium-226 (Ra-226) and natural uranium (U-nat) in soils across the Site are 2 picocuries per gram (pCi/g) each as detailed in the NRC-approved Decommissioning Plan (COGEMA, 2001). The net (above background) cleanup limit for Ra-226 in surface soils is 5 pCi/g (10 CFR 40, Appendix A), giving a gross soil cleanup criterion of 7 pCi/g. The Benchmark Dose approach along with considerations of chemical toxicity and ALARA principles was used to develop an approved net cleanup limit for U-nat in surface soils of 150 pCi/g (COGEMA, 2001), giving a gross soil cleanup criterion of 152 pCi/g. Thorium-230 is not an applicable contaminant from ISR operations at Irigaray as discussed in the NRC-approved Decommissioning Plan (COGEMA, 2001).

These cleanup levels apply to soil concentrations averaged over any 100 square meters (m^2) area to a depth of 15 centimeters (cm). When both radionuclides are present, the sum-of-fractions rule described in Criterion 6(6) of 10 CFR 40, Appendix A applies (COGEMA, 2001). With respect to subsurface soils, the net soil cleanup criteria for Ra-226 and U-nat are 10 pCi/g and 400 pCi/g respectively (COGEMA, 2001), and apply to any 15-cm layer of soil residing at depths greater than 15 cm under the same averaging criteria and sum-of-fractions rule as applied to surface soils.

3. Soil Sampling Methods

Final status sampling of surface soils was conducted in general accordance with Standard Operating Procedure (SOP) D-3 as provided in Appendix E of the approved Decommissioning Plan (COGEMA, 2001).

A sampling grid comprised of 10 m x 10 m transects was developed with GIS software to delineate 100 m^2 boxes in all areas covered by the gamma radiation survey. Five-point composite soil samples were subsequently collected in 10% of the 3,444 survey grid boxes (344 composite samples total).

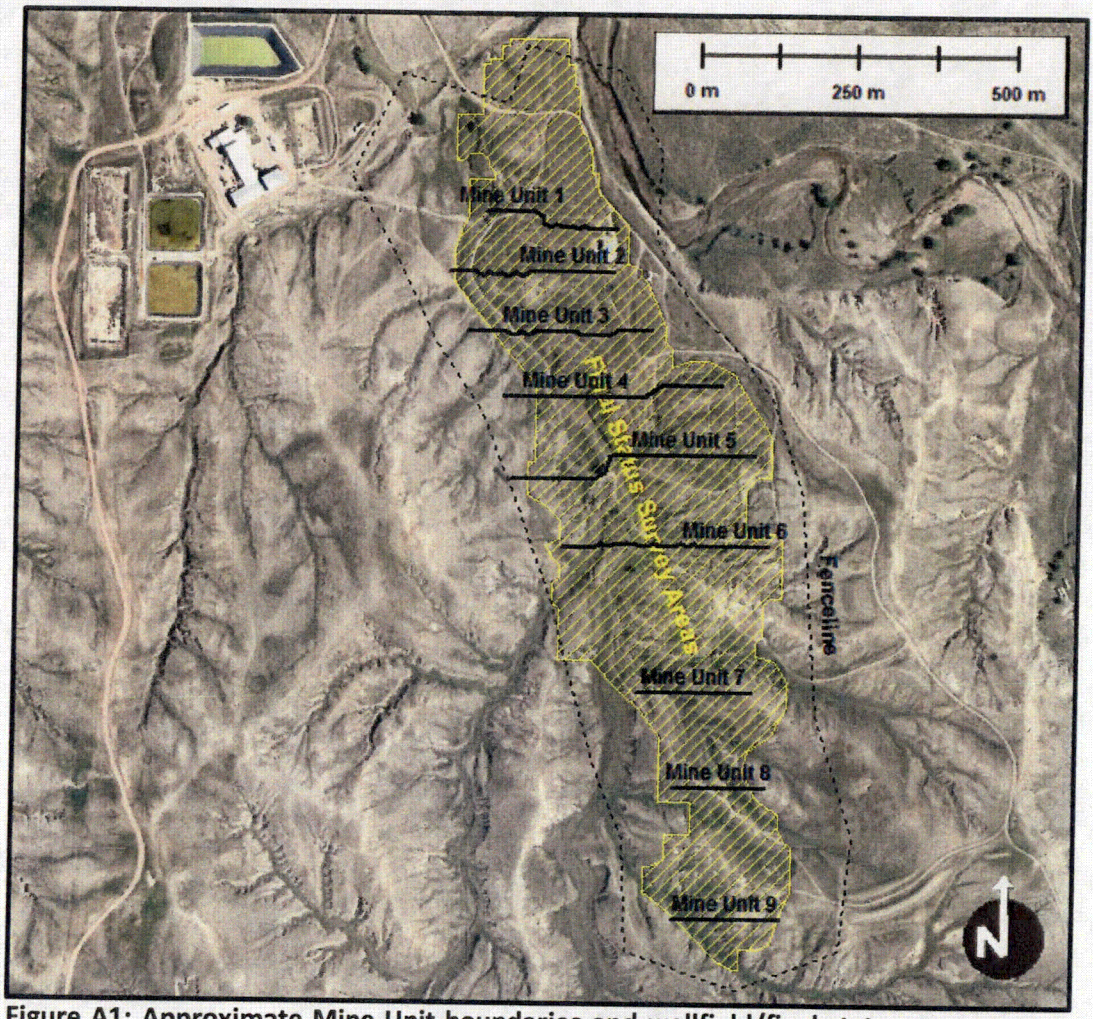

Figure A1: Approximate Mine Unit boundaries and wellfield/final status survey areas at Irigaray.

Because the electronic gamma survey database was not available, the Decommissioning Plan specification of basing soil sampling locations on the highest ranking 10% of all 100 m^2 survey grids with respect to gamma readings could not be quantitatively followed. However, the color-coded gamma survey map (Figure A2) was used to qualitatively select approximately 50 locations for biased sampling in areas of higher readings (U1, 2015). A random number generator was used to randomize the remaining sampling locations. Samples were collected to a depth of 15 cm and were composited/homogenized in the field.

For subsurface samples, the bottom of trenches opened during removal of wellfield infrastructure (piping, trunk lines, etc.) were sampled with grab samples collected along the bottom of the trenches to a depth of 15 cm at sampling intervals that in general were more frequent than the 150-foot spacing

prescribed in SOP D-5 as provided in Appendix E of the approved Decommissioning Plan (COGEMA, 2001).

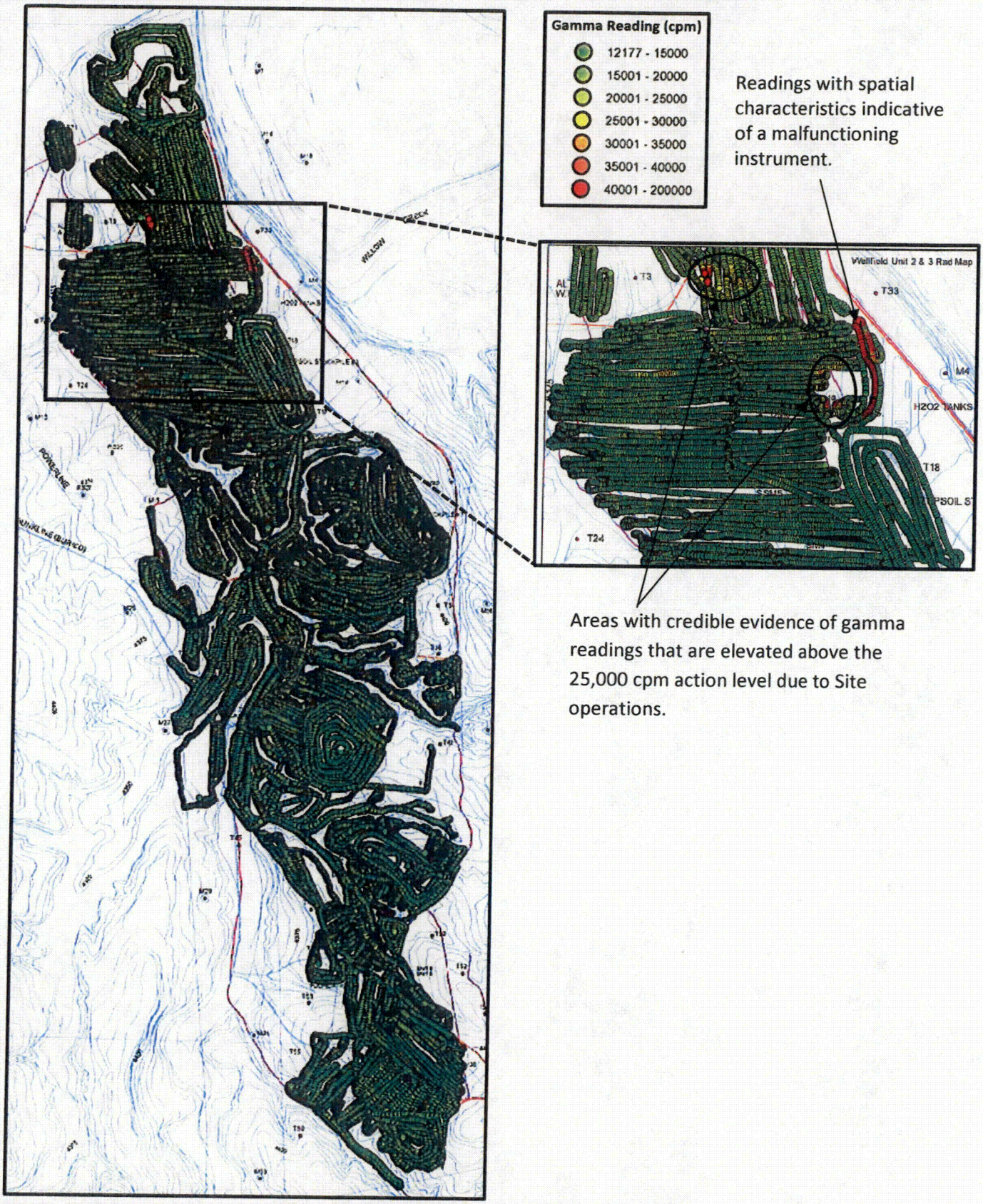

Figure A2: Gamma radiation survey data with annotated data interpretation notes.

Chain-of-custody forms were filled out for all samples prior to submittal to a qualified commercial laboratory (Inter-Mountain Labs, Sheridan, WY) for analysis. Radium-226 analysis was performed using EPA Method 901.1 (gamma spectroscopy with a high-purity germanium detector) and natural (total) uranium (U-nat) analysis was performed using EPA Method 200.8 [Inductively Coupled Plasma (ICP)-Mass Spectrometry].

4. Soil Sampling Results

Tables containing analytical results for both surface soils (0-15 cm depth) and subsurface soils (> 15 cm depth) are respectively provided electronically on CD as Appendices A1-1 and A1-2 in the form of spreadsheet files. Maps and analysis of these data sets are provided in the following Sections.

4.1. Surface soils

A color-coded map showing the spatial distribution of average Ra-226 concentrations in surface soils (0-15 cm depth) within 100 m^2 survey grid boxes is shown in Figure A3. Among all Mine Units, only 1 survey grid box, located in Mine Unit 1, exceeded the 7-pCi/g gross cleanup criterion for Ra-226 in surface soils (Figure A3). The initial average soil Ra-226 concentration in this grid box was 60.7 pCi/g with an average U-nat concentration of 37.3 pCi/g. This box was subsequently excavated until gamma readings fell below the action level of 25,000 counts per minute (cpm). Subsequent soil sampling revealed average soil concentrations for Ra-226 and U-nat of 4.3 and 133 pCi/g respectively, both of which are below their individually applicable cleanup levels. Average soil Ra-226 concentrations in all other grid boxes are below the cleanup level.

The average U-nat concentration occurring in surface soils within 100 m^2 survey grid boxes is shown in Figure A4. None of the samples in any Mine Unit exceeded the gross cleanup criterion for U-nat in surface soils (152 pCi/g). Note that the lowest end of the legend scale in Figure A4 has been increased by 1 pCi/g versus the Ra-226 scale in Figure A3 – this is because at secular equilibrium for the uranium decay series, a Ra-226 concentration of 1 pCi/g should have a U-nat concentration of approximately 2 pCi/g.

Figure A5 shows sum-of-fractions values for the combined Ra-226 and U-nat soil concentrations occurring within each sampled survey grid box. Among all Mine Units, only 2 samples exceeded the sum-of-fractions criterion (unity), both of which occurred in Mine Unit 1 (Figure A5). One of these samples, corresponding to the post-cleanup results for the remediated box described above, had a sum-of-fractions value of 1.49 while the other only slightly exceeded the sum-of-fractions limit (the calculated result was 1.14).

Given the small areas involved, neither of these sum-of-fractions exceedances poses a significant risk to human health or the environment. The derived uranium cleanup criterion was based on conservative assumptions and ALARA principles, and the original intent of the 100 m^2 specification in Appendix A of

10 CFR 40 (adopted from 40 CFR 192) was not based on health risks, but on the typical size of the foundation of a house for reasons related to practicality of cleaning up residential properties located offsite from Title I uranium mill sites (EPA, 1982). This recognition is consistent with NRC guidance to base radium benchmark dose modeling on the extent of site-wide impacts (NRC, 2003), and is also consistent with the data analysis procedure specified in the approved Decommissioning Plan to also evaluate compliance with the sum-of-fractions criterion based on a site-wide average value (COGEMA, 2001).

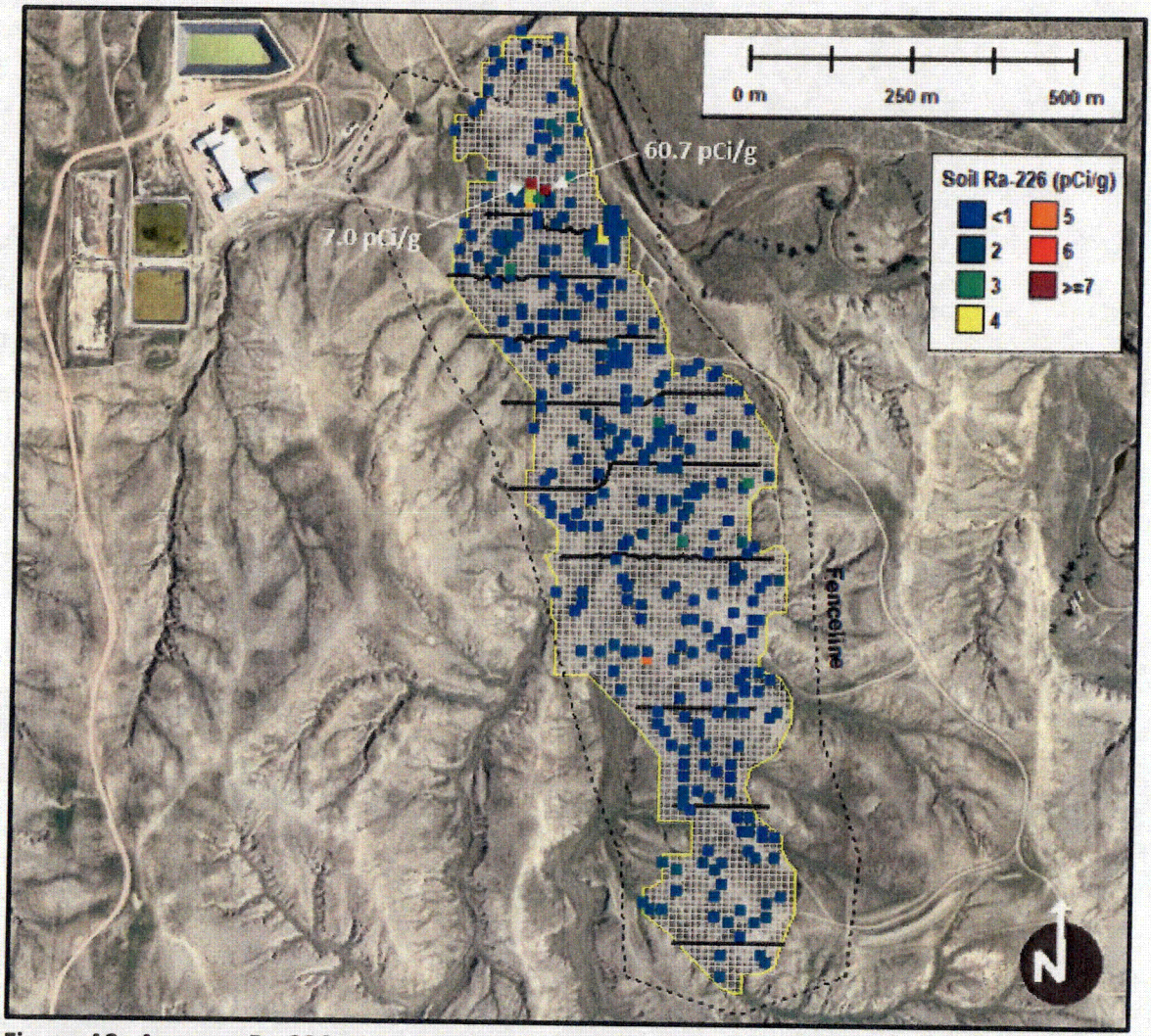

Figure A3: Average Ra-226 concentrations in surface soils within 100 m^2 survey grid boxes (symbol size exaggerated to aid with visual interpretation).

To quantitatively evaluate the potential magnitude of health risks associated with these two small criterion exceedances, a dose assessment was performed using RESRAD for the two 100 m^2 grid boxes in question. The assessment used essentially the same parameter selections indicated for the radium benchmark dose assessment provided in the Decommissioning Plan, with appropriate exceptions for soil concentrations, size of contaminated areas, and occupancy factors. In this case, Ra-226 and U-nat were modeled at the observed concentrations in each of the two affected plots, with one plot having a house

located directly over the plot with indoor occupancy only (using the same factor of 50%), and the other plot modeled as a 100 m^2 garden with a conservative outdoor occupancy of about 4 hours per week on a year-round basis (about 2.4% occupancy). The resulting maximum annual dose occurs at t = 0 years and is equivalent to 12.8 mrem, well below the benchmark dose (28.5 mrem) as well as the 10 CFR 20 annual dose criterion of 25 mrem for unrestricted release. The RESRAD output files are provided in Appendix A2.

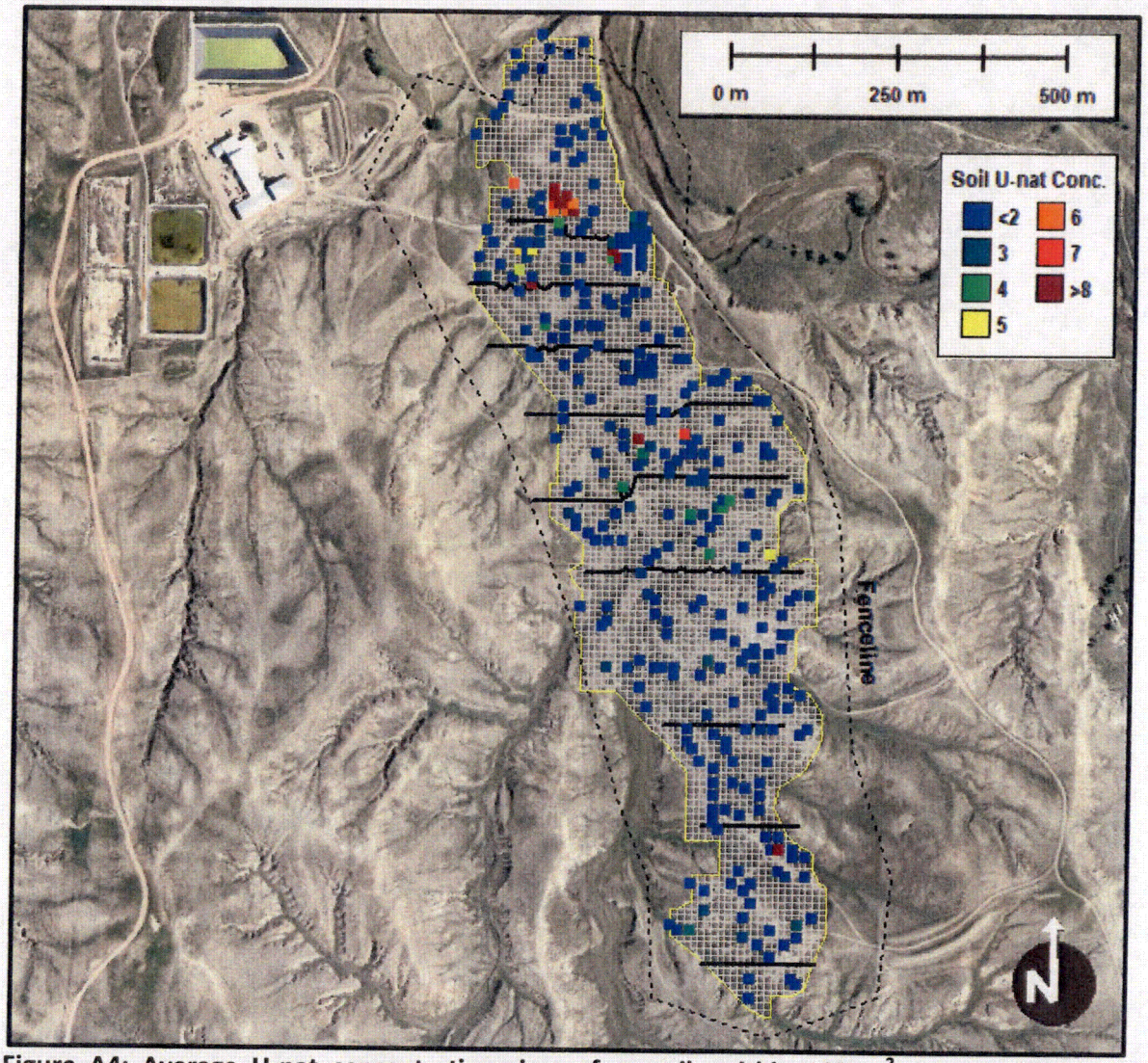

Figure A4: Average U-nat concentrations in surface soils within 100 m^2 survey grid boxes (symbol size exaggerated to aid with visual interpretation).

The Decommissioning Plan requires statistical demonstration that the average sum-of-fractions value across the entire survey area is less than unity (< 1) based on sampling of 10% of the 100 m^2 survey grid boxes. The formula specified to demonstrate compliance with this requirement is based on a parametric statistical test that assumes a normal data distribution. A normal quantile plot indicates that this data set is highly skewed (skewness = 5.5) and does not follow a normal distribution. As a result, a more appropriate non-parametric sign test was performed with ProUCL statistical software (EPA, 2011)

to determine whether the observed median sum-of-fractions value for all sampled 100 m^2 survey grid boxes (0.18) provides sufficient statistical evidence that the true value across the entire site is less than unity. The probability value resulting from the sign test as reported by ProUCL (p-value = 0) indicates that the true median sum-of-fractions value across the entire survey area can statistically be inferred to be below unity at a confidence level of 100%.

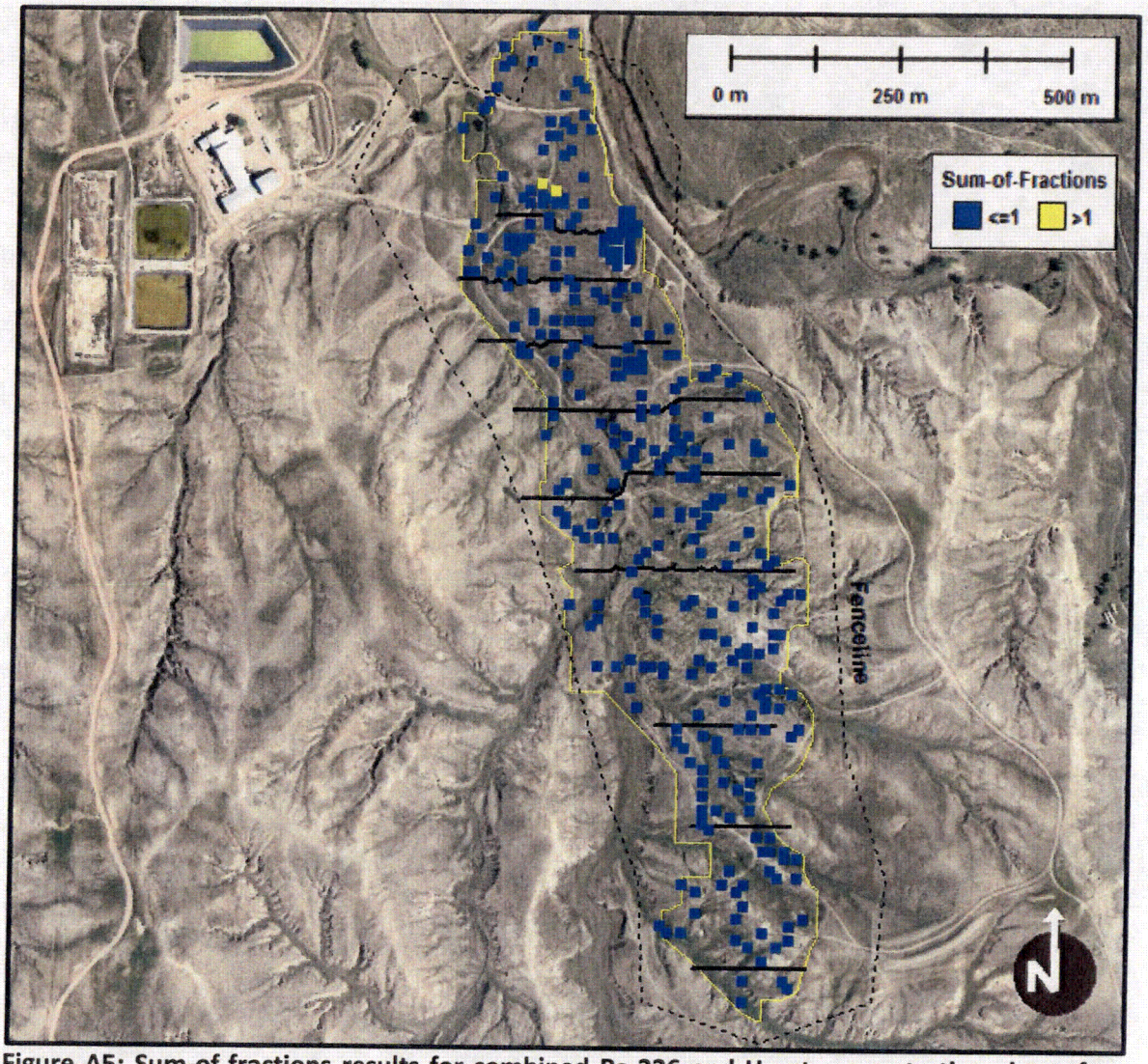

Figure A5: Sum-of-fractions results for combined Ra-226 and U-nat concentrations in surface soils within 100 m^2 survey grid boxes (symbol size exaggerated to aid with visual

4.2. Subsurface soils

All wellfield infrastructure across Mine Units 1-5 was constructed above ground, and is believed by U1 to have been dismantled and removed near the 2005 time frame. Since there was no buried infrastructure in these Mine Units and comprehensive gamma radiation and surface soil surveys across these areas

have now demonstrated no discernible surface impacts in excess of approved cleanup levels, subsurface soil sampling is not warranted in these areas.

Subsurface soil sampling along the bottom of 2-3 foot deep trenches excavated to remove buried wellfield infrastructure across Mine Units 6-9 was conducted in stages between 2005 and 2013 as the wellfields were gradually being decommissioned and reclaimed. Trenches in Mine Unit 6 were sampled in 2005 and 2006 at the locations shown in Figure A6. Results indicate that only one sample exceeded the sum-of-fractions criterion, none exceeded the net (above background) subsurface U-nat concentration criterion (400 pCi/g), and only one sample, the same one that exceeded the sum-of-fractions criterion, exceeded the net 10 pCi/g subsurface Ra-226 criterion (the Ra-226 result was 16.9 pCi/g).

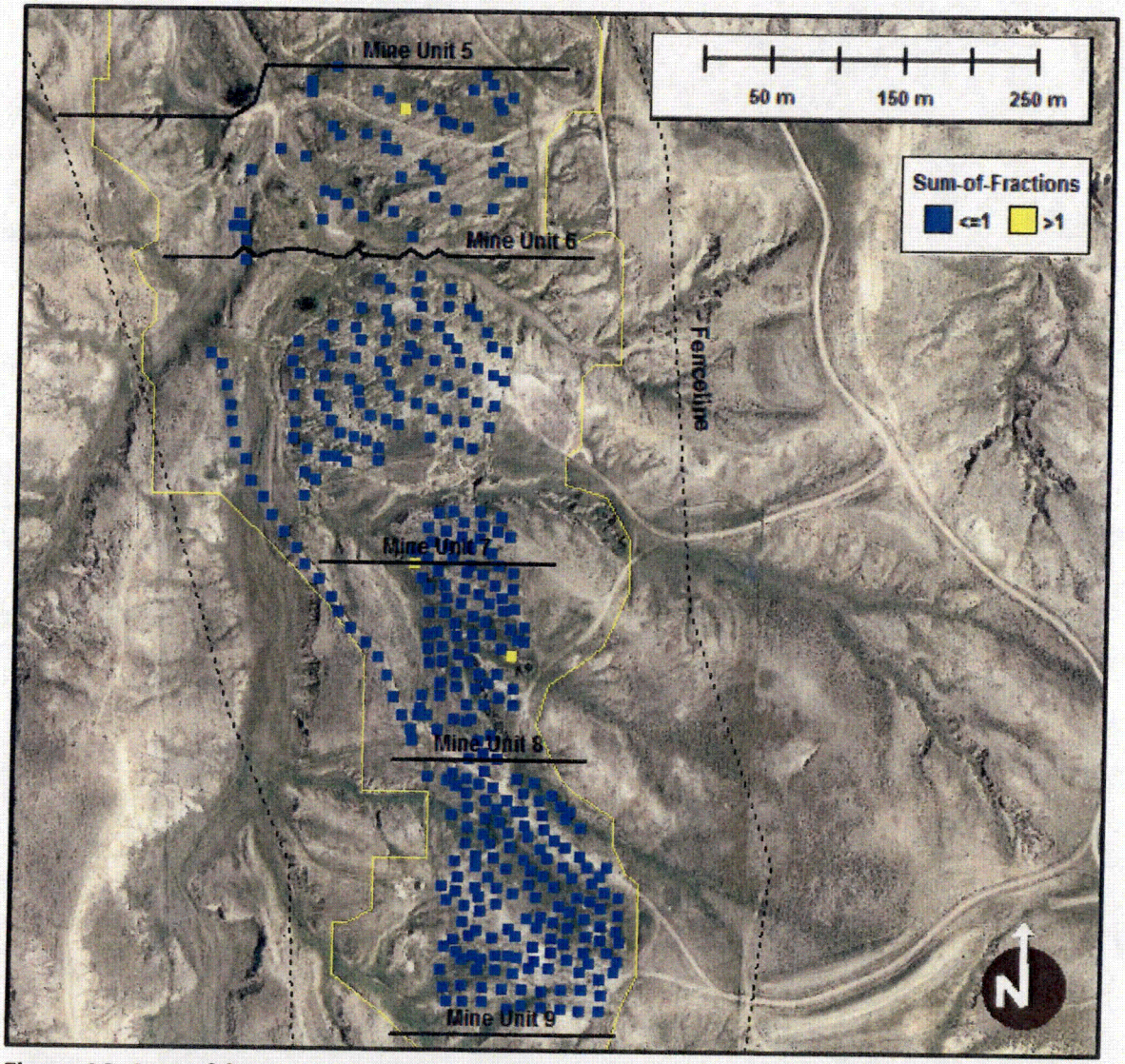

Figure A6: Sum-of-fractions results for combined Ra-226 and U-nat concentrations in samples taken at the bottom of 2-3 foot deep trenches after removal of buried wellfield infrastructure (symbol size exaggerated to aid with visual interpretation).

Subsurface trench sampling across the majority of Mine Unit 7 was conducted by COGEMA in 2009 (Figure A6). None of the 78 samples collected exceeded any applicable cleanup criteria, though there is uncertainty regarding the exact locations of these samples. Because original field maps are not available, the locations shown in Figure A6 for central and northern portions of Mine Unit 7 were estimated based partially on qualitative information obtained from field personnel involved in the sampling with respect to beginning location and the sequential sampling strategy that followed. Given that 78 samples were collected along these trenches, a sample spacing of approximately 25 meters would have covered the majority of Mine Unit 7 areas that had open trenches at the time based on aerial imagery taken circa 2009. While estimated, the locations of these subsurface trench samples in Figure A6 are believed reasonably representative of actual locations. This acknowledged spatial uncertainty should not be consequential to evaluation of release of these areas for unrestricted use since all samples were below all applicable cleanup criteria.

With respect to Mine units 8 and 9 along with bordering southern and far western portions of Mine Unit 7, 255 subsurface trench samples were collected in 2013 by U1 (Figure A6). Only two of these samples exceeded the sum-of-fractions unity criterion (calculated values were 1.70 and 1.44 respectively). None of these samples exceeded the net (above background) subsurface U-nat concentration criterion (400 pCi/g), and only two samples, the same ones that exceeded the sum-of-fractions criterion, exceeded the net 10 pCi/g subsurface Ra-226 criterion (respective results were 19.9 and 16.6 pCi/g).

Overall, only three (3) out of 387 subsurface soil samples collected along wellfield infrastructure removal trenches across Mine Units 6-9 slightly exceeded some applicable cleanup criteria. Given that all trenches were backfilled with 2-3 feet of clean soil, there are no human health or environmental risks associated with these three localized cleanup criteria exceedances.

There is one additional subsurface sampling issue of note. In 2008, a small buried trash pit was discovered next to an auxiliary Site building (Figure A7). This 21 × 18 foot trash pit was excavated to a depth of 9 feet in order to remove potentially radiologically contaminated wellfield process wastes. These wastes were removed to a disposal facility in Shirley Basin, WY which is approved by the NRC to receive 11e.(2) byproduct material from the Irigaray Site. Composite soil samples were collected along the walls and bottom of the pit after excavation was completed. These samples were analyzed for Ra-226, U-nat and asbestos. The measured radionuclide concentrations for Ra-226 (1.9 and 4.1 pCi/g for walls and the bottom respectively) as well as U-nat (2.3 and 4.0 pCi/g for walls and bottom respectively) were each below cleanup levels for both surface and subsurface soils, and asbestos was not detected. The pit was backfilled and reclaimed in 2009.

5. Conclusions

Results of a final status gamma radiation survey across decommissioned ISR wellfield Mine Units 1-9 indicate that terrestrial gamma radiation levels are below the action level in the majority of surveyed locations, with the primary exceptions being two small localized areas of apparent soil impacts within Mine Unit 1. In 2014, a comprehensive surface soil sampling survey was conducted across these areas based on biased sampling in areas with higher gamma radiation levels, and randomized sampling in all other areas. Results indicate that only two 100 m^2 survey grid boxes out of 344 sampled boxes (representing 10% of all survey grid boxes) exceeded some cleanup criteria. After remediation of one of the boxes based on the initial Ra-226 result, neither box exceeds individual Ra-226 or U-nat cleanup criteria, but both slightly exceed the sum-of-fractions criterion.

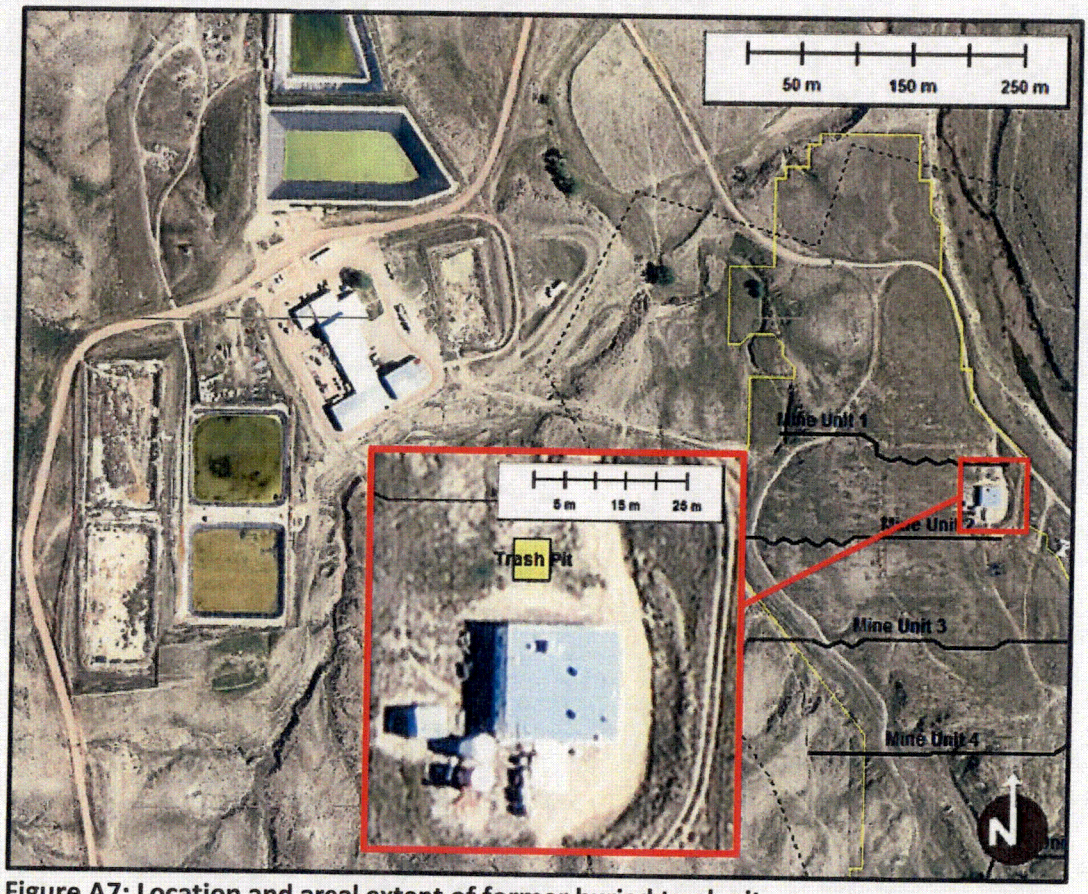

Figure A7: Location and areal extent of former buried trash pit.

A conservative RESRAD-based dose assessment for the two impacted soil sampling grid boxes indicates that potential radiological doses to a receptor in the highly unlikely event that the receptor built a house on one box and had a small garden on the other box would be well below relevant dose-based criteria used by NRC to release land areas for unrestricted future use. A non-parametric sign test on the sampling data indicates a high statistical probability that the median sum-of-fractions value across the entire survey area is in compliance with the corresponding cleanup criterion of unity (a sum-of-fractions value ≤ 1). These results indicate that surface soils across all former wellfield areas and ISR Mine Units would qualify for release from NRC License SUA-1341 for unrestricted future use.

All wellfield infrastructure in Mine Units 1-5 was above ground and after removal/decommissioning and reclamation, final status surveys for terrestrial gamma radiation and surface soils verify that aside from the two small survey grid boxes as noted above, these areas were not radiologically impacted by site operations. Subsurface soil sampling is not warranted in Mine Units 1-5. Subsurface soil samples collected across Mine Units 6-9 after removal of buried wellfield infrastructure indicate that subsurface soils meet criteria for unrestricted future use. Out of 387 subsurface trench sampling locations, only three samples slightly exceeded some cleanup criteria and these locations (as with all trenches) are now buried under 2-3 feet of clean fill and pose no risk to human health or the environment.

A small trash pit was excavated and potentially contaminated materials associated with historical wellfield operations were removed from the Site for proper disposal as 11e.(2) byproduct material at the NRC-approved repository at Shirley Basin, WY. Composite samples collected at the bottom and along the walls of the former trash pit indicate compliance with all applicable cleanup criteria, and the pit has since been backfilled with clean soil and reclaimed.

6. References

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Report B: Final Status Surveys for Buildings

1. Introduction

This report documents the results of a release survey of two utility buildings at the Irigaray Site (part of U1's Willow Creek Project, NRC License SUA-1341). The buildings, both unnamed, are a 60- by 60-ft steel and concrete structure used historically as a wellfield control building for Mine Units 1-5, then a wellfield restoration building, and since completion of wellfield restoration activities, for general storage along with an associated shed. These utility buildings, shown on Figure B1, are located approximately 1,700 feet from the southeast corner of the main plant. The survey was conducted on May 5 and 6, 2015 on behalf of U1 by Environmental Restoration Group, Inc. (ERG) of Albuquerque, NM.

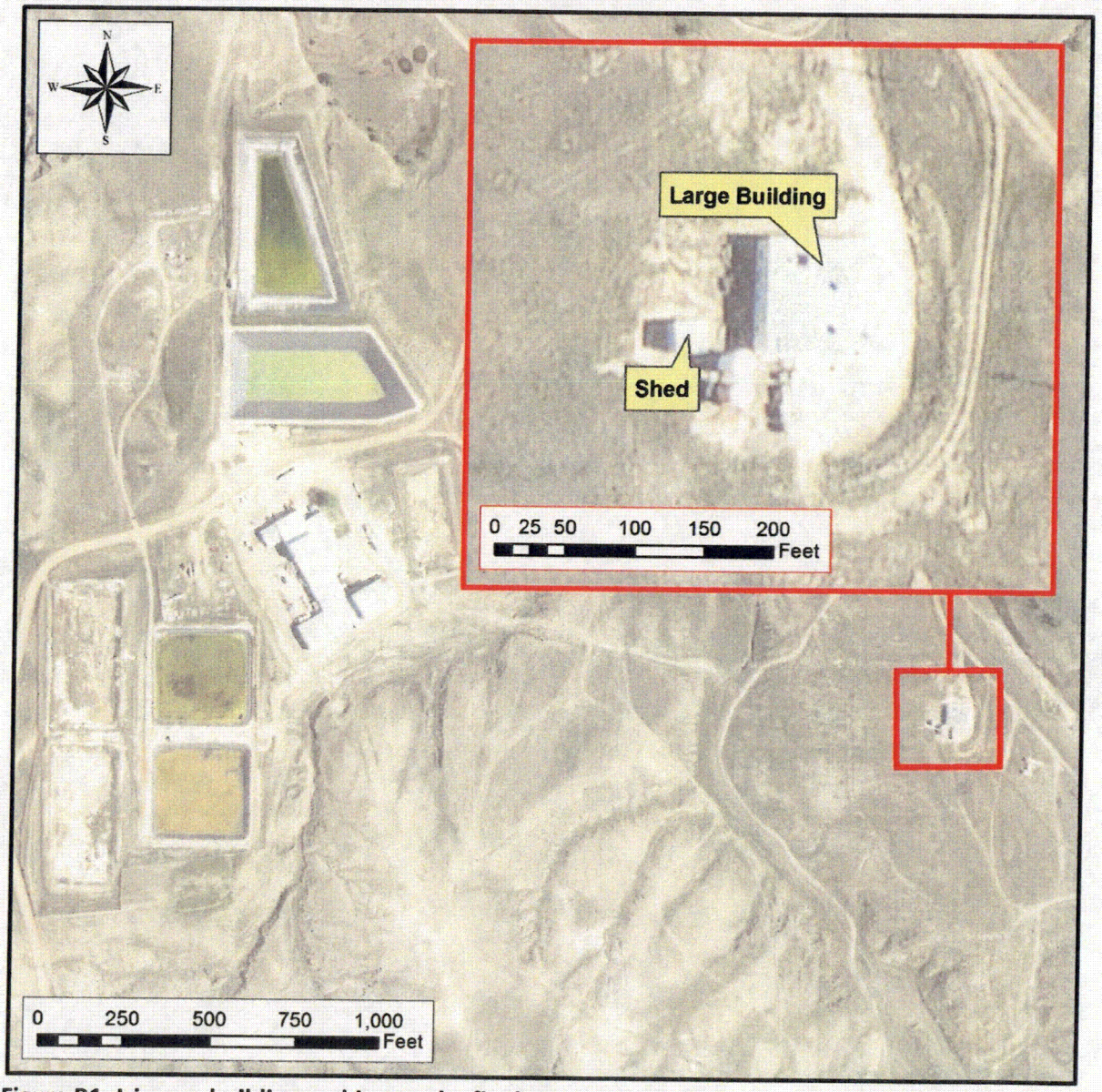


Figure B1: Irigaray buildings subject to the final status survey.

1.1. Description of Buildings

Larger Building

The large building is a steel structure with metal panels and concrete floor. About 20 percent of the floor is covered with linoleum. Miscellaneous items include two wall-mounted fans, one wall-mounted vent, two ceiling mounted heaters, floor drains, a concrete pad, ceiling vents, a PVC roof drain, various ducts hanging from the ceiling, and two floor trenches with associated sumps. The exterior dimensions of the building are 60 by 60 by approximately 15 feet high. The roof is pitched at the center, extending the roof to about 16 foot high. The floors were washed and swept prior to the survey.

Shed

The shed is a steel structure with metal panels and a concrete floor. The exterior dimensions of the shed are 15 by 15 by 10 ft. high. The floors were swept prior to the survey.

1.2. Scope of the Survey

Table 1 in Appendix B1 summarizes the scope of the survey. The table lists the structures, types and numbers of measurements, and their survey units as the latter are defined in the "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM [NRC, 2000]).

1.3. Derived Concentration Guideline Level

Surface activity measurements were compared to a derived concentration guideline level (DCGL), based on a 25 millirem per year dose, of 1,000 decays per minute per 100 square centimeters (dpm/100 cm^2) of alpha activity, in accordance with the Decommissioning Plan (COGEMA, 2001).

2. Survey Methods

The methods in this section are described for radiometric scanning and static measurements. The methods to derive minimum detectable activities (MDAs) for the detection systems are addressed in Section 4.0. Instrument calibration and function check forms are provided in Appendix B2.

Scanning and/or static measurements were conducted in accordance with MARSSIM as specified in the Decommissioning Plan as follows:

- Class 1 areas: 100 percent scan with 16 measurements in each 100 m^2 survey unit
- Class 2 areas: six measurements in each survey unit
- Class 3 areas: biased measurements at 30 locations

Note that static beta measurements were made at a minimum of three locations per survey unit, pursuant to the Decommissioning Plan (COGEMA, 2001).

2.1. Scanning Measurements

Scanning measurements were made --only in the large building-- by hand (walls below 2 m) and with a large area floor scanner with an inherent automated positioning and data collection systems. The instruments were function checked twice daily: once before work started and once at the end of the work day.

2.1.1. Walls

All walls below 2 m in the larger building were subdivided into 1 m^2 grid blocks, each of which was scanned by hand with a Ludlum Model 43-93 coupled to a Ludlum Model 2360 ratemeter/scaler. The ratemeter was set in scaler (integration) mode. Each grid block was scanned over the entire area for one minute, at which point the alpha and beta counts were recorded in a logbook.

Counts obtained by hand scanning were converted to surface activities as follows:

$$SA = C\ x\ 100/\left(W_A\ \varepsilon_s\left(\frac{R_{S+B}\ -\ R_B}{q_{2\pi}}\right)\right)$$

Where:
SA = surface activity (dpm/100 cm^2)
C = counts per counting interval (cpm)
R_{S+B} = gross count rate on the source during the function check (cpm)
R_B = the background count rate during the function check (cpm)
W_A = active area of the detector window in cm^2
$q_{2\pi}$ = surface emission rate of the calibration source in particles per minute
ε_s = source efficiency

The active area of the Ludlum 43-93 detector is 100 cm^2. Source efficiencies of the calibration sources are 0.25 (alpha) and 0.5 (beta), according to guidance in "Multi-Agency Survey and Site Investigation Manual [MARSSIM (NRC, 2000)]. The average of the pre-work and post-work daily function checks was used in the calculation of surface activities.

Ten percent of the measurements were duplicated.

2.1.2. Floors

The floors of the large building were scanned at 5 centimeters per second (cm s^{-1}) using the ERG Model 102F floor scanner. The Model 102F is a laser-based two-dimensional (2-D) mapping system for performing indoor scans for alpha/beta radiation. The Model 102F consists of a manufactured cart containing the equipment and software to acquire position-correlated scanning measurements from floor surfaces and export the data for processing using a variety of applications, such as Microsoft Excel, ESRI ArcGIS, or the ERG Data Manager Software. Figure B2 depicts the floor scanner.

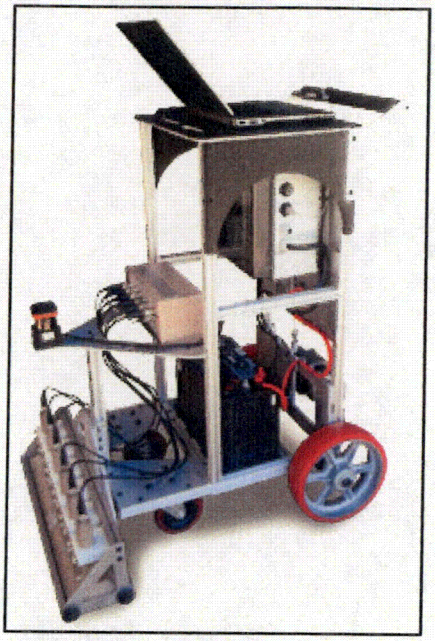


Figure B2: ERG Model 102F Floor Scanner

Counts obtained using the floor scanner were converted to surface activities as follows:

$$SA = \frac{C}{T_s} / (\epsilon_i x\, \epsilon_s)$$

The activity calculation performed is:

SA = surface activity (dpm/100 cm^2)
C = counts per counting interval T_s (cpm)
ε_i = instrument efficiency
ε_s = source efficiency
T_s = counting interval (minutes)

Note that U1 remediated an approximate 23 m^2 area of the floor and re-scanned it with a hand held, Ludlum 43-93 detector coupled to a 2224-1 ratemeter/scaler in June 2015. The area was subdivided into 23, 1 m^2 grid blocks, each of which was scanned for two minutes at 5 cm/s.

Field personnel made five, 1 m^2 scanning measurements by hand on the 4.9 by 10.4 ft. concrete pad in the southwest corner of the large building, using the method described in Section 2.1.1 because bolts extending from the pad precluded use of the 102F.

2.2. Static Measurements

One-minute, static (integrated) alpha/beta measurements were made by hand on the floors and walls of the larger building and shed, and miscellaneous items in the large building. The instruments were function checked twice daily: once before work started and once at the end of the work day.

The measurements were made at fixed locations, using the detection system described in Section 2.1.1. The fixed locations were sited using Visual Sampling Plan, Version 7.3 (Battelle, 2015).

Ten percent of the measurements were duplicated.

2.2.1. Large Building

Interior Walls

Interior walls of the large building were subdivided into two MARSSIM Class 2 survey units as described in the Decommissioning Plan (COGEMA, 2001), each of which included two adjacent walls; i.e., Survey Unit 5 consisted of the north and east walls and Survey Unit 6 consisted of the south and west and walls. Sixteen static measurements were made at fixed points in a random start, triangular grid in each survey unit (8 measurements per wall).

Exterior Wall

A random start, triangular grid of 16 points was placed on the west, exterior wall of the large building, a stand-alone MARSSIM Class 3 survey unit (Survey Unit 7). This wall was included in the survey because of the potential for contamination from three historical tanks and piping standing adjacent to and traversing the wall, respectively. Static measurements were made at each of the 16 locations.

Floors

The floors of the large building were subdivided into four MARSSIM Class 1 survey units, as described in the Decommissioning Plan (COGEMA, 2001): Survey Units 1 through 4.

Sixteen static measurements were made in each survey unit at fixed points in a random start, triangular grid.

Biased Measurements

Biased static measurements were made on miscellaneous items on ceilings and walls above 2 m, established a MARSSIM Class 3 survey unit: floor drains, steel beams, a concrete pad, ceiling vents, a PVC roof drain, and the two floor trenches and their associated sumps.

2.2.2. Shed

The floors and interior walls of the shed comprised one survey unit (Survey Unit 8). Eight static measurements were made on the two random start, triangular grids established on the floor and walls (one grid for the floors, one grid for all four interior walls).

3. Results

The results in this section are described for scanning (large building only) and static (large building and shed) measurements.

3.1. Scanning Measurements

The scanning measurements are reported here for the walls below 2 m and the floor of the large building. Figure B3 depicts the alpha surface activities on these surfaces. Each dot on the floor represents the integrated counts for each of the six detectors in the six zone array. Measurements exceeding 1,000 dpm/100 cm^2 are represented as red dots. Measurements below 1,000 dpm/100 cm^2 are represented as grey dots. As stated in Section 2.1.2, 23 m^2 area of the floor (in Survey Unit 3) was remediated and re-scanned with a hand-held instrument. The dots in this area were replaced with 23, 1 m^2 grid blocks.

3.1.1. Walls

Alpha surface activities on the walls below 2 m are less than 1,000 dpm/100 cm^2 in all grids, with one exception: SU 6-10. The surface activity in this grid is 1,368 dpm/100 cm^2.

Table 2 in Appendix B1 lists the surface activities measured on the walls.

3.1.2. Floors

Alpha surface activities exceed 1,000 dpm/100 cm^2 in the vicinity of the large trench, as shown in Figure B4. Measurements are generally lower on the linoleum than the concrete. Elevated activities are evident in the vicinity of the large trench.

Table 3 in Appendix B1 lists the surface activities in each of the 23 grid blocks (data provided by Uranium One).

The results of the five, 1 m^2 scanning measurements on the 4.9 by 10.4 ft. concrete pad in the southeast corner of the large building are, for the five locations shown on Figure B3 are listed in Table 2 of Appendix B1.

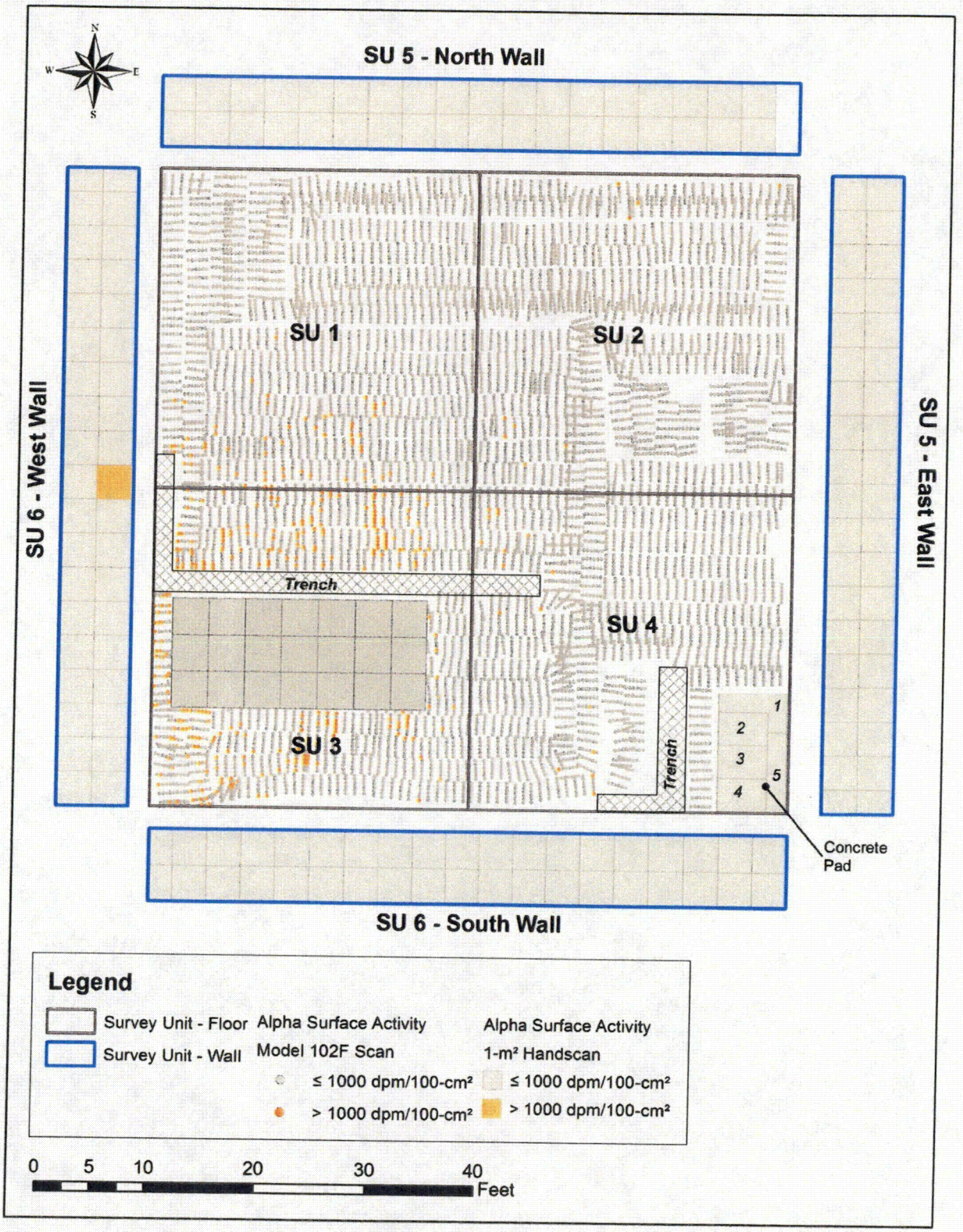


Figure B3. Scanning measurements on the walls and floor of the large building.

3.2. Static Measurements

Static measurements are presented in this section according to building and location.

3.2.1. Large Building

Figure B4 depicts the alpha surface activities on the floors (Survey Units 1 through 4), interior walls (Survey Units 5 and 6), and exterior wall (Survey Unit 7) of the large building.

Duplicate measurements are not presented in the figure. The static measurements on the floors of the large building corroborate those using the large area scanner. The surface activity measurements are generally lower on the linoleum than the concrete, as observed in the scanning measurements.

Elevated activities are evident in the vicinity of the large trench. Note that the measurement at Locations 3-5 through 3-7; and 3-9 through 3-12 shown in Figure B4 were made by U1 after they remediated the 23 m^2 area on the floor.

Biased Measurements

Table 4 in Appendix B1 lists the surface activities at the biased locations on items on walls above 2 m, ceilings, floor trenches, and floor drains.

Alpha surface activities exceeding the DCGL were observed only in the long and short floor trenches and the sump associated with the long trench. The highest observed surface activities in the trenches were 3,358 (long trench) and 1,305 (short trench) dpm/100 cm^2.

At the landowner's request, U1 filled the sump associated with the long trench with concrete upon completion of the survey. In addition, U1 removed the two ceiling-mounted heaters and various ducts from the building after the survey and disposed of them in its 11e.(2) byproduct material disposal facility at Shirley Basin.

Pursuant to the Decommissioning Plan, biased measurements that exceed 25 percent of the limit indicate a need to reclassify at least a portion of the survey unit. Because the area of the trench is small compared to a 100 m^2 survey unit, the area modeled used to establish the DCGL, the trench was not reclassified as a Class 2 area. The average alpha activity of the biased measurement is 412 dpm/100 cm^2 which is below the DCGL.

3.2.2. Shed

The results of the 16 static measurements made in the shed are shown on Figure B5. Alpha surface activities exceeded the DCGL in the shed. Pursuant to the Decommissioning Plan, biased measurements

that exceed 25 percent of the limit indicate a need to reclassify at least a portion of the survey unit. Therefore, the shed should be re-classified to a Class 1 Survey Unit and re-evaluated.

Subsequent to the survey, U1 decided to evaluate the walls separately from the foundation in order to potentially release just the walls. Although such evaluation is a deviation from the Decommissioning Plan, the data indicate that the walls qualify for release based on the sign test results discussed in Section 5.0.

According to U1 (U1, 2015), subsequent to the survey, the structure was removed from the foundation and the concrete floor of the shed was broken up. Further radiological surveys on the concrete rubble has been performed and records are available for review. The remainder of the building is staged on Site, pending approval of its free release. Section 5.0 addresses the evaluation of the final status survey measurements made in the shed.

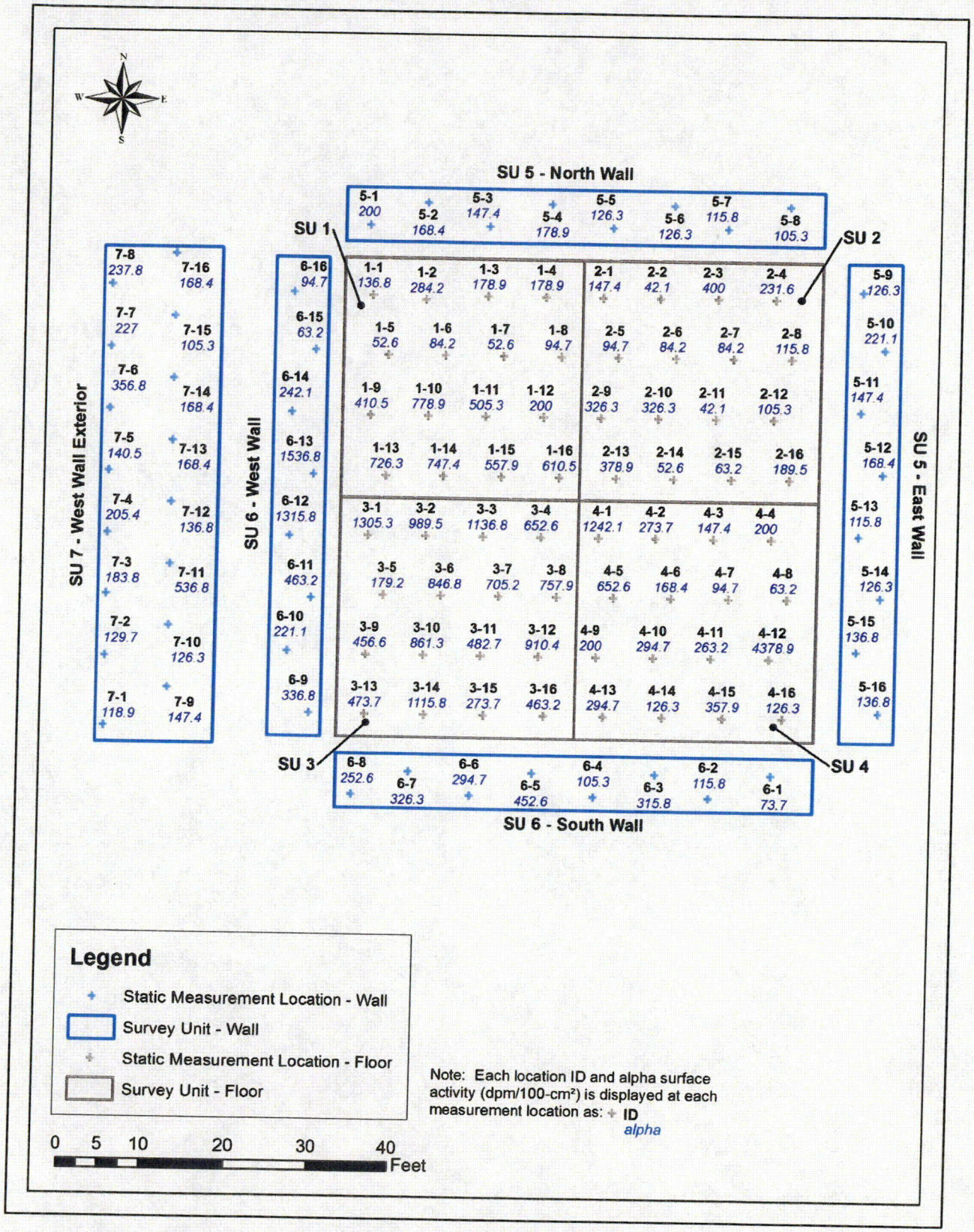


Figure B4: Static measurements on the walls and floor of the large building.

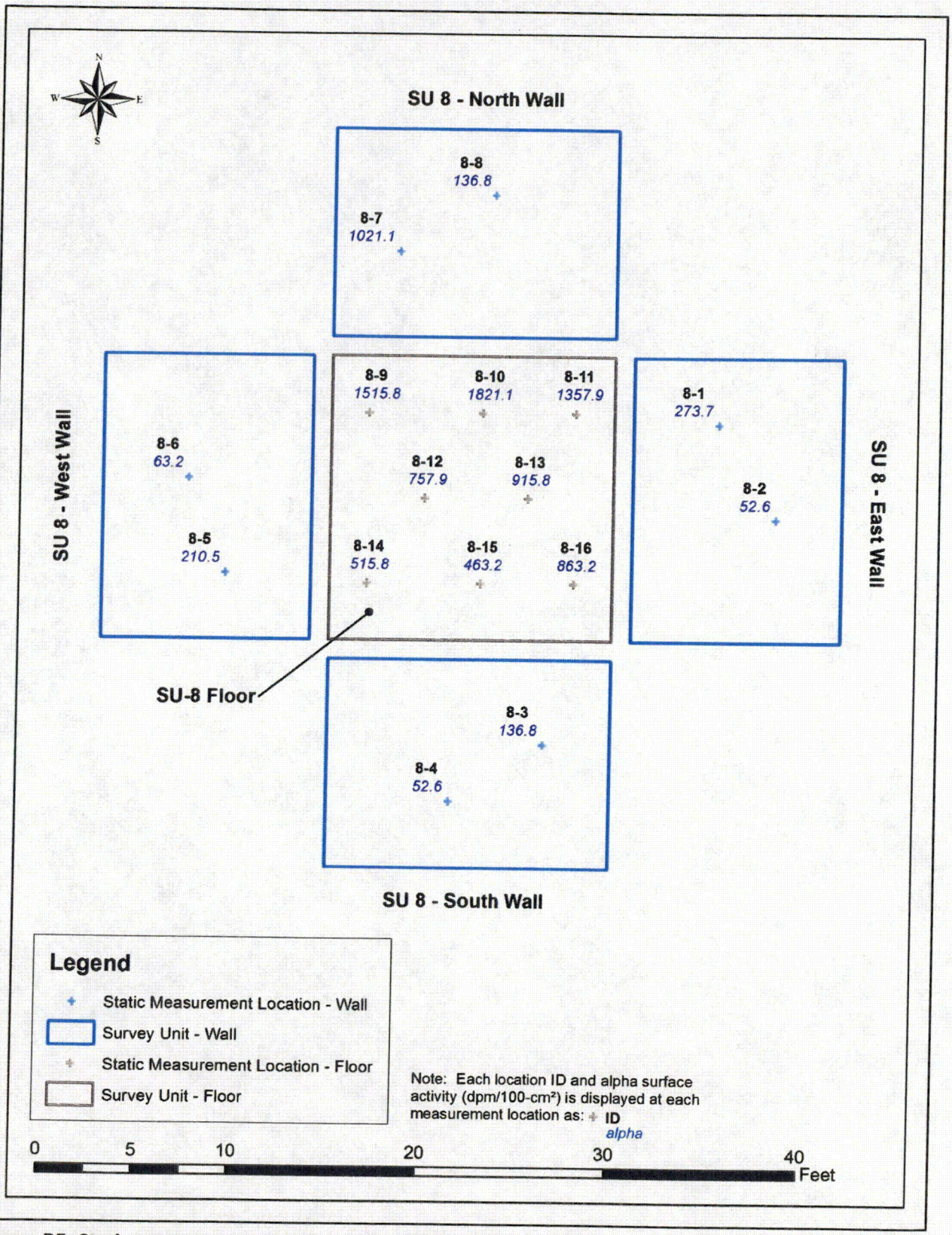


Figure B5: Static measurements on the walls and floor of the shed.

4. Quality Assurance / Quality Control

This section addresses the minimum detectable activities (MDAs) for the instruments and mode (scanning and static measurements).

4.1. Scanning Measurements

The scan MDA for the large area floor scanner was determined as follows:

$$MDA = \frac{2.71 + 3.29\sqrt{R_b(N+1)}}{(N+1) \in tA}$$

Where:

MDA = minimum detectable activity, dpm/100 cm^2
A = detector area factor (unitless) for conversion to 100 cm^2
ε = total detector efficient in counts per disintegration
t = counting time, minutes
R_b = background count rate, cpm
N = number of neighbors averaged

The scan MDA for alpha, using the large area floor scanner, is 157 dpm/100 cm^2 with an observed efficiency of 0.066, background count rate of 7 cpm, scanning speed of 5 cm/s, counting interval of 10 s, six nearest neighbors, and an active detector area of 100 cm^2.

The scan MDA for alpha, using the Ludlum 43-93 at the 90 percent probability of detecting a count can be estimated from the following equation (Ablequist, 2001):

$$\text{Alpha scan } MDA = \frac{-\ln(1 - P(n \geq 1)) \times 60}{\varepsilon_i \times \varepsilon_s \times t}$$

Where:

ε_i = instrument efficiency
ε_s = source efficiency
t = observation interval (from an estimated hot spot width of 50 cm)/(scan speed 5 cm/s)

An estimate of the scan MDA for the Ludlum 43-93 detector is:

$$Alpha\ Scan\ MDA = \frac{-\ln(1-0.9) \times 60}{0.4 \times 0.25 \times 10} = 138 \text{ dpm/100 cm}^2$$

4.2. Static Measurements

The MDA for the static measurements was determined as follows:

$$MDA = \frac{2.71 + 3.29(R_b t_s \sqrt{1 + \frac{t_s}{t_b}})}{\epsilon\, t_s (A/100)}$$

Where:

MDA = minimum detectable activity, dpm/100 cm^2
A = detector area factor (unitless) for conversion to 100 cm^2
ε = total detector efficiency in counts per disintegration
t = counting time, minutes
R_b = background count rate, cpm

The static MDA for alpha, using the Ludlum 43-93 detector, is 156 dpm/100 cm^2, using an observed total detector efficiency of 0.09, background count rate of 6 cpm, counting interval of 1 minute, and an active detector area of 100 cm^2.

5. Discussion

The Sign test was applied to the sets of static measurements in each of the survey units (floors and walls below 2 m and the exterior wall of the large building; and the floors and walls of the shed). The steps in the Sign test, according to MARSSIM (NRC, 2000) are as follows:

1. List the survey unit measurements, X_i, i = 1, 2, 3..., N.

2. Subtract each measurement, X_i, from the DCGL to obtain the differences.

3. Discard each difference that is exactly zero and reduce the sample size, N, by the number of such zero measurements.

4. Count the number of positive differences. The result is the test statistic S+. A positive difference corresponds to a measurement below the DCGL.

5. Large values of S+ indicate that the null hypothesis (that the survey unit exceeds the DCGL) is false. The value of S+ is compared to the critical values in Table I.3 of MARSSIM (NRC, 2000). If S+ is greater than the critical value, k, in that table, the null hypothesis is rejected.

The critical value in Table I.3 in MARSSIM is 11 for N = 16 and a false positive rate of five percent. The null hypothesis, the survey unit exceeds the DCGL can be rejected when 11 of the 16 S+ results are positive.

Table 5 in Appendix B1 lists the alpha surface activities and S+ values for the unbiased static measurements observed in the survey. Duplicate measurements were not considered in this case. Surface activities in the eight survey units are below the DCGL, according to the Sign test as outlined above.

The first eight alpha surface activities and S+ values listed for Survey Unit 8 in Table 5 in Appendix B1 are those made on the walls of the shed. The critical value in Table I.3 in MARSSIM is six for N = 8 and a false positive rate of five percent. The null hypothesis, the survey unit exceeds the DCGL can be rejected when six of the eight S+ results are positive. Seven of the eight S+ results are positive; thus, the wall of the shed is below the DCGL, according to the Sign test.

Separating the wall from the floor of the shed is a deviation to the Decommissioning Plan; i.e., dividing the survey unit and 16 measurements into two. It was done so that U1 could consider releasing the walls: not the floor of the shed.

6. Conclusions

Conclusions and recommendations from the building survey are:

- Surface activities in the eight survey units across the floors and walls of the large building and shed are below the DCGL and meet the criteria for unrestricted release, according to the Sign test as prescribed by MARSSIM.
- Surface activities in the wall of the shed are below the DCGL, when considered separately from the floors.
- Pursuant to the Decommissioning Plan, biased measurements that exceed 25 percent of the limit indicate a need to reclassify at least a portion of the survey unit. Because the area of the trench is small compared to a 100 m^2 survey unit, the area modeled used to establish the DCGL, the trench was not reclassified as a Class 2 area. The average alpha activity of the biased measurements is 412 dpm/100 cm^2 which is below the DCGL and meets the criteria for unrestricted release.

7. References

Abelquist, E.W. 2001. Decommissioning Health Physics: A Handbook for MARSSIM Users. Taylor and Francis Group, LLC. New York.

Battelle Memorial Institute (Battelle). 2015. Visual Sampling Plan, Version 7.3. http://vsp.pnnl.gov/

COGEMA. 2001. Decommissioning Plan for Irigaray and Christensen Ranch Projects, December 19, 2000, June 15, June 18 and August 31, 2001. (ADAMS accession numbers ML0037812380, ML0117006550, ML0117100350, and ML0124901123).

U.S. Nuclear Regulatory Commission (NRC). 2000. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1. NUREG 1575. Washington, D.C.

Appendix A1-1: Surface Soil Sampling Data (provided electronically on CD)

Appendix A1-2: Subsurface Soil Sampling Data (provided electronically on CD)

Appendix A2: RESRAD output (provided electronically on CD)

Appendix B1: Building Survey Tables

Table 1. Summary of the Scope of the Building Survey

Structure	Location	Type of Measurement and Detection System	Survey Units	Number[a]
Large Building	Walls below 2 m	• Hand scanning • Ludlum 43-93/2360 detection system	N/A	1 m^2 grid blocks (approximately 38 per wall)
	Walls below 2 m	• Random systematic static (integrated) • Ludlum 43-93/2360 detection system	2	4 walls (2 survey units) and 16 measurement locations in each survey unit (32 total)
	Floors	• Large area scanning with automated data collection and positioning. • ERG 102F floor scanner	4	100 percent of floor surface
	Floors	• Random systematic static (integrated) • Ludlum 43-93/2360 detection system	4	16 in each survey unit (64 total)
	Walls above 2 m, ceiling, and features on floor	• Biased static (integrated) • Ludlum 43-93/2360 detection system	1	One per location (47 total)
Shed	Walls and Floors	• Random systematic static (integrated) • Ludlum 43-93/2360 detection system	1	16 (8 each on the walls and floor)

Notes:
[a]Ten percent duplicate measurements
m = meters

Table 2. Surface activities for scanning measurements on walls of large building and concrete pad on floor.

Grid ID[a]	4π Efficiency		Counts Per Minute		dpm/100 cm^2	
	Alpha	Beta[b]	Alpha	Beta	Alpha	Beta
5-1	0.095	0.095	7	218	74	2295
5-2	0.095	0.095	8	169	84	1779
5-3	0.095	0.095	4	186	42	1958
5-4	0.095	0.095	6	159	63	1674
5-5	0.095	0.095	4	159	42	1674
5-6	0.095	0.095	6	163	63	1716
5-7	0.095	0.095	1	169	11	1779
5-8	0.095	0.095	2	182	21	1916
5-9	0.095	0.095	4	152	42	1600
5-10	0.095	0.095	6	139	63	1463
5-10 Dup	0.095	0.095	5	151	53	1589
5-11	0.095	0.095	3	189	32	1989
5-12	0.095	0.095	6	188	63	1979
5-13	0.095	0.095	4	163	42	1716
5-14	0.095	0.095	4	182	42	1916
5-15	0.095	0.095	6	190	63	2000
5-16	0.095	0.095	2	143	21	1505
5-17	0.095	0.095	6	191	63	2011
5-18	0.095	0.095	7	175	74	1842
5-18 Dup	0.095	0.095	5	171	53	1800
5-19	0.095	0.095	5	189	53	1989
5-1	0.095	0.105	2	186	21	1771
5-2	0.095	0.105	6	208	63	1981
5-3	0.095	0.105	5	181	53	1724
5-4	0.095	0.105	3	174	32	1657
5-5	0.095	0.105	3	188	32	1790
5-6	0.095	0.105	5	182	53	1733
5-7	0.095	0.105	9	181	95	1724
5-7 Dup	0.095	0.105	4	194	42	1848
5-8	0.095	0.105	7	203	74	1933
5-9	0.095	0.105	7	193	74	1838
5-10	0.095	0.105	3	200	32	1905
5-11	0.095	0.105	5	193	53	1838
5-12	0.095	0.105	3	178	32	1695
5-12 Dup	0.095	0.105	6	202	63	1924

Table 2. Surface activities for scanning measurements on walls of large building and concrete pad on floor (continued).

Grid ID[a]	4π Efficiency		Counts Per Minute		dpm/100 cm^2	
	Alpha	Beta	Alpha	Beta	Alpha	Beta
5-13	0.095	0.105	7	189	74	1800
5-14	0.095	0.105	6	187	63	1781
5-15	0.095	0.105	0	193	0	1838
5-16	0.095	0.105	5	207	53	1971
5-17	0.095	0.105	2	201	21	1914
5-18	0.095	0.105	5	199	53	1895
5-19	0.095	0.105	4	206	42	1962
5-1	0.095	0.105	0	192	0	1829
5-2	0.095	0.105	0	179	0	1705
5-3	0.095	0.105	2	187	21	1781
5-4	0.095	0.105	3	206	32	1962
5-5	0.095	0.105	2	183	21	1743
5-6	0.095	0.105	2	168	21	1600
5-7	0.095	0.105	1	167	11	1590
5-8	0.095	0.105	3	202	32	1924
5-9	0.095	0.105	1	199	11	1895
5-10	0.095	0.105	1	222	11	2114
5-11	0.095	0.105	3	222	32	2114
5-12	0.095	0.105	2	288	21	2743
5-12 Dup	0.095	0.105	3	276	32	2629
5-13	0.095	0.105	1	166	11	1581
5-14	0.095	0.105	4	199	42	1895
5-15	0.095	0.105	1	230	11	2190
5-16	0.095	0.105	1	235	11	2238
5-17	0.095	0.105	3	229	32	2181
5-18	0.095	0.105	6	241	63	2295
5-18 Dup	0.095	0.105	5	218	53	2076
5-1	0.095	0.105	2	183	21	1743
5-2	0.095	0.105	2	204	21	1943
5-3	0.095	0.105	1	213	11	2029
5-4	0.095	0.105	8	180	84	1714
5-5	0.095	0.105	3	184	32	1752
5-6	0.095	0.105	3	179	32	1705
5-7	0.095	0.105	3	187	32	1781
5-8	0.095	0.105	2	193	21	1838

Table 2. Surface activities for scanning measurements on walls of large building and concrete pad on floor (continued).

Grid ID[a]	4π Efficiency		Counts Per Minute		dpm/100 cm^2	
	Alpha	Beta	Alpha	Beta	Alpha	Beta
5-9	0.095	0.105	1	196	11	1867
5-10	0.095	0.105	2	232	21	2210
5-10 dup	0.095	0.105	4	219	42	2086
5-11	0.095	0.105	0	223	0	2124
5-12	0.095	0.105	4	202	42	1924
5-13	0.095	0.105	3	205	32	1952
5-14	0.095	0.105	3	190	32	1810
5-15	0.095	0.105	3	200	32	1905
5-16	0.095	0.105	2	214	21	2038
5-17	0.095	0.105	4	195	42	1857
5-17 Dup	0.095	0.105	6	199	63	1895
5-18	0.095	0.105	4	198	42	1886
6-1	0.095	0.095	12	440	126	4632
6-2	0.095	0.095	2	349	21	3674
6-3	0.095	0.095	16	368	168	3874
6-4	0.095	0.095	14	321	147	3379
6-5	0.095	0.095	13	342	137	3600
6-5 Dup	0.095	0.095	17	338	179	3558
6-6	0.095	0.095	13	304	137	3200
6-7	0.095	0.095	23	301	242	3168
6-8	0.095	0.095	26	297	274	3126
6-9	0.095	0.095	12	281	126	2958
6-10	0.095	0.095	8	233	84	2453
6-11	0.095	0.095	8	241	84	2537
6-12	0.095	0.095	15	245	158	2579
6-13	0.095	0.095	12	232	126	2442
6-14	0.095	0.095	11	224	116	2358
6-15	0.095	0.095	7	233	74	2453
6-16	0.095	0.095	4	224	42	2358
6-17	0.095	0.095	2	186	21	1958
6-18	0.095	0.095	8	170	84	1789
6-19	0.095	0.095	3	173	32	1821
6-1	0.095	0.105	8	359	84	3419
6-2	0.095	0.105	6	373	63	3552
6-3	0.095	0.105	7	369	74	3514

Table 2. Surface activities for scanning measurements on walls of large building and concrete pad on floor (continued).

Grid ID[a]	4π Efficiency		Counts Per Minute		dpm/100 cm^2	
	Alpha	Beta	Alpha	Beta	Alpha	Beta
6-4	0.095	0.105	10	287	105	2733
6-5	0.095	0.105	11	298	116	2838
6-6	0.095	0.105	21	281	221	2676
6-7	0.095	0.105	17	276	179	2629
6-8	0.095	0.105	13	272	137	2590
6-8 Dup	0.095	0.105	14	282	147	2686
6-9	0.095	0.105	3	289	32	2752
6-10	0.095	0.105	8	255	84	2429
6-11	0.095	0.105	1	234	11	2229
6-12	0.095	0.105	6	237	63	2257
6-13	0.095	0.105	8	206	84	1962
6-14	0.095	0.105	6	242	63	2305
6-15	0.095	0.105	8	186	84	1771
6-16	0.095	0.105	3	207	32	1971
6-17	0.095	0.105	4	192	42	1829
6-17 Dup	0.095	0.105	2	197	21	1876
6-18	0.095	0.105	2	193	21	1838
6-19	0.095	0.105	5	186	53	1771
6-1	0.095	0.095	2	205	21	2158
6-1 Dup	0.095	0.095	3	218	32	2295
6-2	0.095	0.095	5	255	53	2684
6-3	0.095	0.095	6	208	63	2189
6-4	0.095	0.095	5	223	53	2347
6-5	0.095	0.095	3	277	32	2916
6-6	0.095	0.095	5	245	53	2579
6-7	0.095	0.095	5	302	53	3179
6-8	0.095	0.095	40	502	421	5284
6-9	0.095	0.095	72	620	758	6526
6-10	0.095	0.095	130	811	1368	8537
6-11	0.095	0.095	58	584	611	6147
6-11 Dup	0.095	0.095	65	606	684	6379
6-12	0.095	0.095	42	687	442	7232
6-13	0.095	0.095	8	652	84	6863
6-14	0.095	0.095	12	470	126	4947
6-15	0.095	0.095	8	425	84	4474

Table 2. Surface activities for scanning measurements on walls of large building (concluded).

Grid ID[a]	4π Efficiency		Counts Per Minute		dpm/100 cm^2	
	Alpha	Beta	Alpha	Beta	Alpha	Beta
6-16	0.095	0.095	10	463	105	4874
6-17	0.095	0.095	14	393	147	4137
6-18	0.095	0.095	15	475	158	5000
6-19	0.095	0.095	12	458	126	4821
6-1	0.095	0.095	5	223	53	2347
6-2	0.095	0.095	5	196	53	2063
6-3	0.095	0.095	8	214	84	2253
6-4	0.095	0.095	5	207	53	2179
6-5	0.095	0.095	5	259	53	2726
6-6	0.095	0.095	4	226	42	2379
6-7	0.095	0.095	9	288	95	3032
6-8	0.095	0.095	6	276	63	2905
6-8 Dup	0.095	0.095	8	275	84	2895
6-9	0.095	0.095	13	282	137	2968
6-10	0.095	0.095	50	443	526	4663
6-11	0.095	0.095	90	688	947	7242
6-12	0.095	0.095	65	463	684	4874
6-13	0.095	0.095	25	410	263	4316
6-14	0.095	0.095	17	355	179	3737
6-15	0.095	0.095	14	347	147	3653
6-15 Dup	0.095	0.095	16	364	168	3832
6-16	0.095	0.095	9	321	95	3379
6-17	0.095	0.095	11	319	116	3358
6-18	0.095	0.095	4	319	42	3358
6-19	0.095	0.095	19	340	200	3579
Concrete Pad 1	0.095	0.105	7	310	74	2953
Concrete Pad 2	0.095	0.105	13	320	137	3048
Concrete Pad 3	0.095	0.105	13	283	137	2695
Concrete Pad 4	0.095	0.105	3	260	32	2476
Concrete Pad 5	0.095	0.105	8	277	84	2638

Notes:

[a] Nomenclature of Grid ID is; e.g., 5-1 is Survey Unit 5 Grid 1.

[b] Results with beta efficiencies of 0.105 were made using Ludlum 43-93/2360 S/N 220263/PR298374. Results with beta efficiencies of 0.095 were made using Ludlum 43-93/2360 S/N 276943/PR29426.

dpm/100 cm^2 = disintegrations per minute per 100 square centimeters

Table 3. Surface activity measurements in the 23 remediated grid blocks (data provided by Uranium One).

	Scanning Measurement		Static Measurement	
Grid Block	cp2m[a]	dpm/m^2	cp2m[a]	dpm/100 cm^2 [b]
1	50	144.5	40	115
2	28	80.9	62	179.2
3	59	170.5	61	176.3
4	115	332.4	293	846.8
5	152	439.3	214	618.5
6	146	479.8	244	705.2
7	101	291.9	67	193.6
8	198	572.3	246	711.0
9	104	300.6	101	291.9
10	76	219.7	148	427.7
11	92	265.9	100	289.0
12	178	514.5	235	679.2
13	169	488.4	431	1245.7
14	135	390.2	211	609.8
15	182	526.0	158	456.6
16	140	404.6	310	895.9
17	180	520.2	298	861.3
18	41	118.5	30	86.8
19	218	630.1	167	482.7
20	241	696.5	230	664.8
21	154	445.1	315	910.4

Notes:

[a] Measurement made using Ludlum 43-93/2224-1.

[b] Maximum measurement or measurement at assigned location.

cp2m = counts per two minutes

dpm/100 cm^2 = disintegrations per minute per 100 square centimeters

dpm/m^2 = disintegrations per minute per 100 square meter

Table 4. Surface activities at biased measurement locations.

Measurement Location	Number	Alpha Surface Activity dpm/100 cm^2
Exterior of heater in southwest corner	1	42
Exterior of heater in southwest corner	1 Dup	32
Interior of heater in southwest corner	2	137
West Wall SW corner fiberglass cover	3	189
Face of steel beam above location 3	4	105
Vertical beam near its apex adjacent to small entry door on S wall	5	95
Primary steel beam above location 5	6	84
Barrel of rolling door	7	84
Bottom of ceiling air vent closest to rolling door	8	116
Louver inside of item in location 8	9	126
Primary beam adj to item in location 8	10	84
Primary beam adj to item in location 8	10 Dup	84
Exterior of hanging 3-ft rectangular duct SE corner	11	179
interior of hanging 3-ft rectangular duct SE corner	12	179
Edge N-S crossbeam, E wall	13	95
E-W steel beam, 5th from S wall	14	63
Exterior of hanging 7-ft vertical vent near E wall	15	105
interior of hanging 7-ft vertical vent near E wall	16	116
Ceiling to floor PVC pipe (measured at 4 ft from ceiling)	17	95
Louver of ceiling air vent center of building	18	147
Primary steel beam adjacent to item in location 18	19	84
Interior of paired ceiling vents in center N of bldg: S vent	20	53
Interior of paired ceiling vents in center N of bldg: N vent	21	137
Exterior of hanging 6-ft rectangular duct NW corner	22	84
Exterior of hanging 6-ft rectangular duct NW corner	22 Dup	74
Interior of hanging 6-ft rectangular duct NW corner	23	168
Exterior of heater in NW corner	24	147
Interior of heater in NW corner	25	253
Plastic cover on fiberglass, wall 3 ft S of sump, 2 ft below lower steel beam	26	158
Steel beam 2 ft above item in Location 26	27	53
Exposed interior of exterior panel above S edge of sump	28	53
Plastic cover on fiberglass, adj to location 28	29	242
Exposed interior of exterior panel above 3rd hole to tanks from S side of bldg	30	95
Plastic cover on fiberglass adj to location 30	31	200
Long Trench 1 E end	32	1053
Long Trench 2 midpoint	33	1411
Long Trench 3 at L	34	3253
Long Trench 4 sidewall at L	35	3358

Table 4. Surface activities at biased measurement locations (concluded).

Measurement Location	Number	Alpha Surface Activity dpm/100 cm^2
Long Trench 5 before sump	36	1495
Long Trench 6 sump sidewall	37	1274
Short Trench 1 N end	38	716
Short Trench 1 N end	38 Dup	1011
Short Trench 2 midpoint	39	1305
Short Trench 3 sump sidewall	40	274
Floor Drain 1 adjacent to concrete platform, metal cover intact	41	274
Floor Drain 1 adjecent to concrete platform, metal cover intact	41 Dup	305
Floor Drain 2 metal cover intact	42	211
Floor Drain 3 no cover	43	32
Floor Drain 4 epoxy ring, no cover	44	326
Floor Drain 5 PVC flange, no cover	45	221
Floor Drain 6 metal cover intact	46	189
Floor Drain 7 no cover	47	221

Notes:
Static measurements made on May 5, 2015 using a Ludlum 43-93/2360, S/N 220263/PR298374

Table 5. Sign Test of Survey Unit Measurements

Survey Unit	Measurement Location	Alpha Surface Activity (dpm/100 cm^2)	S+	Number of Positive S+
1	1	137	863	16
	2	284	716	
	3	179	821	
	4	179	821	
	5	53	947	
	6	84	916	
	7	53	947	
	8	95	905	
	9	411	589	
	10	779	221	
	11	505	495	
	12	200	800	
	13	726	274	
	14	747	253	
	15	558	442	
	16	611	389	
2	1	147	853	16
	2	42	958	
	3	400	600	
	4	232	768	
	5	95	905	
	6	84	916	
	7	84	916	
	8	116	884	
	9	326	674	
	10	326	674	
	11	42	958	
	12	105	895	
	13	379	621	
	14	53	947	
	15	63	937	
	16	189	811	

Table 5. Sign Test of Survey Unit Measurements (continued)

Survey Unit	Measurement Location	Alpha Surface Activity (dpm/100 cm^2)	S+	Number of Positive S+
3	1	1305	-305	13
	2	990	11	
	3	1137	-137	
	4	653	347	
	5	179	821	
	6	847	153	
	7	705	295	
	8	758	242	
	9	457	543	
	10	861	139	
	11	483	517	
	12	910	90	
	13	474	526	
	14	1116	-116	
	15	274	726	
	16	463	537	
4	1	1242	-242	14
	2	274	726	
	3	147	853	
	4	200	800	
	5	653	347	
	6	168	832	
	7	95	905	
	8	63	937	
	9	200	800	
	10	295	705	
	11	263	737	
	12	4379	-3379	
	13	295	705	
	14	126	874	
	15	358	642	
	16	126	874	

Table 5. Sign Test of Survey Unit Measurements (continued)

Survey Unit	Measurement Location	Alpha Surface Activity (dpm/100 cm^2)	S+	Number of Positive S+
5	1	200	800	16
	2	168	832	
	3	147	853	
	4	179	821	
	5	126	874	
	6	126	874	
	7	116	884	
	8	105	895	
	9	126	874	
	10	221	779	
	11	147	853	
	12	168	832	
	13	116	884	
	14	126	874	
	15	137	863	
	16	137	863	
6	1	74	926	14
	2	116	884	
	3	316	684	
	4	105	895	
	5	453	547	
	6	295	705	
	7	326	674	
	8	253	747	
	9	337	663	
	10	221	779	
	11	463	537	
	12	1316	-316	
	13	1537	-537	
	14	242	758	
	15	63	937	
	16	95	905	

Table 5. Sign Test of Survey Unit Measurements (concluded)

Survey Unit	Measurement Location	Alpha Surface Activity (dpm/100 cm^2)	S+	Number of Positive S+
7	1	119	881	16
	2	130	870	
	3	184	816	
	4	205	795	
	5	141	859	
	6	357	643	
	7	227	773	
	8	238	762	
	9	147	853	
	10	126	874	
	11	537	463	
	12	137	863	
	13	168	832	
	14	168	832	
	15	105	895	
	16	168	832	
8	1	274	726	12
	2	53	947	
	3	137	863	
	4	53	947	
	5	211	789	
	6	63	937	
	7	1021	-21	
	8	137	863	
	9	1516	-516	
	10	1821	-821	
	11	1358	-358	
	12	758	242	
	13	916	84	
	14	516	484	
	15	463	537	
	16	863	137	

Notes:
dpm/100 cm^2 = disintegrations per 100 square centimeters

Appendix B2: Instrument calibration and function check forms

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter:	Manufacturer:	Ludlum	Model Number:	2360	Serial Number:	276943
Detector:	Manufacturer:	Ludlum	Model Number:	43-93	Serial Number:	PR298426

☑ Mechanical Check ☑ THR/WIN Operation HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V
☐ F/S Response Check ☑ Reset Check Cable Length: ☑ 39-inch ☐ 72-inch ☐ Other:
☑ Geotropism ☑ Audio Check
☑ Meter Zeroed ☑ Battery Check (Min 4.4 VDC)
Source Distance: ☑ Contact ☐ 6 inches ☐ Other:
Source Geometry ☐ Side ☑ Below ☐ Other:

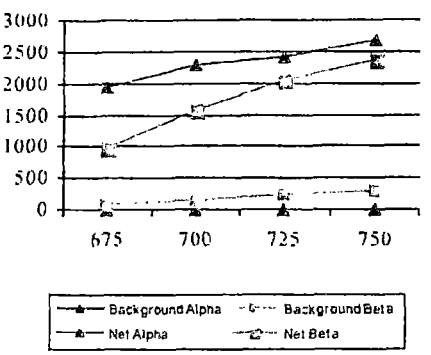
Alpha Threshold:	120 mV	Barometric Pressure:	24.66	inches Hg
Beta Threshold:	4	Temperature:	74	°F
Beta Window:	30 mV	Relative Humidity	20	%

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count α	Integrated 1-Min. Count β
x 1000	400 Kcpm	400	400	398264	398727
x 1000	100 Kcpm	100	100		
x 100	40 Kcpm	400	400	39812	39814
x 100	10 Kcpm	100	100		
x 10	4 Kcpm	400	400	3981	3982
x 10	1 Kcpm	100	100		
x 1	400 cpm	400	400	398	398
x 1	100 cpm	100	100		

High Voltage	Alpha Source α	Alpha Source β	Beta Source α	Beta Source β	Background α	Background β
675	1927	295	5	1072	1	79
700	2281	327	5	1719	3	149
725	2401	372	6	2290	0	231
750	2663	466	6	2695	2	307

Voltage Plateau



Comments: HV Plateau Scaler Count Time = 1 min. Recommended HV = 725

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932 Fluke multimeter serial number ☑ 8749012

☑ Alpha Source: Th-230 (s/n 4098-03) 12.800 dpm on 1/4/12 Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
☑ Beta Source: Tc-99 (sn: 4099-03) 17.700 dpm on 1/4/12 ☐ Other Source:

Calibrated By: Calibration Date: 2-23-15 Calibration Due 2-23-16

Reviewed By: Date: 2/23/15

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter:	Manufacturer:	Ludlum	Model Number:	2360	Serial Number:	184951
Detector:	Manufacturer:	Ludlum	Model Number:	43-93	Serial Number:	PR299685

- [x] Mechanical Check
- [ ] F/S Response Check
- [x] Geotropism
- [x] Meter Zeroed
- [x] THR/WIN Operation
- [x] Reset Check
- [x] Audio Check
- [x] Battery Check (Min 4.4 VDC)

HV Check (+/- 2.5%): [x] 500 V [x] 1000 V [x] 1500 V

Cable Length: [x] 39-inch [ ] 72-inch [ ] Other:

Source Distance: [x] Contact [ ] 6 inches [ ] Other:

Source Geometry [ ] Side [x] Below [ ] Other:

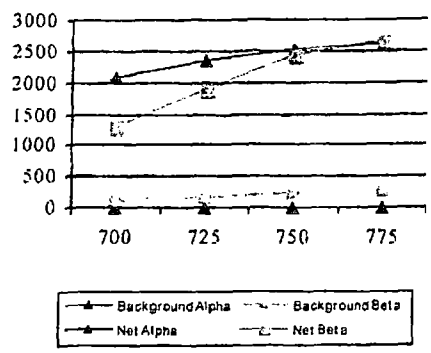
Alpha Threshold:	120 mV	Barometric Pressure:	24.75	inches Hg
Beta Threshold:	4	Temperature:	71	°F
Beta Window:	30 mV	Relative Humidity	20	%

Instrument found within tolerance: [x] Yes [ ] No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count α	Integrated 1-Min. Count β
x 1000	400 Kcpm	400	400	399395	399425
x 1000	100 Kcpm	100	100		
x 100	40 Kcpm	400	400	39958	39972
x 100	10 Kcpm	100	100		
x 10	4 Kcpm	400	400	3997	3999
x 10	1 Kcpm	100	100		
x 1	400 cpm	400	400	400	400
x 1	100 cpm	100	100		

High Voltage	Alpha Source α	Alpha Source β	Beta Source α	Beta Source β	Background α	Background β
700	2080	332	4	1425	1	104
725	2361	408	0	2056	1	164
750	2539	487	2	2672	1	226
775	2611	569	5	2959	1	282

Voltage Plateau



Comments: HV Plateau Scaler Count Time = 1 min. Recommended HV = 750

Reference Instruments and/or Sources:

Ludlum pulser serial number: [ ] 97743 [x] 201932

Fluke multimeter serial number [x] 8749012

[x] Alpha Source: Th-230 (s/n 4098-03) 12,800 dpm on 1/4/12

[x] Beta Source: TA/C (sn: 4099-03) 17,700 dpm on 1/4/12

[ ] Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03

[ ] Other Source:

Calibrated By:

Calibration Date: 4-28-15 Calibration Due 4-28-16

Reviewed By:

Date: 4/28/15

This calibration conforms to the requirements and acceptable calibration [illegible] 3538.3253A-199

Certificate of Calibration

Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE. Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter:	Manufacturer:	Ludlum	Model Number:	2360	Serial Number:	220263	
Detector:	Manufacturer:	Ludlum	Model Number:	43-93	Serial Number:	PR298374	

☑ Mechanical Check ☑ TIR/WIN Operation HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V
☐ F/S Response Check ☑ Reset Check Cable Length: ✔ 39-inch ☐ 72-inch Other:
☑ Geotropism ☑ Audio Check
☑ Meter Zeroed ☑ Battery Check (Min 4.4 VDC)
Source Distance: ☑ Contact ☐ 6 inches ☐ Other:
Source Geometry ☐ Side ☑ Below ☐ Other:

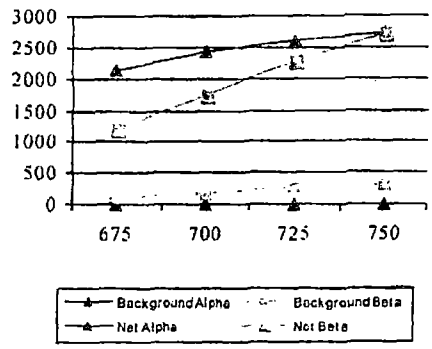
Alpha Threshold:	120 mV	Barometric Pressure:	24.48	inches Hg
Beta Threshold:	4	Temperature:	75	°F
Beta Window:	30 mV	Relative Humidity	20	%

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count α	Integrated 1-Min. Count β
x 1000	400 Kcpm	400	400	399417	399549
x 1000	100 Kcpm	100	100		
x 100	40 Kcpm	400	400	39979	39984
x 100	10 Kcpm	100	100		
x 10	4 Kcpm	400	400	4001	4004
x 10	1 Kcpm	100	100		
x 1	400 cpm	400	400	401	401
x 1	100 cpm	100	100		

High Voltage	Alpha Source α	Alpha Source β	Beta Source α	Beta Source β	Background α	Background β
675	2146	290	9	1321	0	116
700	2425	340	8	1933	2	190
725	2615	431	7	2534	2	258
750	2729	586	9	3027	6	305

Voltage Plateau



Comments: HV Plateau Scaler Count Time = 1 min. Recommended HV = 725

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932 Fluke multimeter serial number ☑ 8749012

☑ Alpha Source: Th-230 (s/n 4098-03) 12,800 dpm on 1/4/12 ☐ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03

☑ Beta Source: Tc-99 (sn: 4099-03) 17,700 dpm on 1/4/12 ☐ Other Source:

Calibrated By: Calibration Date: 4-27-15 Calibration Due 4-27-16

Reviewed By: Date: 4/27/15

This calibration certificate [illegible]

ERG

8809 Washington St NE STE 150
Albuquerque, NM. 87113
(505)-298-4224

Ludlum Model 4612/43-134-4 Calibration

Zone: 1

Model 4612 Serial Number: 291500
Model 43-134-4 Serial Number: PR327888

Calibration Due Date: 4/23/2016
Calibration Due Date: 4/23/2016

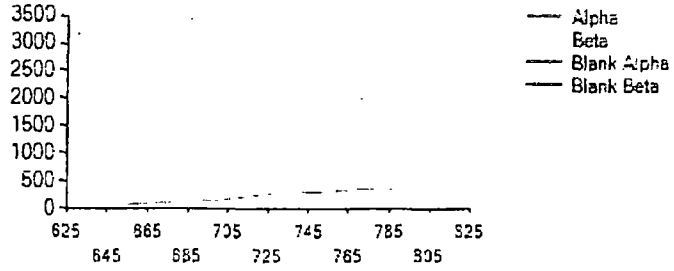
Alpha Source: Th-230 (4098-03)
Beta Source: Tc-99 (4099-03)

Emission Rate: 6520 epm
Emission Rate: 11100 epm

Counting Time: 60 seconds

Alpha LLD: 119.1 mV
Alpha ULD: 330 mV

Beta LLD: 3.2 mV
Beta ULD: 32.2 mV



	Alpha Source		Beta Source		Background		Crosstalk (%)		2π Efficiency	
HV	α	β	α	β	α	β	α	β	α	β
650	1028	416	2	1214	1	79	28.8	0.2	0.16	0.1
675	1435	369	7	1805	4	130	20.5	0.4	0.22	0.15
700	1739	427	12	2231	2	166	19.7	0.5	0.27	0.19
725	1786	448	6	2483	1	272	20.1	0.2	0.27	0.2
750	1962	634	5	2976	5	308	24.4	0.2	0.3	0.24
775	2024	1524	10	3179	6	372	43	0.3	0.31	0.25
800	2175	5776	7	3414	0	364	72.6	0.2	0.33	0.27

Recommended High Voltage: 725 volts

Calibrated By: _____ Date: 04/23/2015

Reviewed By: _____ Date: 4/27/15

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997.
NMRCB Registration No. 0213 * Calibration of Radiation Detection Instrument Devices

ERG

8809 Washington St NE STE 150
Albuquerque, NM. 87113
(505)-298-4224

Ludlum Model 4612/43-134-4 Calibration

Zone: 2

Model 4612 Serial Number: 291500
Calibration Due Date: 4/23/2016

Model 43-134-4 Serial Number: PR327888
Calibration Due Date: 4/23/2016

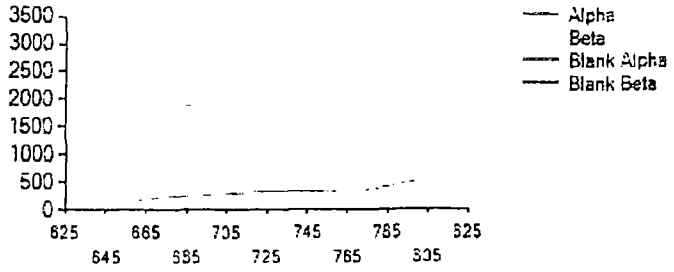
Alpha Source: Th-230 (4098-03)
Emission Rate: 6520 epm

Beta Source: Tc-99 (4099-03)
Emission Rate: 11100 epm

Counting Time: 60 seconds

Alpha LLD: 118.9 mV
Alpha ULD: 330 mV

Beta LLD: 3.1 mV
Beta ULD: 32.8 mV



	Alpha Source		Beta Source		Background		Crosstalk (%)		2π Efficiency	
HV	α	β	α	β	α	β	α	β	α	β
650	1630	354	8	1713	3	145	17.8	0.5	0.25	0.14
675	1882	412	6	2171	3	235	18	0.3	0.29	0.17
700	1918	482	6	2562	2	288	20.1	0.2	0.29	0.2
725	2120	713	5	2790	1	339	25.2	0.2	0.32	0.22
750	2059	2176	7	3245	2	337	51.4	0.2	0.32	0.26
775	2150	9387	10	3266	2	362	81.4	0.3	0.33	0.26
800	2236	26886	10	3241	5	534	92.3	0.3	0.34	0.24

Recommended High Voltage: 700 volts

Calibrated By: _____ Date: 04/23/2015

Reviewed By: _____ Date: 4/27/15

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997.
NVLAP Registration No. 92[illegible] * Calibration of Radiation Detection Instrument Devices

ERG

8809 Washington St NE STE 150
Albuquerque, NM. 87113
(505)-298-4224

Ludlum Model 4612/43-134-4 Calibration

Zone: 3

Model 4612 Serial Number: 291500
Calibration Due Date: 4/23/2016

Model 43-134-4 Serial Number: PR327888
Calibration Due Date: 4/23/2016

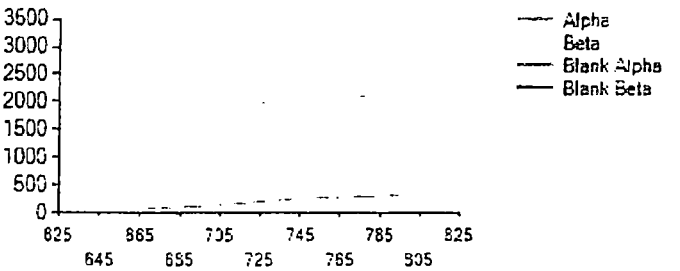
Alpha Source: Th-230 (4098-03)
Emission Rate: 6520 epm

Beta Source: Tc-99 (4099-03)
Emission Rate: 11100 epm

Counting Time: 60 seconds

Alpha LLD: 118.1 mV
Alpha ULD: 330 mV

Beta LLD: 3.5 mV
Beta ULD: 32.2 mV



	Alpha Source		Beta Source		Background		Crosstalk (%)		2π Efficiency	
HV	α	β	α	β	α	β	α	β	α	β
650	939	316	4	717	2	69	25.2	0.6	0.14	0.06
675	1361	343	1	1259	4	95	20.1	0.1	0.21	0.1
700	1720	373	7	1719	3	144	17.8	0.4	0.26	0.14
725	1985	351	5	2159	1	217	15	0.2	0.3	0.17
750	2061	435	5	2516	1	270	17.4	0.2	0.32	0.2
775	2104	521	7	2737	7	299	19.8	0.3	0.32	0.22
800	2162	983	5	3008	2	350	31.3	0.2	0.33	0.24

Recommended High Voltage: 725 volts

Calibrated By: _____ Date: 04/23/2015

Reviewed By: _____ Date: 4/27/15

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NVLAP Registration No. 92-3 • Calibration of Radiation Detection Instrument Devices

ERG

8809 Washington St NE STE 150
Albuquerque, NM. 87113
(505)-298-4224

Ludlum Model 4612/43-134-4 Calibration

Zone: 4

Model 4612 Serial Number: 291500
Model 43-134-4 Serial Number: PR327888

Calibration Due Date: 4/23/2016
Calibration Due Date: 4/23/2016

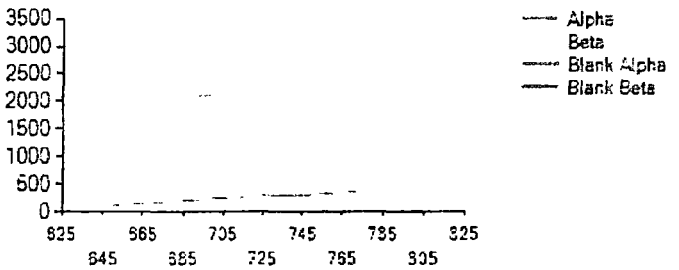
Alpha Source: Th-230 (4098-03)
Beta Source: Tc-99 (4099-03)

Emission Rate: 6520 epm
Emission Rate: 11100 epm

Counting Time: 60 seconds

Alpha LLD: 119.4 mV
Alpha ULD: 330 mV

Beta LLD: 3.2 mV
Beta ULD: 31.9 mV



	Alpha Source		Beta Source		Background		Crosstalk (%)		2π Efficiency	
HV	α	β	α	β	α	β	α	β	α	β
650	1809	338	7	1671	0	123	15.7	0.4	0.28	0.14
675	2096	375	7	2202	1	191	15.2	0.3	0.32	0.18
700	2110	460	4	2624	2	240	17.9	0.2	0.32	0.21
725	2245	694	8	2919	2	301	23.6	0.3	0.34	0.24
750	2363	2023	4	3178	0	317	46.1	0.1	0.36	0.26
775	2384	9080	4	3257	5	376	79.2	0.1	0.36	0.26
800	2354	24340	5	3121	5	353	91.2	0.2	0.36	0.25

Recommended High Voltage: 700 volts

Calibrated By: _____ Date: 04/23/2015

Reviewed By: _____ Date: 4/27/15

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997
NMRCB Registration No. [illegible] * Calibration of * Radiation Detection Instrument Devices

ERG

8809 Washington St. NE STE 150
Albuquerque, NM, 87113
(505)-298-4224

Ludlum Model 4612/43-134-4 Calibration

Zone: 5

Model 4612 Serial Number: 291500
Calibration Due Date: 4/23/2016

Model 43-134-4 Serial Number: PR327888
Calibration Due Date: 4/23/2016

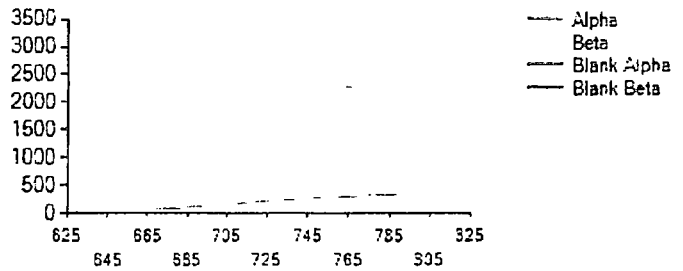
Alpha Source: Th-230 (4098-03)
Emission Rate: 6520 epm

Beta Source: Tc-99 (4099-03)
Emission Rate: 11100 epm

Counting Time: 60 seconds

Alpha LLD: 117.7 mV
Alpha ULD: 330 mV

Beta LLD: 3.1 mV
Beta ULD: 31.5 mV



	Alpha Source		Beta Source		Background		Crosstalk (%)		2π Efficiency	
HV	α	β	α	β	α	β	α	β	α	β
650	1261	309	4	1110	1	69	19.7	0.4	0.19	0.09
675	1677	320	5	1742	0	94	16	0.3	0.26	0.15
700	1921	301	2	2182	1	153	13.5	0.1	0.29	0.18
725	2146	403	6	2571	3	224	15.8	0.2	0.33	0.21
750	2272	471	5	2851	1	276	17.2	0.2	0.35	0.23
775	2292	1050	7	3217	1	327	31.4	0.2	0.35	0.26
800	2358	4468	3	3234	3	364	65.5	0.1	0.36	0.26

Recommended High Voltage: 725 volts

Calibrated By: _____ Date: 04/23/2015

Reviewed By: _____ Date: 4/27/15

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997.
NVLAP Registration No. 92-3 * Calibration of Radiation Detection Instrument Devices

ERG

8809 Washington St NE STE 150
Albuquerque, NM. 87113
(505)-298-4224

Ludlum Model 4612/43-134-4 Calibration

Zone: 6

Model 4612 Serial Number: 291500

Model 43-134-4 Serial Number: PR327888

Alpha Source: Th-230 (4098-03)

Beta Source: Tc-99 (4099-03)

Calibration Due Date: 4/23/2016

Calibration Due Date: 4/23/2016

Emission Rate: 6520 epm

Emission Rate: 11100 epm

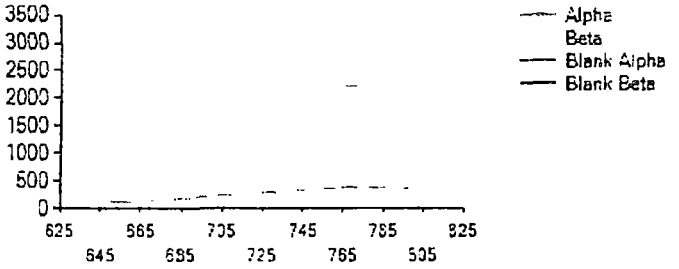
Counting Time: 60 seconds

Alpha LLD: 120.2 mV

Alpha ULD: 330 mV

Beta LLD: 3.3 mV

Beta ULD: 31.8 mV



	Alpha Source		Beta Source		Background		Crosstalk (%)		2π Efficiency	
HV	α	β	α	β	α	β	α	β	α	β
650	1844	328	7	1821	1	125	15.1	0.4	0.28	0.15
675	2028	383	6	2206	1	161	15.9	0.3	0.31	0.18
700	2139	448	1	2611	1	229	17.3	0	0.33	0.21
725	2204	585	4	2927	2	297	21	0.1	0.34	0.24
750	2201	2095	12	3199	2	348	48.8	0.4	0.34	0.26
775	2232	10464	8	3217	4	412	82.4	0.2	0.34	0.25
800	2368	28158	6	3121	4	356	92.2	0.2	0.36	0.25

Recommended High Voltage: 725 volts

Calibrated By: _____ Date: 04/23/2015

Reviewed By: _____ Date: 4/29/15

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997.
NMRCB Registration No. 92-3 * Calibration of Radiation Detection Instrument Devices

Certificate of Calibration

ERG
Environmental Restoration Group, Inc
8809 Washington, NE Suite 150
Albuquerque, NM 87113
(505) 298-4224

Model 4612 Serial Number 291500

HV Readout (7 points)

	HV 500 Instrument Reading	HV 1250 Instrument Reading	1 min count Ref 400K
Channel 1	492	1241	399014
Channel 2	N/A	N/A	
Channel 3	498	1247	399025
Channel 4	N/A	N/A	
Channel 5	499	1232	399010
Channel 6	N/A	N/A	
Channel 7	501	1261	399017
Channel 8	N/A	N/A	
Channel 9	500	1236	398997
Channel 10	N/A	N/A	
Channel 11	498	1241	399000
Channel 12	N/A	N/A	

Instruments Readings

	HV		LLD		ULD	
	Ref.	Reading	Ref.	Reading	Ref	Reading
Channel 1	1250	1241	35	45	335	345
Channel 2			1200	1215	3300	3308
Channel 3	1250	1247	35	39	335	346
Channel 4			1200	1210	3300	3318
Channel 5	1250	1232	35	33	335	348
Channel 6			1200	1208	3300	3325
Channel 7	1250	1261	35	40	335	346
Channel 8			1200	1213	3300	3335
Channel 9	1250	1236	35	43	335	352
Channel 10			1200	1218	3300	3333
Channel 11	1250	1241	35	46	335	348
Channel 12			1200	1209	3300	3305

Calibrated By: _____ Calibration Date: 4/20/15 Calibration Due: 4/20/16

Reviewed By: _____ Date: 4/27/15

MODEL 46xx PARAMETER SETTINGS

Date: 04/20/2015 2:10:34 PM
Serial Number: 291500

Channel	Count Time
1	00:01:00.000
2	00:01:00.000
3	00:01:00.000
4	00:01:00.000
5	00:01:00.000
6	00:01:00.000
7	00:01:00.000
8	00:01:00.000
9	00:01:00.000
10	00:01:00.000
11	00:01:00.000
12	00:01:00.000

Channel	HV Set Point	Measured	Readback	Actual Cal	Readback Cal
1	500	----	492	+0.0	+0.0
2	500	----	1945	+0.0	-9.9
3	500	----	498	+0.0	+0.0
4	500	----	1949	+0.0	-9.9
5	500	----	499	+0.0	+0.0
6	500	----	2052	+0.0	-9.9
7	500	----	501	+0.0	+0.0
8	500	----	1921	+0.0	-9.9
9	500	----	500	+0.0	+0.0
10	500	----	1944	+0.0	-9.9
11	500	----	498	+0.0	+0.0
12	500	----	1938	+0.0	-9.9

Channel	LLD Set Point	Measured	Readback	Actual Cal
1	35	----	35	+0.0
2	1200	----	1214	+0.5
3	35	----	35	+0.0
4	1200	----	1199	+0.3
5	35	----	34	+0.0
6	1200	----	1212	+0.7
7	35	----	37	+0.0
8	1200	----	1208	+0.6
9	35	----	35	+0.0
10	1200	----	1203	+0.1
11	35	----	36	+0.0
12	1200	----	1207	+0.0

Channel	ULD Set Point	Measured	Readback	Actual Cal
1	335	----	338	+0.0
2	3300	----	3300	+0.0
3	335	----	333	+0.0
4	3300	----	3300	-0.3
5	335	----	335	+0.0
6	3300	----	3300	-0.2
7	335	----	338	+0.0
8	3300	----	3300	-0.5
9	335	----	335	+0.0
10	3300	----	3300	-0.7
11	335	----	338	+0.0
12	3300	----	3300	+0.2

MODEL 46xx PARAMETER SETTINGS

Date: 04/20/2015 2:10:41 PM
Serial Number: 291500

Channel	Count Time
1	00:01:00.000
2	00:01:00.000
3	00:01:00.000
4	00:01:00.000
5	00:01:00.000
6	00:01:00.000
7	00:01:00.000
8	00:01:00.000
9	00:01:00.000
10	00:01:00.000
11	00:01:00.000
12	00:01:00.000

Channel	HV Set Point	Measured	Readback	Actual Cal	Readback Cal
1	1250	1250	1241	+0.0	+0.7
2	500	500	2141	+0.0	-9.9
3	1250	1250	1247	+0.0	+0.2
4	500	500	2145	+0.0	-9.9
5	1250	1250	1232	+0.0	+1.4
6	500	500	2258	+0.0	-9.9
7	1250	1250	1261	+0.0	-0.9
8	500	500	2122	+0.0	-9.9
9	1250	1250	1236	+0.0	+1.1
10	500	500	2141	+0.0	-9.9
11	1250	1250	1241	+0.0	+0.7
12	500	500	2139	+0.0	-9.9

Channel	LLD Set Point	Measured	Readback	Actual Cal
1	35	45	36	-9.9
2	1200	1215	1215	-1.3
3	35	39	35	-9.9
4	1200	1210	1203	-0.8
5	35	33	34	+5.7
6	1200	1208	1202	-0.7
7	35	40	35	-9.9
8	1200	1213	1217	-1.1
9	35	43	36	-9.9
10	1200	1218	1203	-1.5
11	35	46	36	-9.9
12	1200	1209	1197	-0.8

Channel	ULD Set Point	Measured	Readback	Actual Cal
1	335	345	335	-3.0
2	3300	3308	3300	-0.2
3	335	346	334	-3.3
4	3300	3318	3300	-0.5
5	335	348	336	-3.9
6	3300	3325	3300	-0.8
7	335	346	335	-3.3
8	3300	3335	3300	-1.1
9	335	352	333	-5.1
10	3300	3333	3300	-1.0
11	335	348	334	-3.9
12	3300	3305	3300	-0.2

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Beta Standard

S.O.# 7085
P.O.# N/A

Description of Standard:

Model No. DNS-12 Serial No. 7182-11 Isotope Tc-99

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi beta emission rate was measured using an internal gas flow proportional chamber. Absolute counting of beta particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated beta source S/N 75323-201.

Measurement Result:

The observed beta count rate from the surface of the disc per minute (cpm) on the calibration date was:

9,920 ± 396

The total disintegration rate (dpm) assuming 25 % backscatter of beta particles from the surface of the disc, was:

15,900 ± 635 (0.00715 µCi)

The uncertainty of the measurement is 4 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by:

Calibration Technician: Q.A. Manager:

Calibration Date: 3-07-2011 Reviewed Date: 03-08-11

Source Manufacturing Lab
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 761-5413 Fax (505) 761-5416
areust@eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O.# 6233
P.O.# 1093

Description of Standard:

Model No. DNS-11 Serial No. 5447-05 Isotope Th-230

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2π alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated alpha source S/N 4001-02.

Measurement Result:

The observed alpha particles emitted from the surface of the disc per minute (cpm) on the calibration date was:

10,800 ± 431

The total disintegration rate (dpm) assuming 1.5% backscatter of alpha particles from the surface of the disc, was:

21,300 ± 850 (0.00958 μCi

The uncertainty of the measurement is 4 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by:

Calibration Technician: Q.A. Representative:

Calibration Date: 3-28-2005 Reviewed Date: 032805

Analytical Services
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 345-3461 Fax (505) 761-5416
Toll Free (866) RAD-LABS (723-5227)
www.eberlineservices.com

ERG

Daily Function Check Form

Dual Channel

Date: 5/5/2015

System ID: 1

Meter Type: **4612** Serial Number: **291500**

Detector Type: **43-134-4** Serial Number: **PR327888** Zone Area: **100 cm²**

Alpha Source: **Th-230** Serial Number: **5447-05** Emission Rate: **10,800 cpm**

Beta Source: **Tc-99** Serial Number: **7182-11** Emission Rate: **9,920 cpm**

			Th-230 (cpm)		Tc-99 (cpm)		Blank (cpm)		2π Efficiency			
Date/Time	Channel	HV	α	β	α	β	α	β	α	β	Initials	Flag
5/5/2015 10:48:51 AM	1	722	3020	499	14	2340	6	496	0.28	0.19	nw	
5/5/2015 10:48:51 AM	2	698	3209	555	12	2398	2	653642	0.3	-65.65	nw	
5/5/2015 10:48:51 AM	3	722	2889	450	8	2028	2	386	0.27	0.17	nw	
5/5/2015 10:48:51 AM	4	698	3139	554	17	2422	3	464	0.29	0.2	nw	
5/5/2015 10:48:51 AM	5	722	2979	491	15	2231	2	424	0.28	0.18	nw	
5/5/2015 10:48:51 AM	6	723	2929	754	19	2647	2	684	0.27	0.2	nw	

None

- Beta channel 2 function check out of tolerance low on right here. Data not used

Reviewed By: Michael Lee Date: 8-03-15

ERG

Dual-Channel Function Check Log

Environmental Restoration Group, Inc.
5000 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	ludlum
Model:	2360
Serial No.:	276943
Cal. Due Date:	2-23-16

DETECTOR	
Manufacturer:	ludlum
Model:	43-93
Serial No.:	PR 298426
Cal. Due Date:	2-23-16

Comments:
black label

Alpha Source: Th-230 Emission Rate: 10800 cpm/emissions Source Date: 3-28-05 Distance to Source: contact
Serial No: 5447-05

Beta Source: Tc-99 Emission Rate: 9920 cpm/emissions Source Date: 3-7-11 Distance to Source: contact
Serial No: 7182-11

Date	Time	Battery	High Voltage	Alpha Counts		Beta Counts		BKG Counts		Efficiency		Initials
				Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	
5-5-15	0937	ok	727	4106	444	3	2088	0	178	0.38	0.19	NW JH
5-5-15	1700	ok	725	4069	486	3	2012	4	180	0.38	0.18	NW JH
5-6-15	0728	ok	725	4216	445	5	1993	0	157	0.40	0.19	NW JH
5-6-15	1328	ok	725	3872	464	2	2010	4	188	0.36	0.18	NW JH
						5-6-15						

Reviewed by: [signature] Review Date: 4/3/15

ERG

Dual-Channel Function Check Log

Environmental Restoration Group, Inc
8809 Washington St. NE, Suite 159
Albuquerque, NM 87113
(505) 298-4224

METER	
Manufacturer:	Ludlum
Model:	2360
Serial No.:	184951
Cal. Due Date:	4-28-16

DETECTOR	
Manufacturer:	Ludlum
Model:	43-93
Serial No.:	PR 299865
Cal. Due Date:	4-28-16

Comments:
ej label

Alpha Source: Th-230 Emission Rate: 10800 cpm/emissions Source Date: 3-28-05 Distance to Source: contact

Serial No: 7447-07

Beta Source: Tc-99 Emission Rate: 4920 cpm/emissions Source Date: 3-7-11 Distance to Source: contact

Serial No: 7182-11

Date	Time	Battery	High Voltage	Alpha Counts		Beta Counts		BKG Counts		Efficiency		Initials
				Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	
5-5-15	0943	ok	790	4023	630	6	2442	6	196	0.37	0.23	NW SH
5-5-15	743	ok	790	4091	574	0	2340	2	194	0.38	0.22	
5-6-15	0732	ok	790	4041	599	2	2375	0	237	0.37	0.22	
5-6-15	1332	ok	790	5978	618	3	2368	5	235	0.37	0.22	

5-6-15

Reviewed by: [signature] Review Date: 8/3/15

ERG

Dual-Channel Function Check Log

Environmental Restoration Group, Inc.
8509 Washington St. NE, Suite 150
Albuquerque, NM 87113
(505) 298-1224

METER	
Manufacturer:	Ludlum
Model:	2360
Serial No.:	220263
Cal. Due Date:	4-27-16

DETECTOR	
Manufacturer:	Ludlum
Model:	43-93
Serial No.:	PR 298374
Cal. Due Date:	4-27-16

Comments:
Wipe Label

Alpha Source: Th-230 Emission Rate: 10800 cpm/emissions Source Date: 3-28-05 Distance to Source: Contact

Serial No: 3447-05

Beta Source: Tc-99 Emission Rate: 9920 cpm/emissions Source Date: 3-7-11 Distance to Source: contact

Serial No: 7182-11

Date	Time	Battery	High Voltage	Alpha Counts		Beta Counts		BKG Counts		Efficiency		Initials
				Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	
7-5-15	0928	ok	725	4047	550	4	2324	1	184	0.37	0.22	MW SH
5-5-15	1747	ok	725	4241	528	5	2256	~~8~~ 1	211	0.39	0.19	
5-6-15	0734	ok	725	4157	521	6	2242	1	203	0.38	0.21	
5-6-15	1327	ok	725	4053	514	9	2269	8	212	0.37	0.21	
						2						
						5-6-15						

Reviewed by: [signature] Review Date: 5/13/15