Remediation of Mixed Waste Disposal Site
USDA National Animal Disease Center (NADC)
Ames, Iowa

CLOSEOUT REPORT

FINAL

Prepared for:

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Prepared by:

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RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

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ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
bgs	Below Ground Surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	Curie
COC	Chemicals of Concern
DAC	Derived Air Concentration
$DCGL_w$	Derived Concentration Guideline Level (working)
$DCGL_{EMC}$	Derived Concentration Guideline Level (EMC)
DOT	Department of Transportation
dpm	disintegrations per minute
DQOs	Data Quality Objectives
EE/CA	Engineering Evaluation/Cost Analysis
EMC	Elevated Measurement Comparison
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
FSS	Final Status Survey
GM	Geiger-Mueller radiation detector
GPS	Global Positioning System
GWS	Gamma Walkover Survey
HEPA	High Efficiency Particulate Air
HPT	Health Physics Technicians
IDW	Investigation Derived Waste
JMC	U.S. Army Joint Munitions Command (formerly Operations Support Command)
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
MDL	Method Detection Limit
MeV	Megaelectron Volts
MW	Monitoring Well
NaI	Sodium Iodide radiation detector
NADC	USDA National Animal Disease Center
NIST	National Institute of Standards and Testing
NPL	National Priorities List
NRC	Nuclear Regulatory Commission

OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
ROC	Radionuclides of Concern
RCA	Radiologically Controlled Area
RSP	Radiation Safety Program
RWP	Radiation Work Permit
SOR	Sum of the Ratios (equivalent to the sum of the fractions)
SSHP	Site Safety and Health Plan
SU	Survey Unit
SVOC	Semivolatile Organic Compounds
TBD	To Be Determined
TCLP	Toxicity Characteristic Leachability Procedure
USDA	United States Department of Agriculture
VOC	Volatile Organic Compounds
WAC	Waste Acceptance Criteria
WP	Interim Removal Action Work Plan
WRS	Wilcoxon Rank Sum (statistical test)
W_r	Sum of Adjusted Reference Area ranks from the WRS test
W_s	Sum of Survey Unit Ranks from the WRS test
yd^3	cubic yards

1.0 EXECUTIVE SUMMARY

Cabrera Services, Inc. (CABRERA) was contracted by the U.S. Army Joint Munitions Command (JMC) under Contract No. DAAA09-00-G-0004/0003 to remediate the contents of former mixed waste burial pits located at the United States Department of Agriculture (USDA) National Animal Disease Center (NADC) in Ames, Iowa (hereafter referred to as "Site 1"). This report documents the results of the remediation effort, including the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM, NRC, 2000) final status survey (FSS) for the Site.

All remediation activities were performed in accordance with the Interim Removal Action Work Plan (WP, CABRERA 2002b) for Site 1 as approved by the Nuclear Regulatory Commission (NRC) under License Amendment No. 131983 issued to the USDA's Broad Scope Radioactive Materials License on October 24, 2002.

Site 1 consisted of 16 burial pits, configured end to end, in a 300-foot long line adjacent to the south boundary fence of the NADC. The majority of the waste was made up of test tubes and scintillation vials containing hazardous liquid scintillation fluids. Burials were conducted semiannually between 1971 and 1980. The last burial at Site 1 was completed on October 20, 1980 (Pit 16).

The total volume of mixed waste removed was 111 cubic yards (yd^3), compared to the estimate of 40 yd^3 originally buried. This volume of waste required (101) 55-gallon drums and (30) B-25 boxes. The increase in mixed waste volume was a direct result of the uncontained nature of the waste and the presence of groundwater at shallow depths (~6 feet). Seventy-two (72) yd^3 of 'buffer soils' surrounding the buried wastes within the pits was also excavated and containerized for land disposal prior to execution of the FSS.

The following items were also discovered in one or more of the pits:

- Centrifuge tubes – with and without rubber stoppers;
- Laboratory glassware, including large bottles and flasks;
- Lead shields (pigs), ranging in size from vial shields (~1 lb) to larger source shields (~30 lbs);
- Syringes (with and without needles attached);
- Box-type filter assemblies (nominal 12 in. x 16 in.);
- Labeled "radioactive material" bags; and
- Packaging from used radioactive standard sources, including Iodine-131, Iodine-125, Phosphorus-32, and Carbon-14.

The MARSSIM FSS performed at Site 1 included scan surveys, surface soil samples, and subsurface soil samples for the radionuclides of concern (ROCs) and chemicals of concern (COC) established in the Engineering Evaluation and Cost Analysis (EE/CA, CABRERA, 2002a). A review of sample data shows that data of sufficient quality and quantity have been taken and that no significant residual radioactive or chemical contamination remains at Site 1 above the stated cleanup goals in WP. This conclusion is based on the results of the statistical analysis of the data as identified in the Work Plan. Therefore, Site 1 should be suitable for release for unrestricted use with no additional radiological or chemical controls necessary.

2.0 INTRODUCTION

2.1 Purpose of Investigation

Cabrera Services, Inc. (CABRERA) was contracted by the U.S. Army Joint Munitions Command (JMC) under Contract No. DAAA09-00-G-0004/0003 to remediate the contents of former mixed waste burial pits located at the United States Department of Agriculture (USDA) National Animal Disease Center (NADC) in Ames, Iowa (hereafter referred to as "Site 1"). This report documents the results of the remediation effort, including the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) final status survey (FSS) for the Site.

Remediation of Site 1 is also being performed in support of the greater NADC modernization project. The proposed facility would modernize and update the USDA facilities in Ames, Iowa, which include the Agriculture Research Service's (ARS) NADC, and the National Veterinary Services Laboratories (NVSL) and Center for Veterinary Biologics (CVB), administered by the USDA Animal and Plant Health Inspection Service (APHIS). The USDA is already begun construction of new facilities designed to meet national needs for animal health research, diagnosis and product evaluation and to replace existing facilities that are antiquated and inefficient.

All remediation activities were performed in accordance with the Interim Removal Action Work Plan (WP, CABRERA 2002b) for Site 1 as approved by the Nuclear Regulatory Commission (NRC) under License Amendment No. 131983 issued to the USDA's Broad Scope Radioactive Materials License on October 24, 2002. The remediation was also overseen by the Environmental Protection Agency (EPA) as a voluntary removal action administered under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

2.2 Site Description and Background

The NADC is part of the ARS that began operations in 1961. (Initially the facility was named the National Animal Disease Laboratory, but was later changed to NADC). It is the USDA's principal research center for investigating domestic diseases of livestock. It currently consists of an 80-building complex covering 320 acres. The mission of the center has been to conduct basic research on animal disease of economic importance to U.S. agriculture and to apply the results to animal disease prevention and control programs.

In 1971, the NADC Waste Site Safety Officer authorized disposal by burial of radioactive waste materials in organic solvents pursuant to the conditions detailed in the regulations found in Part 20 of the Code of Federal Regulations, Title 10, subpart 304 (10CFR 20.304). The maximum quantity of radioisotopes to be buried at any one time was determined to be 100 micro-Curies (µCi). The 1975 USDA Radiological Safety Handbook, Section 3.4.6, indicates that the quantities buried at any one location and time shall not exceed at the time of burial, one-thousand times the amount specified in 10CFR 20 Appendix C, and that the remaining provisions of Section 20.304 shall also have been satisfied. The Handbook also stated:

> *"Burial shall be accomplished on land owned by the Department in an area from which the public can be excluded and whose long-range use for other purposes is not planned."*

Radioactive and hazardous waste materials were collected in plastic bags and placed in 32-gallon waste containers. The plastic bags were transferred approximately every 6 months (spring and fall) to the NADC radioactive burial site. The NADC waste site consisted of 16 burial pits, configured end to end, in a 300-foot long line adjacent to the south boundary fence of the NADC. The burial pits contain materials associated with conducting bench scale research with radionuclides, such as lead pigs, source vials, pipettes, packaging materials, gloves, absorbent paper, test tubes, scintillation vials, carbon filters, and liquid scintillation counting fluid. The majority of the waste was made up of test tubes and scintillation vials containing hazardous liquid scintillation cocktail. The average activity introduced during the burials was typically a small fraction of the 1000 times 10CFR 20 Appendix C limits. It was estimated that there were 40 cubic yards (yd^3) buried with a total activity of 250 mCi, based on isotope purchasing and disposal logs. The waste buried prior to 1975 was radioactive waste with an approximate volume of 150 cubic feet (ft^3) or 5.5 yd^3. Waste buried after and including 1976 was radioactive and chemical waste with an approximate volume of approximately 932 ft^3 (34.5 yd^3). (CABRERA, 2002a)

In January 1981, the USDA Radiological Safety Officer (RSO) informed the NADC that the NRC had amended its regulations to delete subpart 304 of 10CFR 20. As of January 28, 1981, no radioactive waste was to be disposed of by burial by individual licensees. The last burial at Site 1 was completed on October 20, 1980 (Pit 16). In the time since the last burial, Site 1 has been posted as a radioactive materials area with bricks placed at the approximate locations of each burial for reference. No physical boundaries were erected since the materials were buried below ground level.

2.3 Prior Remedial Actions at NADC

A facility-wide inventory conducted to meet the requirements of Section 3016 of the Resource Conservation and Recovery Act (RCRA) revealed the possible existence of potential hazardous waste sites at the NADC facility. As a result of USDA's RCRA 3016 report to the EPA, the facility was listed in the November 1988 update to the 'Federal Agency Hazardous Waste Compliance Docket'. Facilities listed were given 18 months to complete a Preliminary Assessment (PA) as required by CERCLA Section 120(d). As a result, the USDA NADC developed an Environmental Action Plan in 1988 to evaluate the potential groundwater effects from radioactive and organic waste from the waste burials. This plan included a PA of Site 1.

On November 6, 1989, NADC personnel used a backhoe to excavate the initial burial, opened in 1971. This remediation effort was part of the CERCLA response actions initiated in 1988. NADC indicated that the polyethylene bags that were disposed did not break during the removal process. Soil samples were assayed by gas chromatograph and showed no evidence of organic solvents. Scintillation counts on soil for alpha and beta particles were at background levels and a survey of the burial did not detect gamma emitters. At that time, the bags appeared to be intact and in much the same condition they were when placed in the burial 18 years prior. (USDA, 1989) There were no indications that groundwater had ever reached the level of the buried material and the soil surrounding the materials is hard yellow clay. There was no record of how the removed waste materials from Pit 1 were disposed.

The NADC conducted a geological study in 1996 to obtain supplemental information to further characterize Site 1. Six (6) soil borings to approximately 15 feet were conducted on-site to characterize the local geology, groundwater occurrence, and scan for potential volatile organic compounds in the subsurface. These borings were converted to two-inch diameter groundwater monitoring wells, as noted in Figure 3-1. The boring and well locations were selected based on historical information; approximated groundwater flow direction based on topographic relief and approximated regional groundwater flow directions, and orientation of the burial sites. The NADC has sampled these wells annually for hydrocarbons and volatile organic compounds (VOCs) with no positive results. (CABRERA, 2002a)

3.0 REMEDIATION OF BURIED WASTES

All work activities described in this report were performed under CABRERA's NRC-approved Radiation Safety Program (RSP, CABRERA, 2000) and under the guidance set forth in the WP and Site Safety and Health Plan (SSHP, CABRERA, 2002c). As mentioned previously, the WP was prepared to satisfy requirements set forth by both the NRC and EPA. Therefore, the WP was reviewed and approved by the appropriate region of each agency having jurisdiction at the NADC. These were NRC Region 1 and EPA Region VII.

3.1 Mobilization and Site Preparation

CABRERA personnel arrived at the NADC on October 10, 2002 to begin Site 1 preparations. The remediation project began with removal of an existing chain link fence located directly north of the burials. The fence was removed to allow heavy machinery better access to the surrounding areas. The unearthed fence posts and chain link sections were stored along the fence line to the west of Site 1 for future NADC use or disposal.

The groundwater monitoring wells were left in place with work proceeding around them. No clearing or grubbing was necessary prior to excavation activities, as the NADC had already prepared the area prior to CABRERA's arrival. The layout of Site 1, including the prepared construction zone (CZ) and surroundings areas, is shown in Figure 3-1 (also provided in Appendix A). The excavated trench outline is shown correctly as a 'V" shape. The direction of the excavation turned slightly around the time of the Pit 5 excavation, corresponding to the indicated inflection point.

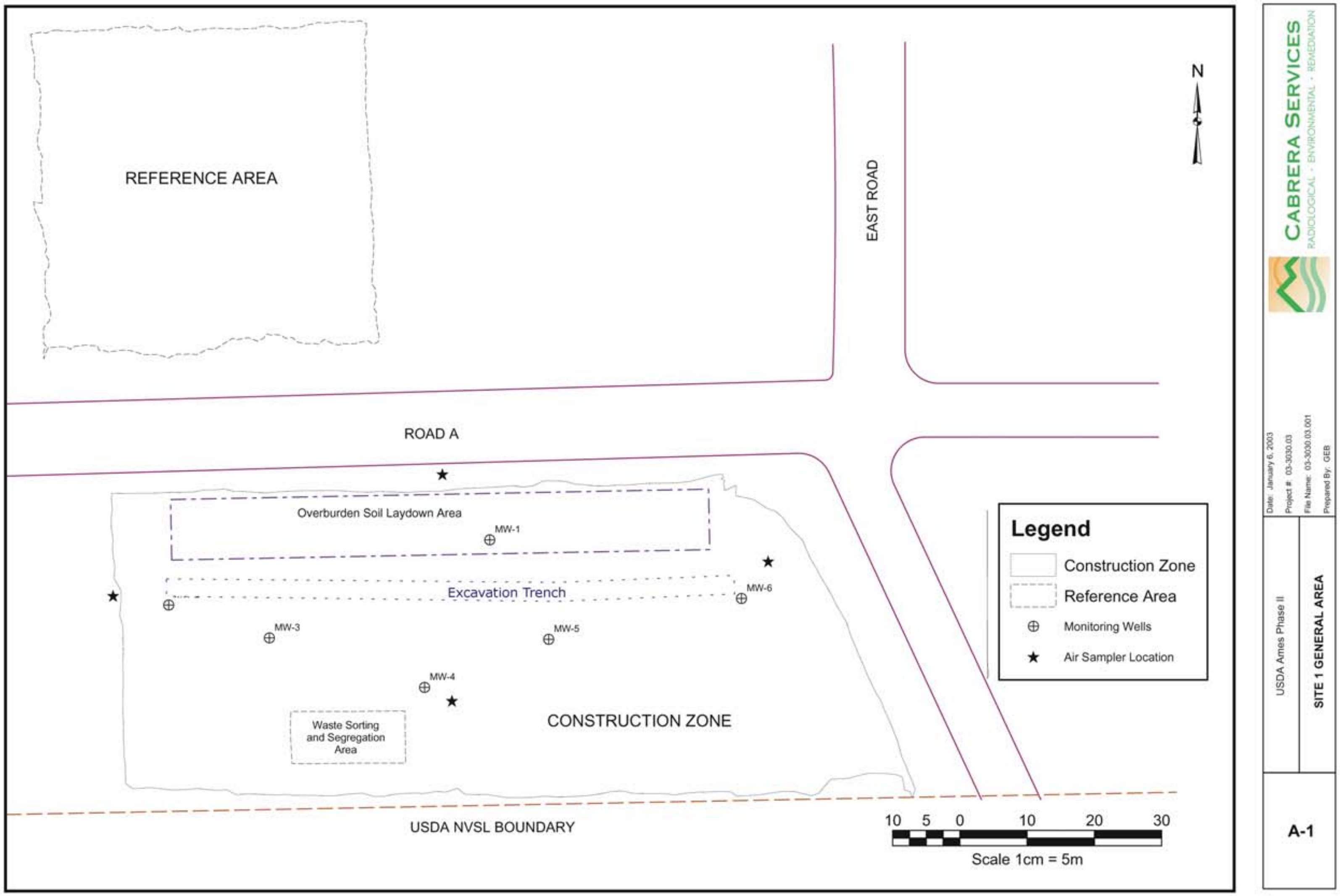

Figure 3-1: Site 1 Remediation Area Layout

An outer CZ boundary was then erected to serve as the primary construction area during the remediation project. All remediation activities at the Site were performed within the CZ. The CZ was marked using steel fence posts and standard orange snow fencing for easy identification (see Figure 3-2). Temporary gates were also installed to control for vehicle ingress and egress.

Figure 3-2: Temporary fencing around CZ

A waste sorting and segregation area was constructed within a 40-ft 'Seavan' container as described in the WP (see Figure 3-3). A negative pressure enclosure was created using a HEPA-filtered air machine located outside the containment tent that continuously drew air from the enclosed area. The purpose of the negative-pressure enclosure was to prevent any airborne contaminants from escaping the boundaries of the tent during waste sorting and segregation activities. The containment tent was also continuously monitored for volatile organic compounds via a flame ionization detector (FID) and airborne tritium (H-3) by way of a vapor collection bubbler apparatus. The H-3 sampler hose is shown near the top left of Figure 3-3.

Figure 3-3: Sorting/segregation tent with exhaust system

3.2 Remediation Sequence

The WP described the planned remediation sequence for safely uncovering the buried wastes, removing and packaging the wastes, and performing characterization and final status surveys of the pits and waste. The sequence as executed, is described below.

3.2.1 Authorization to Proceed

The USDA's Radiation Safety Staff was granted an amendment to their broad scope radioactive materials license from the NRC on October 24, 2002. The amendment, which was recorded as Condition #33 of the amended license, allowed decommissioning activities to begin at the NADC burial site in accordance with the NRC-approved WP.

3.2.2 Removal of Overburden Soils

Before the actual waste materials could be excavated, a topsoil cover layer was removed from above the burial pit locations. This soil represents the backfill soil returned to each burial pit following initial waste burial. Records indicated that approximately 3 ft of overburden soils had been laid down over the waste materials. The actual depth of cover encountered ranged from 1.5 – 4 ft. These soils were removed with an excavator and placed in the overburden soil laydown area, designated in Figure 3-1.

The area between the northern edge of the excavation and Road A was used to store the overburden soils during the project. Prior to placing any soils in this area, a layer of 10-mil polyethylene was placed on the ground. This was done as a precaution to prevent potential cross-contamination of the underlying non-impacted soil. Silt fencing was also installed at the eastern and western edges of the overburden soil laydown area to prevent sediments in surface water runoff from exiting the CZ.

The excavator created an initial excavation approximately 12 ft wide by 3 ft deep that served as the first level of the 'benched' excavation profile described in WP Figure 6.2.

3.2.3 Initial Remediation Activities

3.2.3.1 Investigation of Previously Remediated Pit #1

Once the overburden soils were removed to a depth of 3 ft, the focus of the excavation changed to finding the boundaries of the 16 burial pits. The excavator began by scraping back soil in the center of the trench until evidence of the burial was seen. Several workers were positioned within the trench to closely watch the progress of the excavation and stop scraping if evidence of buried waste materials was observed. This was particularly important for two reasons, to avoid inadvertent placement of wastes in the overburden soil laydown area and to prevent tearing bags and wastes.

The approximate boundaries of the burial pits were known based on historical documentation and field markings installed by current and former NADC staff. The burial pits were excavated in ascending chronological order, starting at the eastern end of the trench (Pit 1) and proceeding to the west. Despite the fact that the waste materials had been removed from Pit 1 in 1989, investigation of this pit was necessary because no FSS had been performed. Uncovering the first pit was also viewed as a useful exercise to gauge physical characteristics of the soils that would aid the team in identifying other pit boundaries.

Figure 3-4: Photo showing backfill line in Pit 1. The soil to the right of the yellow line(clay) indicates the pit location.

The natural topsoil layer was observed to extend to an average depth 3.5 to 4 ft below ground surface (bgs). Outside the actual pit excavations, a sharp contact separates the above topsoil from native, hard yellow clay. The yellow clay is a glacial till deposit that contains very little silt, but does contain sparse pockets of reddish-yellow medium to coarse sand. Actual delineation of the burial pits was fairly simple due to the distinct color and texture change from the dark topsoil to the underlying yellow clay. Soils within the pit boundaries consisted of mixed topsoil and clay with sharp contacts distinguishing the edges of the pits.

The completed excavation was temporarily covered with tents constructed by CABRERA to prevent surface water runoff into the pits. The tents were built using truss members, construction lumber, and reinforced polyethylene sheeting. The tents were constructed to be modular so that they could be easily placed over the excavation (or removed) as necessary.

3.2.3.2 Excavation Process

Excavation of existing buried wastes began with Pit 2. Preparation of the trench was accomplished in the same manner as described for Pit 1 above, with overburden soils removed and the center portion of the trench excavated gradually until evidence of the waste was observed. However, during removal of the center portion of the overburden soils, loose vials and other laboratory debris were observed prior to uncovering any intact bags. At this point, the remediation crew switched to manual excavation techniques to dig around the observed items to find the extent of the burial. The results of these efforts were largely unsuccessful as the bags were found to be degraded, torn, or shredded, leaving the buried wastes generally uncontained. Observed waste condition from Pit 2 is shown in Figure 3-5. The white objects in the photo are scintillation vial caps.

Figure 3-5: Close-up view of loose waste materials in Pit 2.

Waste removal proceeded using the bucket of the excavator. The excavator scooped the buried waste out of Pit 2 and placed it on 6-mil polyethelene sheeting adjacent to the trench for manual sorting and segregation. The volume of material, coupled with the gross amounts of soil incorporated, made use of the waste sorting and segregation tent impractical. Vials and other debris were removed by hand from the soil/waste mixtures as effectively as possible with all wastes loaded into drums, as shown in Figure 3-6.

The condition of the waste in Pit 2 (i.e. bags not intact) required CABRERA to reevaluate the techniques and processes planned to accomplish the Site 1 remediation. The proposed field change involved mobilizing a mini-excavator and second heavy-equipment operator to the NADC. The mini-excavator is a scaled-down version of the large unit equipped with a much smaller bucket. This allowed excavation with greater precision (i.e. less soil waste) as well as direct loading into drums. Despite the fact that the use of heavy machinery had the potential to increase the total mixed waste volume, the overall process was determined to be the most efficient means for removing the buried wastes from the remainder of the pits. These field modifications were approved by NRC Region 1 and EPA Region VII prior to execution.

The loading of excavated waste materials directly into drums, as shown in Figure 3-6, was used to remediate Pits 2 through 8. Plastic sheeting was placed underneath and behind the drums as a contamination control measure during drum loading and removal. Once the final drum for the pit was filled, the plastic was folded up and packed into the drum before it was sealed. The sealed drums were then wiped down with a large area (i.e. masselin) wipe and scanned with a GM survey meter for gross contamination. If no contamination was detected, the drum was lifted from the trench and placed in a staging area to the south of the trench for final weighing and labeling.

Figure 3-6: Photographs of drum loading and handling procedures during pit remediation

Although this waste removal process proved effective, the loading and handling of waste into 55-gallon drums proved too inefficient to attempt for the remaining burial pits. As an alternative, 96 cubic foot (ft^3) 'B-25' boxes were mobilized to expedite the removal and packaging of the mixed wastes. The B-25 boxes had industry standard dimensions of 6-ft long by 4-ft wide by 4-ft tall with a net weight capacity of approximately 6000 pounds. The use of B-25s was advantageous to the Site 1 remediation project as it allowed waste loading to proceed at a much faster pace (each B-25 will hold an equivalent volume of (10) 55-gallon drums).

Figure 3-7: Loading of excavated wastes into B-25 box.

The waste from Pits 9 through 16 was loaded into B-25 boxes. Loading and handling of the B25s was done in much the same way as the drums. The mini-excavator removed wastes from the pits and directly loaded them into the boxes. This process is shown in Figure 3-7. Each box was incrementally weighed using the large excavator, equipped with a 10,000-pound (lb) digital scale to avoid potential overfilling. It was observed that the boxes could only be filled to approximately 75% of their total volume before reaching weight capacity. Once the box was satisfactorily filled and weighed, the top was attached and the box was labeled and staged in the southwest corner of the CZ.

3.2.4 Groundwater Infiltration Controls

Based on historical groundwater monitoring data from nearby wells, and observations recorded during the 1989 remediation of Pit 1, it was not anticipated that groundwater would be encountered during pit remediation. This however, was not the case. Once excavation activities proceeded beyond 6 ft bgs, groundwater infiltration was readily observed through the surrounding clay into the pit. The level of the groundwater table encountered during the excavation was consistently observed at a depth of 6 ft. The recharge rates were relatively slow due to the dense nature of the clays, so the remediation crew generally had 30-45 minutes to remove and containerize the excavated bags and vials until standing water was again observed on the pit floor. Figure 3-8 is a photograph of the typical standing groundwater level seen once waste materials were removed from the pits.

Figure 3-8: View of standing groundwater level in finished pit

The presence of groundwater at shallow depths had a profound impact on the remediation activities. All standing water was pumped from the excavation to a holding tank, with any residual water solidified using SP-400 polymer absorbent. The use of polymer absorbent had the added effect of trapping any loose vials and other debris from the pit floor for easier removal.

Once all loose materials had been removed, groundwater was allowed to recharge into the pits until the buffer soils were to be removed. At this time, all standing water was pumped to the holding tank such that buffer soils could be removed without having to add a significant amount of SP-400. Approximately 1000 gallons of groundwater was pumped to the holding tank during the remediation.

3.2.5 Removal of Buffer Soils

The WP prescribed removal of approximately one foot of surrounding soil from all sides of each pit once all waste materials had been removed. During remediation of the first few pits (i.e. Pits 1-5), buffer soil removal immediately followed the mixed waste removal. This procedure allowed for prompt sampling of the excavated pits prior to moving on to the next burial. However, this procedure was abandoned after Pit 5 due to discoloration of soil observed beyond one foot on the northern face of the excavation (see Figure 3-9). Additional soils were removed from the north wall and floor until the remaining soils appeared normal in color. This over-excavation was done as a conservative measure to ensure that remaining soils would be below cleanup criteria. Due to the increased volume removed from Pit 5, all buffer soil removal was suspended until all of the burial pits were remediated in order to better manage the overall waste volumes.

Figure 3-9: Pit 5 post-buffer soil removal. Discolored soil on north wall is seen to the left of shovel handle.

Buffer soil removal began again on November 15, 2002, starting at the western edge of Site 1 and working to the east. In addition to the soils within the pits, a thin layer of soil from the benched portions of the trench was also removed to account for any residual wastes that may have fallen or splashed during loading and packaging prior to beginning the FSS. Since removal of the buffer soils was being performed last, the excavator had to be located within the trench. This placement limited the reach of the bucket, precluding direct loading into the 25-yd^3 hard-top roll-off dumpsters called 'intermodal containers.' Therefore, a 4 cubic-yard (yd^3) capacity payloader was brought in to serve as a transport vehicle between the excavator and the intermodals. Figure 3-10 shows this process in action. Approximately 72 yd^3 of buffer soils were removed during the Site 1 remediation project.

Figure 3-10: Buffer Soil Removal Process

3.3 Excavation Observations

3.3.1 Location Inconsistencies

The burial logs kept by NADC staff recorded the distance from the start of each pit to a fixed reference point located at the eastern edge of Pit 1. The reference point also corresponded to the eastern end of the east/west border fence that was removed just prior to excavation (discussed in Section 3.1). The burial logs also noted that each burial was "6 ft down" and had "6 ft between burials." This information was used to plan the excavation and predict the locations of each underground pit. The actual characteristics of the burial pits were considerably different from what was recorded in the burial logs. Table 3-1 provides a summary of a comparison between the recorded dimensions for each pit and actual dimensions measured by CABRERA.

Table 3-1: Comparison Table of Predicted versus Actual Pit Dimensions

Pit Number	Assumed Start Point (feet)	Assumed Pit Length (feet)	Actual Start Point (feet)	Actual Pit Length (feet)	Actual Spacing to Next Pit (feet)	Approximate Pit Depth (feet bgs)
1	0	15	3	6	10	6
2	21	10	19	8	8	6
3	37	9	35	9	6	7
4	52	4	50	8	5	9
5	62	8	63	10	4	9
6	76	10	77	12	6	8
7	92	7	95	12	6	7
8	104	5	113	7	1	7
9	116	15	121	15	0	9
10	137	7	136	8	10	9
11	150	16	154	16	6	10
12	172	14	176	15	8	8
13	192	12	199	14	6	8
14	210	22	219	20	9	10
15	237	18	248	16	9	10
16	262	22	273	12	--	13

Pit depths were found to be highly variable as well, ranging from 6 ft to 13 ft bgs. Pits dug in the later years (Pits 9-16; 1976-1980) were found to be deeper than those excavated from 1971 to 1975. This was not unexpected since the documented burial volumes also increased significantly during the same period.

3.3.2 Contents of NADC Burials

The historical information noted burial of scintillation vials, laboratory radioactive wastes, and other miscellaneous debris. The largest constituent of the waste volume was vials, both in the form of standard 20-milliliter (ml) scintillation vials and 10-ml specimen vials. The following items were also discovered in one or more of the pits:

- Centrifuge tubes – with and without rubber stoppers;
- Laboratory glassware, including large bottles and flasks;
- Lead pigs, ranging in size from vial shields (~1 lb) to larger source shields (~30 lbs);
- Syringes (with and without needles attached);
- Box-type filter assemblies (nominal 12 in. x 16 in.);
- Labeled “radioactive material” bags; and

- Packaging from used radioactive standard sources, including Iodine-131, Iodine-125, Phosphorus-32, and Carbon-14 (C-14). With the exception of C-14 (which was already on the ROC list), all nuclides had decayed away, with no measurable activity seen.

Debris that could be segregated as 'radioactive waste only' was placed in an intermodal container for disposal at Envirocare of Utah. Items that fit this description included filters, waste packages labeled 'radioactive', and the expired source containers discussed above. All other materials were included with the mixed wastes loaded into either drums or B-25 boxes. The syringes were first packaged within puncture-resistant pails prior to their placement in drums.

3.4 Radiological and Environmental Controls

3.4.1 Radiological Work Permits

Two Radiological Work Permits (RWP) were generated for the remediation activities at Site 1. The first addressed work activities within the CZ including excavation, handling, and packaging of the waste materials. The second RWP addressed sorting, segregation, and re-packaging the wastes within the containment tent. The RWPs discuss the radiological conditions, required radiological controls, and any special instructions necessary to perform work within each radiologically controlled area (RCA). Copies of both RWPs are included in Appendix B.

3.4.2 Radiation Surveys and Monitoring

The extent of the excavated area and the waste sorting area were both posted as radiologically controlled areas (RCA). All personnel were required to read and sign the RWPs prior to performing work within either RCA. The survey and monitoring requirements for the Site 1 remediation were commensurate with routine radiological work including direct frisk measurements, equipment and personnel contamination surveys, and air sampling. A log of surveys performed at Site 1, along with their radiological survey sheets, are included in Appendix C.

3.4.2.1 Contamination Surveys

Contamination surveys were performed whenever a worker or piece of equipment needed to cross the RCA boundary. Surveys for fixed contamination were performed using a standard ratemeter equipped with either a GM or alpha/beta scintillator probe. Removable contamination was assessed using swipes and counting in a portable liquid scintillation counter. Large area wipes (e.g. masselin) were also used to survey drums and B-25 boxes for removable contamination prior to removal from the RCA. The results of all surveys were compared to the "Acceptable Surface Contamination Levels" defined in Table 8-1 in the WP.

3.4.2.2 Air Sampling

Air sampling was performed at the boundaries of the CZ and in the breathing zone for workers performing intrusive work. Breathing zone air sampling was accomplished using 0-100 cubic centimeter per minute (cc/min) lapel samplers loaded with particulate filter papers. The sampling head was typically attached to the workers coveralls using tape to ensure that the collected sample was indicative of the worker's breathing zone air supply. CZ boundary samples were collected using low volume samplers with a typical flow rate of 80 liters per minute (lpm). Samplers were placed near the boundaries of the CZ on the north, south, east, and west sides to monitor airborne particulate levels during excavation activities. These locations are denoted in Figure 3-1.

Filters were loaded into the air samplers at the beginning of each workday and allowed to run until all intrusive activities were completed. The minimum collection time for all air samples was four hours. All air sample filters were counted on a Ludlum Model 2929 alpha/beta smear counter for one minute. The appropriate sample collection and count times were predetermined in order to meet the minimum Derived Air Concentration (DAC) value of 7.00E-07 μCi/ml for Ni-63, the most restrictive ROC for beta airborne radioactivity. The samples were allowed to decay a minimum of 12 hours to account for decay of radon daughter products. All raw air sample data and associated calculations are found in Appendix D.

3.4.3 Respiratory Protection

During remediation of Pit 2, VOC measurements taken in close proximity to waste material were observed to be greater than or equal to 1 part per milliion (ppm) using the photoionization detector (PID). A typical field scan during remediation is shown in Figure 3-11.

Figure 3-11: Use of a Photoionization Detector (PID) During Waste Removal

This data, in conjunction with the guidance in Table 8-1 of the SSHP triggered an upgrade in personnel protective equipment (PPE) level to a modified Level C, requiring the use of half-face air purifying respirators with combination cartridges whenever PID measurements exceeded stated action levels. Respirators were typically worn only during direct excavation and packaging of waste materials. It should be noted that this upgrade was conservative, as all PID measurements taken within the breathing zone of the workers were below stated action limits.

4.0 WASTE MANAGEMENT

4.1 Waste Characterization

The contents of the burial pit bags were characterized as mixed waste early in the project based on historical information documented in the EE/CA (CABRERA, 2002a). Laboratory wastes containing radionuclides in a liquid scintillation fluid matrix are common mixed waste streams requiring treatment prior to disposal. However, the associated contaminated soils that were excavated as part of the bulk excavation also required characterization to ensure accurate waste profiling.

Soil samples were collected to document variations in waste materials over the 10-year burial period. A total of five composite samples were collected from noticeably affected soils in Pits 2, 8, 10, and 15 (two samples were collected from Pit 2 as part of the original bulk excavation).

These soil samples were sent for a complete waste characterization suite of analyses, including Toxicity Characteristic Leaching Procedure (TCLP) for 32 organics and 8 metals, volatile and semi-volatile organics, pesticides and herbicides, polychlorinated biphenyls (PCBs), ignitability, compaction, reactivity, and free-standing liquids. This suite of analyses is also referred to as the 'Envirocare Suite' as this represents the battery of analyses that any given waste sample must undergo before the profile is approved for shipment to Envirocare of Utah. The results of these samples were used to prepare the waste profile records for both Envirocare of Utah and Perma-Fix of Florida.

Based on the results of the impacted soils, the buffer soils slated for disposal at Envirocare also had to be profiled as mixed wastes to account for the listed hazardous wastes discovered in the profile samples.

4.2 Generated Waste Volumes

Actual field conditions resulted in a total volume of mixed waste of 111 yd^3, compared to the original estimate of 40 yd^3. This total volume consisted of (101) 55-gallon drums and (30) B-25 boxes.

4.3 Waste Packaging and Classification

4.3.1 Mixed Wastes

All mixed wastes were loaded into either 55-gallon drums or 96 ft^3 B-25 boxes. Drums were used primarily for sorted and segregated vials but were also used for bulk mixed waste purposes before B-25 boxes could be obtained. All drums used for this project were 16-gauge steel drums with gasketed lids and "C-ring" closure mechanisms commonly used for hazardous wastes. The B-25 boxes used for bulk mixed waste were standard 4 ft by 4 ft x 6 ft containers with a net weight rating of 6000 pounds. Each box came with a removable lid and locking clips that were either pounded in from the top or side of welded clasps at 14 locations around the outside of the box.

The loaded drums and B-25s were labeled as 'Hazardous Waste' with EPA hazardous waste codes F001-F005 listed. During waste shipments, the drums were classified as DOT Hazard Class 3 – Flammable Liquids, UN 1993, due to the presence of volatile liquid scintillation components. The B-25 boxes were classified as DOT Hazard Class 7 – Low Specific Activity, UN 2910, since they did not meet the minimum requirements for bulk packaging of flammable liquids.

4.3.2 Buffer Soils

The buffer soils were loaded into 25 yd^3 intermodal containers, used specifically for soil and debris contaminated with low level radioactivity. Each intermodal was equipped with a hinged metal top and rubber gaskets to prevent infiltration of runoff water. Plastic liners were also installed in each intemodal prior to loading of any soils to ease removal of the materials at the disposal facility. The intermodals were labeled as DOT Hazard Class 7 – Low Specific Activity, UN 2910.

4.3.3 Wastewater

The wastewater collected in the 4000-gallon holding tank required characterization as well in order to evaluate if any potential permitting or processing may have been required prior to release. Two water samples were collected from the tank and sent to Paragon Analytics for chemical and radiological analysis. The results of both sets of analyses were submitted to the City of Ames Water and Pollution Control Department for evaluation. The contents of the tank were compared to both the City of Ames Local Pretreatment Limits (Ames, 2001) for hazardous materials and 10CFR 20 Appendix B for radiological release conditions. The evaluation showed that the hazardous constituents were the limiting case with regard to the City of Ames wastewater treatment system's ability to treat the wastewater. As a result, a conditional one-time release permit from the City of Ames was granted to the NADC on January 13, 2003. The contents of the tank may be released to the sanitary sewer over a period of nine days, either by means of continuous release or in equal volume batches once per day (~115 gallons/day). Supporting information regarding the wastewater release may be found in Appendix E.

4.3.4 Operational Waste Management

Operational waste materials generated during the remediation project were separated as non-investigative waste or investigation derived waste (IDW). Non-investigative waste, such as litter and household garbage, was collected in bins and taken to onsite dumpsters or receptacles at the NADC. IDW generated during the project included used PPE or consumable supplies used within the CZ. All IDW was treated as potentially contaminated waste and collected into bags or spare drums and loaded into intermodal containers for disposal. Approximately 100 ft^3 of IDW was generated during the investigation.

5.0 FINAL STATUS SURVEY OF SITE 1

A FSS designed in accordance with the MARSSIM (NRC, 2000) was performed to verify successful remediation of Site 1. Details of the design and methodology for the Site 1 FSS are provided in Appendix A of the WP.

5.1 Designated Survey Units

Site 1 was divided into two basic survey units (SU) and a single reference area:

Class 1 SU Interior surfaces (4 side walls and floor) of all 16 burial pits. Effective area ~820 m^2.

Class 2 SU Surface soils surrounding the burial locations, both within the primary excavation and outside. Survey Unit Area ~2000 m^2.

Reference Area 150 ft by 150 ft (2090 m^2) area located to the north of Road A. Area chosen since it has similar physical, chemical, radiological, and biological characteristics as the site area being remediated, but which has not been contaminated by site activities.

The relative locations of each survey unit are shown in Appendix A.

5.2 Cleanup Criteria for FSS

For the purposes of the USDA NADC site remediation project, a comparison of the EPA Generic Soil Screening Guidance for Radionuclides versus risk-based Derived Concentration Guideline Levels (DCGLs) for soil using RESRAD (ANL, 2002) and a dose limit of 15 mrem/yr was performed (CABRERA 2002a). Since the NADC is permitted to possess radioactive material under the USDA's broad scope license, the remediation of Site 1 must also adhere to NRC decommissioning guidance. Therefore, the risk-based derived DCGLs were also compared to the Interim Screening Values for Surface Soil Contamination, as published in NUREG-1727. (NRC 2000b) The intent of this screening was to choose appropriately conservative cleanup goals that would be found acceptable to both the EPA and NRC. The chosen Cleanup Goals for Site 1 are shown in Table 5-1.

Table 5-1: Radiological Cleanup Criteria for Site 1

Radionuclide	Name	Half Life (years)	Principal Modes of Decay	Cleanup Goal (pCi/g)
H-3	Tritium	12.3	β (0.0185 MeV)	110
C-14	Carbon-14	5,730	β (0.157 MeV)	5.57
Ni-63	Nickel-63	100	β (0.0669 MeV)	2100

When determining appropriate cleanup goals for chemicals for the USDA NADC site project, reviews of the Iowa Land Recycling Program limits for soil (mg/kg) and groundwater (mg/L) and generic Soil Screening Levels for Chemicals in Soil (EPA, 1996) were performed. Cleanup goals were set at the lowest soil and groundwater concentrations. (CABRERA 2002a)

Table 5-2: Chemical Cleanup Criteria for Site 1

Chemical	Soil (mg/kg)	Groundwater (mg/L)
Benzene	0.03	0.005
Ethyl Benzene	13	0.7
Toluene	12	1
Xylene	190	10
Lead	400	0.015
Cyanide	40	0.2
PPO[1]	0.03	0.05
POPOP[1]	0.03	0.05
Formaldehyde[2]	-	1
1,2,4-Trimethylbenzene[3]	5.2	1.2

1 According to the manufacturer of POPOP and PPO, the chemical, physical, and toxicological properties have not been thoroughly investigated. Therefore, benzene will be used as a surrogate screening material for PPO and POPOP, as it represents the primary constituent of PPO and POPOP scintillation cocktails. Please see Appendix C of the EE/CA for the NADC waste site for more information on the risk assessment. (CABRERA 2002a).
2 Toxicity information for formaldehyde is only available for groundwater.
3 The cleanup goals for 1,2,4-Trimethylbenzene were chosen as 10% of the EPA preliminary remediation goals for residential soil (52 mg/L) and tap water (12 mg/L).

5.3 Survey Methodology

5.3.1 Scan Surveys

Radiological scan surveys were performed within all survey units at Site 1 following the MARSSIM protocol described in the WP (CABRERA 2002b). One hundred percent (100%) scan surveys were performed on all surfaces within the Class 1 SU with both sodium iodide (NaI) and Geiger-Mueller (GM) detectors. The Class 2 SU was also scanned with an approximate coverage of 50% (compared to the minimum 25% prescribed in the WP).

The survey was performed by walking straight, parallel lines over an area while moving a suspended 2-inch by 2-inch (2x2) NaI gamma scintillation detector or GM detector in a serpentine motion, 1 to 2 inches above the ground surface. Survey passes were performed, where possible, with a spacing of one meter at an approximate survey speed of 0.5 meters per second. The purpose of the GM survey was to detect local areas of elevated beta activity (specifically C-14) that the NaI would be unable to detect.

A differentially corrected global positioning system (GPS) was also utilized during the NaI Class 2 SU and reference area surveys to allow for geospatial correlation and imaging of the survey data. Data from the Ludlum Model 2221 ratemeter/scaler was automatically logged into the GPS unit once per second while surveys were performed. After completion of the survey, the data was downloaded from the GPS into geographic information software (GIS) for processing and imaging. The imaged survey data was then plotted on a site map for investigation and presentation. The results of the NaI survey for Site 1 are presented in Figure A-2.

All surveys with the GM array were performed manually as it was not equipped with a GPS unit. The survey methodology consisted of observing the meter for count rates exceeding twice that of a previously established background value. If any areas exhibited count rates greater than twice background, the technician would mark the spot with a survey flag for a biased static count to be performed. In addition to the surface scan, static counts were also performed at eight soil sample locations, chosen randomly.

All scan surveys within the excavated burial pits were recorded manually as the small size of each survey made GPS use ineffective. These survey forms are included in Appendix A.

5.3.2 Soil Sampling And Analysis

Soil samples were collected from the Class 1, Class 2, and Reference Area survey units in accordance with the WP and FSS Plan. Surface grab samples were collected with either a hand auger or trowel from the first six inches of available soil. All composite samples were thoroughly mixed in a stainless steel bowl prior to being placed into the sample container. All radiological soil samples were collected in double-lined ziplock bags and labeled using laboratory-supplied sample labels.

5.3.2.1 FSS Radiological Samples

A summary of the number and type of soil samples collected is presented in Table 5-3.

Table 5-3: Summary of FSS Soil Samples

Survey Unit	Sample Type	Number of Samples Collected	Number of QC Duplicates Collected
Class 1	Surface Soil	80	7
Class 1	Subsurface Soil	16	1
Class 2	Surface Soil	24	2
Reference Area	Surface Soil	24	2

The MARSSIM specified number of soil samples (refer to Section 3.2.4.2 of the WP) was used for the Class 2 and Reference Area survey units. Despite the fact that 24 samples does represent a statistically valid number for disproving the null hypothesis for Site 1, it was determined to be too few based on the nature and geometry of the burials. With this in mind, an alternate Class 1 sampling criteria was developed. The new sampling criteria called for a surface soil sample (0-6”) from the ‘floor’ and a sample from each ‘wall’ of the pit plus one subsurface sample from the floor (6”-12”). The subsurface sample was prescribed to help ensure that the NRC soil screening criteria was being appropriately applied. The ‘wall’ samples were collected at the center portion of the wall approximately 1 foot above the excavation floor. A consistent sample naming convention was used, with the sample from the south wall as #1, east #2, north #3, and west #4. All pit wall samples were labeled using this convention.

The Class 2 samples were collected at systematic locations using a triangular grid pattern with a spacing of 10 meters as described in the WP. Samples 1 through 9 were placed within the overburden soil laydown area to the north of the burial pits; samples 10 through 17 from the benched portion of the excavation adjacent to the north wall of the pits; and samples 18 through 24 in the support zone of the CZ where material packaging and loading activities were performed. Actual sample locations as measured with the GPS unit are indicated in Figure A-3. The actual sample points were as close to the planned locations as possible, taking into account physical obstructions.

The reference area sample locations were randomly located within the boundaries of the survey unit in accordance with MARSSIM recommendations. GPS locations of these points are also shown in Figure A-3.

5.3.2.2 FSS Chemical Samples

Soil samples for chemical analyses were also collected during the FSS in accordance with Table 7-1 of the WP. Two 500-ml amber jars were filled with composite samples of the same soils sampled for radiological analysis. Three 5-gram Encore® samplers were also collected for VOC analysis. Encore® samplers were chosen for VOC samples such that field preservation techniques would not be required. Results of the chemical samples are provided in Section 6.4.

5.3.3 Groundwater Sampling and Analysis

The existing groundwater monitoring wells at Site 1 were sampled before and after remediation of the buried waste materials. The wells were sampled using disposable 1-liter polyethylene balers. Approximately 5-gallons of water were purged from each well prior to sample collection. Three liters of water were collected from each well for analysis. Monitoring well 5 (MW-5) was not sampled as it was out of service. Baseline samples were collected at the NADC on August 27, 2002 and analyzed for each ROC. The post-remediation samples were collected on November 20, 2002 using the same techniques. Results of both rounds of sampling are provided in Section 6.6.2.

6.0 SURVEY RESULTS AND EVALUATION OF DATA QUALITY OBJECTIVES

6.1 Identify the Decision

Survey and sampling data have been evaluated with respect to the following in order to demonstrate compliance with Data Quality Objectives (DQOs) stated in the WP (CABRERA 2002b). Principally,

- *Do Radionuclides of Concern (ROCs) concentrations in each survey unit at the NADC site exceed background concentrations by more than the Derived Concentration Guideline Level ($DCGL_W$) of Sum of the Ratios (SOR) of 1.0 and, if so, where are elevated concentrations located?*

- *Do subsurface concentrations of ROCs exist above instrument minimum detectable activities (MDAs) such that application of the Nuclear Regulatory Commission's (NRC) Soil Screening Values (SSVs) is no longer appropriate?*

6.2 Evaluation of Scan Survey Results

Scan surveys of both SUs and the background reference area were performed in accordance with the FSS plan. The results of the gamma walkover surveys for the Class 2 and reference areas were recorded with the GPS and plotted onto image maps for viewing. The results are shown in Figure A-2. The observed ambient background count rates for Site 1 varied between 7000 – 11,000 counts per minute (cpm), depending upon area and weather conditions. A more detailed discussion of the effects of weather on the ambient backgrounds is provided in Appendix F, Instrument Quality Assurance/Quality Control.

Scan surveys with a GM detector were also performed in the Class 1 and Class 2 SUs to investigate the potential for discrete areas of measurable beta contamination (i.e. C-14). The survey forms recorded during the GM scans are provided in Appendix C. The results of the gamma scan survey and GM scans indicated no discrete areas of contamination in either SU that would warrant further investigation or biased sampling.

6.3 Evaluation of Radiological Laboratory Sample Results

All surface soil samples collected at Site 1 were analyzed for the ROCs using liquid scintillation and gamma spectroscopy counting techniques. Liquid scintillation counting was the primary analysis used to quantify residual levels of the ROCs in the collected FSS samples since all three are pure beta emitting radionuclides. The gamma scan was performed as a conservative measure in the event that any other radionuclides used at NADC in the past (e.g. Na-22, Ra-226) were present in unexpected quantities.

All soil survey results were analyzed using the Wilcoxon Rank Sum (WRS) test described in Section 3.1.3.1 of the FSS Plan and in the MARSSIM. In summary, the results from the Class 1 SU (pit samples), Class 2 SU, and reference area were reduced to sums of ratios (SOR) with regard to each ROC and its respective Cleanup Goal (aka $DCGL_w$). The reference area SOR results were then adjusted ("+1") in preparation for ranking with the raw SOR values from each SU. Once ranking of all samples was performed, the sum of the ranks of the adjusted reference area measurements (W_r) was calculated. The calculated W_r is then directly compared to the Critical Value for the Site 1 SUs. The Critical Value is the minimum value that the W_r can be to successfully reject the null hypothesis.

6.3.1 Class 1 Surface Soil Sample Results

A summary of the Class 1 surface soil sample analysis results for the ROCs is shown in Table 6-1. Detailed results for each ROC are also provided in Appendix C.

Table 6-1: Summary of Class 1 Surface Soil Sample Results for Site 1

Sample Location	H-3 Mean Result (pCi/g)	H-3 Std Dev (2σ)	C-14 Mean Result (pCi/g)	C-14 Std Dev (2σ)	Ni-63 Mean Result (pCi/g)	Ni-63 Std Dev (2σ)	Gamma Scan Result (pCi/g)
Pit 1	-0.12	0.03	0.98	0.73	-1.56	0.92	<MDC
Pit 2	0.00	0.04	1.56	1.68	-0.92	2.46	<MDC
Pit 3	0.01	0.06	0.57	2.47	-0.34	0.93	<MDC
Pit 4	0.01	0.03	0.86	2.83	-1.12	3.53	<MDC
Pit 5	0.01	0.05	1.30	0.76	-0.62	1.07	<MDC
Pit 6	0.03	0.02	1.02	1.69	-0.22	1.48	<MDC
Pit 7	0.13	0.21	0.20	0.98	-3.06	3.11	<MDC
Pit 8	0.17	0.13	0.35	1.63	-1.50	1.04	<MDC
Pit 9	0.31	0.36	0.87	2.54	-1.53	1.25	<MDC
Pit 10	0.65	0.83	2.20	3.12	-2.60	3.08	<MDC
Pit 11	0.29	0.22	2.15	2.59	-1.75	1.35	<MDC
Pit 12	0.10	0.07	0.10	1.62	-1.30	1.52	<MDC
Pit 13	0.07	0.09	1.13	1.81	-0.98	1.92	<MDC
Pit 14	0.39	0.25	1.20	1.66	0.14	0.83	<MDC
Pit 15	1.17	2.34	4.42	6.99	0.92	1.05	<MDC
Pit 16	0.41	0.84	1.82	2.23	0.12	2.14	<MDC
Cumulative Mean (pCi/g)	**0.23**		**1.28**		**-1.04**		
Cumulative Std Dev (2σ) (pCi/g)	**0.85**		**3.12**		**2.60**		
DCGLw (pCi/g)	**110**		**5.57**		**2100**		
Number of Samples	**87**		**87**		**87**		

The mean for each set of pit samples and the cumulative mean for the Class 1 SU are both below the $DCGL_w$ for each ROC. All gamma spectroscopy scan results only indicated terrestrial sources of natural background (Bismuth-214 and Lead-214).

Only one soil sample taken from the Class 1 SU had a result greater than a $DCGL_w$. Sample RP15S03-GB, taken from the northern wall of Pit 15, had a C-14 result of 10.2 pCi/g, versus a $DCGL_w$ of 5.57 pCi/g. However, the mean C-14 value for all five soil samples in Pit 15 was only 4.42 pCi/g. The results of the WRS test for this data are provided in Section 6.5.2 below.

6.3.2 Class 2 Surface Soil Samples

A summary of the Class 2 surface soil sample analysis results is shown in Table 6-2. Detailed results for each ROC are also provided in Appendix C.

Table 6-2: Summary of Class 2 surface soil sample results for Site 1

Sample ID	H-3 Result (pCi/g)	C-14 Result (pCi/g)	Ni-63 Result (pCi/g)	Gamma Scan Result
RC2S01-GB	0.02	2.4	-2.2	<MDC
RC2S02-GB	0.02	1.7	-3.7	<MDC
RC2S03-GB	0.00	0.8	-2.7	<MDC
RC2S04-GB	0.03	0.9	-5	<MDC
RC2S05-GB	-0.02	1.2	-0.7	<MDC
RC2S06-GB	-0.01	-0.9	-1.6	<MDC
RC2S07-GB	0.02	-0.3	-3	<MDC
RC2S08-GB	0.02	0.3	-2.4	<MDC
RC2S09-GB	0.02	-0.4	-2.1	<MDC
RC2S10-GB	0.23	1.2	-1.9	<MDC
RC2S11-GB	0.08	0.2	-3	<MDC
RC2S12-GB	0.22	0.0	-2.4	<MDC
RC2S13-GB	0.14	0.3	-3.4	<MDC
RC2S14-GB	0.04	0.3	-3.2	<MDC
RC2S15-GB	0.04	0.9	-2.3	<MDC
RC2S16-GB	0.32	1.7	-2.6	<MDC
RC2S17-GB	0.06	-0.1	-5.2	<MDC
RC2S18-GB	0.00	0.4	-2.8	<MDC
RC2S19-GB	0.01	2.6	-3.4	<MDC
RC2S20-GB	0.02	0.9	-3.7	<MDC
RC2S21-GB	-0.3	-0.3	-0.3	<MDC
RC2S22-GB	-0.8	-0.8	-0.8	<MDC
RC2S23-GB	-0.1	-0.1	-0.1	<MDC
RC2S24-GB	0.7	0.7	0.7	<MDC
RC2S01-GB-D	-1.1	-1.1	-1.1	<MDC
RC2S08-GB-D	1.1	1.1	1.1	<MDC
Cumulative Mean (pCi/g)	**0.03**	**0.5**	**-2.2**	
Cumulative Std Dev (2σ, pCi/g)	**0.79**	**1.9**	**3.1**	
DCGLw (pCi/g)	**110**	**5.57**	**2100**	
Number of Samples	**26**	**26**	**26**	

All Class 2 SU samples were both below the $DCGL_W$ for each ROC. The gamma spectroscopy scan results indicated only terrestrial sources of natural background (Bismuth-214 and Lead-214).

6.4 Evaluation of Chemical Laboratory Sample Results

The chemical samples were analyzed for the COCs listed in Table 5-2. A summary of results for all analyses is provided in Table 6-3. The method utilized by the analytical laboratory is listed along with the Method Detection Limit (MDL).

Detectable levels of Toluene, 1,2,4 Trimethylbenzene, and formaldehyde were reported during the course of the FSS, but at concentrations far below the established cleanup goals. The Trimethylbenzene did not appear in the original list of COCs but was added after sample results showed positive indication of the chemical (see Section 5.2).

Table 6-3: Summary of COC Sample Analyses

Sample ID	Benzene	Ethyl Benzene	Toluene	Total Xylene	1,2,4 Trimethyl Benzene	Lead	Cyanide	PPO[1]	POPOP[2]	Formal-dehyde[3]	ph[3]
Method	EPA 8260	EPA 8260	EPA 8260	EPA 8260	EPA 8260	EPA SW6010	EPA SW846	EPA 8260	EPA 8260	NIOSH 3500	EPA 150.1
Cleanup Goal	30	1300	1200	19000	5200	40000	4000	30	30	N/A	N/A
MDL	5 - 7.9	5 - 7.9	5 - 7.9	5 - 7.9	5 - 7.9	360	100	5 - 7.9	5 - 7.9	3.1	0.1
CP1S01-CO	MDL	MDL	MDL	MDL	MDL	5400	MDL	MDL	MDL	6.2	7.7
CP2S01-CO	MDL	MDL	MDL	MDL	MDL	5600	MDL	MDL	MDL	MDL	7.8
CP3S01-CO	MDL	MDL	MDL	MDL	MDL	5500	MDL	MDL	MDL	5.7	8.3
CP4S01-CO	MDL	MDL	MDL	MDL	MDL	4700	MDL	MDL	MDL	MDL	7.8
CP5S01-CO	MDL	MDL	MDL	MDL	MDL	4900	MDL	MDL	MDL	MDL	8.0
CP6S01-CO	MDL	MDL	MDL	MDL	MDL	5900	MDL	MDL	MDL	MDL	8.8
CP7S01-CO	MDL	MDL	MDL	MDL	MDL	5200	MDL	MDL	MDL	MDL	8.3
CP7S01-CO-D	MDL	MDL	MDL	MDL	MDL	6500	MDL	MDL	MDL	MDL	8.4
CP8S01-CO	MDL	MDL	MDL	MDL	MDL	6200	MDL	MDL	MDL	MDL	8.5
CP9S01-CO	MDL	MDL	MDL	MDL	MDL	4900	MDL	MDL	MDL	MDL	8.2
CP10S01-CO	MDL	MDL	MDL	MDL	MDL	4800	MDL	MDL	MDL	MDL	8.1
CP11S01-CO	MDL	MDL	MDL	MDL	MDL	4600	MDL	MDL	MDL	MDL	7.9
CP12S01-CO	MDL	MDL	MDL	MDL	MDL	5400	MDL	MDL	MDL	MDL	8.1
CP13S01-CO	MDL	MDL	MDL	MDL	MDL	6000	MDL	MDL	MDL	MDL	8.1

Table Notes

All results are in micrograms/kilogram (ppb)
[1] PPO (2, 5-Diphenyloxazole)
[2] POPOP (2-(5-Phenyloxazole)Benzene)
[3] No specified clean-up goal

MDL = Method Detection Limit
"CP" = Class 1 (Pit) Samples
"CC2" = Class 2 Area Samples
"CRF" = Reference Area Samples

Table 6-3 (cont.): Summary of COC Sample Analyses

Sample ID	Benzene	Ethyl Benzene	Toluene	Total Xylene	1,2,4 Trimethyl Benzene	Lead	Cyanide	PPO[1]	POPOP[2]	Formal-dehyde[3]	ph[3]
Method	EPA 8260	EPA 8260	EPA 8260	EPA 8260	EPA 8260	EPA SW 6010	EPA SW 846	EPA 8260	EPA 8260	NIOSH 3500	EPA 150.1
Cleanup Goal	30	1300	1200	19000	5200	40000	4000	30	30	N/A	N/A
MDL	5 - 7.9	5 - 7.9	5 - 7.9	5 - 7.9	5 - 7.9	360	100	5 - 7.9	5 - 7.9	3.1	0.1
CP14S01-CO	MDL	MDL	MDL	MDL	MDL	5000	MDL	MDL	MDL	BQL	8.1
CP15S01-CO	MDL	MDL	MDL	MDL	MDL	5200	MDL	MDL	MDL	BQL	8
CP16S01-CO	MDL	MDL	91	MDL	54	4700	MDL	MDL	MDL	BQL	8.4
CC2S01-CO	MDL	MDL	MDL	MDL	MDL	9700	MDL	MDL	MDL	N/A	7.9
CC2S02-CO	MDL	MDL	MDL	MDL	MDL	7400	MDL	MDL	MDL	N/A	8
CRFS01-CO	MDL	MDL	MDL	MDL	MDL	12000	MDL	MDL	MDL	N/A	7.6
CRFS01-CO	MDL	MDL	MDL	MDL	MDL	11000	MDL	MDL	MDL	N/A	7.7

Table Notes

All results are in micrograms/kilogram (ppb)
[1] PPO (2, 5-Diphenyloxazole)
[2] POPOP (2-(5-Phenyloxazole)Benzene)
[3] No specified clean-up goal

MDL = Method Detection Limit
“CP” = Class 1 (Pit) Samples
“CC2” = Class 2 Area Samples
“CRF” = Reference Area Samples

6.5 Results of MARSSIM Statistical Tests

6.5.1 Calculation of Critical Values

Appendix I of the MARSSIM manual (NRC 2000) provides guidance for developing Critical Values for SUs requiring use of the WRS test to evaluate surface soils. Critical Values for the SUs at Site 1 were calculated because the number of samples exceeded the predetermined values in the MARSSIM tables. The equation used is shown below:

$$CriticalValue = \frac{m(n+m=1)}{2} + z\sqrt{\frac{nm(n+m+1)}{12}}$$

where: m = number of reference area samples = 26
n = number of survey unit samples = 87 for Class 1 SU
= 26 for Class 2 SU
z = (1-alpha) percentile factor for a standard normal distribution = 1.645

The resulting Critical Values for Site 1 are: **Class 1 = 1723**
Class 2 = 779

6.5.2 Results of WRS Test

The results of the WRS test for the Class 1 and Class 2 SUs is presented in Table 6-4. The complete WRS test calculation worksheets are presented in Appendix G.

Table 6-4: WRS Test Results Summary

FSS Parameter / Criteria	Class 1	Class 2
Sum of Reference Area Ranks (W_r)	2489	988
Critical Value	1723	779
Survey Unit Pass / Fail ?	**PASS**	**PASS**

By virtue of W_r being greater than the Critical Value, both SUs satisfy the criterion for passing the WRS test. Therefore, the null hypothesis is rejected and the first decision posed in the DQOs has been successfully answered.

6.5.3 Elevated Measurement Comparison

The MARSSIM statistical tests on the results of the systematic sampling evaluate whether or not the average residual radioactivity in a survey unit exceeds the $DCGL_W$. Since the mean includes values that are higher and lower than the cleanup goal, there should be a reasonable level of assurance that any small areas of elevated residual radioactivity are not too high. In MARSSIM, the process of determining the value that is "too high" is termed the cleanup goal elevated measurement comparison $DCGL_{EMC}$.

One method for determining values for the $DCGL_{EMC}$ is to modify the $DCGL_w$ using a correction factor that accounts for the difference in area and the resulting change in dose or risk. That is, as the concentration of radionuclide is elevated, the area must be reduced to keep the risk from rising. The area factor (AF) is the magnitude by which the concentration of radionuclide within the small area of elevated activity can exceed $DCGL_w$ while maintaining compliance with the dose-based release criteria. If the $DCGL_w$ for residual radioactivity distributed over the entire Class 1 area is multiplied by this AF value, the resulting concentration distributed over the specified smaller area delivers the same calculated radiation dose.

Since one C-14 sample resulted in a value greater than the DCGLw, an AF was calculated using the same RESRAD exposure pathway model as in the EE/CA (CABRERA, 2002a). The default area of contamination was set to $10m^2$, corresponding to the entire surface area of the north wall of Pit 15, where the elevated sample result was collected (wall dimensions ~ 15 ft. wide by 7 ft deep = 105 ft^2 = 9.75 m^2). AF's were calculated for C-14 over areas of 5, 10, and 20 m^2 at Site 1 as shown in Table 6-5 below.

Table 6-5: Area Factors for C-14 at Site 1

Area of Elevated Activity (m^2)	20	10	5
C-14 Area Factor	62	122	248

Based on the AFs calculated in Table 6-5, the elevated result would have to be at least a factor of 62 greater than the $DCGL_w$ of 5.57 pCi/g (~345 pCi/g) to give a subsequent dose greater than 15 millirem (mrem) per year. The measurement in Pit 15 is less than a factor of 2 greater (10.2 pCi/g) so the EMC criteria are satisfied at Site 1.

6.6 Other Survey Considerations

6.6.1 Subsurface Soil Sample Results

Subsurface soil samples were also collected in the Class 1 SU approximately 6 to 12 inches below the floor of each excavation. This was done to support the use of NRC soil screening values (SSVs) during the FSS planning process. The SSVs only apply to surface soils, so these subsurface soil samples were collected to provide information regarding whether any residual contamination was present in the remediated pits at depth (i.e. volumetric contamination). A comparison of the subsurface sample results to the reference area results is provided in Table 6-6.

Table 6-6: Subsurface Soil Sample Results Comparison

	Subsurface Sample Statistics	Reference Area Statistics
H-3		
Number of Samples	17	26
Max (pCi/g)	0.92	0.07
Mean (pCi/g)	0.25	0.01
Std Deviation (1σ)	0.30	0.03
Mean + 2σ	0.85	0.07
Mean + 3σ	1.15	0.10
C-14		
Number of Samples	17	26
Max (pCi/g)	2.90	3.70
Mean (pCi/g)	0.86	2.14
Std Deviation (1σ)	0.93	0.94
Mean + 2σ	2.72	4.03
Mean + 3σ	3.65	4.97
Ni-63		
Number of Samples	17	26
Max (pCi/g)	1.2	-0.10
Mean (pCi/g)	-0.58	-1.79
Std Deviation (1σ)	0.95	1.20
Mean + 2σ	1.32	0.61
Mean + 3σ	2.27	1.81

Analysis of the subsurface soil results in Table 6-5 shows no discernible activity above the mean value in the reference area for either C-14 or Ni-63. The sample data for H-3 does appear to indicate positive residual activity above the mean value of the reference area. However, the maximum single measurement observed in the sample population represents less than 1% of the surface soil DCGLw for H-3, with the mean value lower by a factor of four. [The mere detectability of H-3 does not justify rejection of the applicability of the SSV at Site 1 as the presence at any concentration above background is not necessarily an indication of a subsurface, volumetric source of contamination. Given the distribution and very low levels, additional excavation does not appear to be warranted and the DQO principal question #2 has been satisfactorily answered.]

6.6.2 Groundwater Well Sample Results

The existing groundwater wells were sampled before and after remediation of the burial pits as prescribed in the WP. The results of the analytical results are provided in Table 6-7 below. The scope of the remediation project at Site 1 only called for analysis for the ROCs as the NADC conducts independent testing of the groundwater monitoring wells for hazardous constituents.

Table 6-7: Summary of Groundwater Well Radiological Results

Sample Location / ID		H-3 Result (pCi/L)	H-3 Uncert (2σ) (pCi/L)	H-3 MDC (pCi/L)	C-14 Result (pCi/L)	C-14 Uncert[2] (2σ) (pCi/L)	C-14 MDC[2] (pCi/L)	Ni-63 Result (pCi/L)	Ni-63 Uncert (2σ) (pCi/L)	Ni-63 MDC (pCi/L)
Blanks[1] (MW-5)	Baseline	-140	230	380	90	270	440	-1.0	3.5	6.0
	Post-Remed	-30	210	360	90	110	180	-6.5	4.7	7.6
MW-1	Baseline	-230	220	380	-50	270	440	-1.3	2.2	3.7
	Post-Remed	-80	210	360	80	110	180	-6.7	4.1	6.4
MW-2	Baseline	-30	220	380	130	270	440	0.1	1.5	2.5
	Post-Remed	-40	210	360	90	110	180	-3.1	4.3	7.1
MW-3	Baseline	-250	230	380	30	270	440	-1.5	2.2	3.7
	Post-Remed	-20	210	360	170	120	180	-3.8	4.6	7.7
MW-4	Baseline	-70	220	380	-100	270	440	-0.1	2.7	4.5
	Post-Remed	-10	210	360	20	110	180	-4.4	3.9	6.3
MW-6	Baseline	-160	220	380	-40	270	440	-1.6	2.7	4.5
	Post-Remed	30	210	360	180	120	180	-7.6	5.3	8.5

1 Deionized water was used in place of the MW-5 samples to serve as blanks.
2 The difference in sample uncertainty and MDC between the first and second rounds of sampling was due to a change of count time used by the analytical laboratory (150 minutes for baseline counts versus 220 minutes for post-remediation samples.

Comparison of the pre- and post-remediation monitoring well samples shows that all samples were at or below the sample-specific MDC for each ROC.

6.6.3 Analysis of Field Duplicate Samples

The duplicate samples collected during the FSS were investigated using the normal absolute difference (NAD) methodology described in Section 7.5 of the WP. All radiological duplicate results were found to be satisfactorily within the 1.96 criteria. NAD calculations are provided in Appendix F.

7.0 CONCLUSIONS

CABRERA has completed remediation of the mixed waste burial pits at Site 1. Laboratory wastes buried between the years of 1971 and 1980 were excavated, packaged, and disposed in accordance with the approved WP. A MARSSIM FSS was also performed following remediation. The FSS included radiological scan surveys, surface soil samples, and subsurface soil samples for the ROCs and COCs presented in the approved WP.

A review of sample data shows that data of sufficient quality and quantity have been taken and that no significant residual radioactive or chemical contamination exists at Site 1 above the stated cleanup goals. This conclusion is based on the results of the statistical analysis of the data as identified in the Work Plan. Therefore, Site 1 should be suitable for release for unrestricted use with no additional radiological or chemical controls necessary.

8.0 REFERENCES

(ANL, 2002) RESRAD for Windows computer code. Version 6.2. Environmental Assessment Division, Argonne National Laboratory. May 16, 2002.

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(CABRERA, 2002a) EE/CA for the USDA NADC Site, July 2002.

(CABRERA, 2002b) Interim Removal Action Work Plan for the USDA NADC Site, August 2002.

(CABRERA, 2002c) Site Safety and Health Plan for the USDA NADC Site, August 2002.

(EPA, 1996) Soil Screening Guidance: Technical Background Document, Second Edition. Publication No. 9355.4-17A, Environmental Protection Agency, Washington D.C., May 1996.

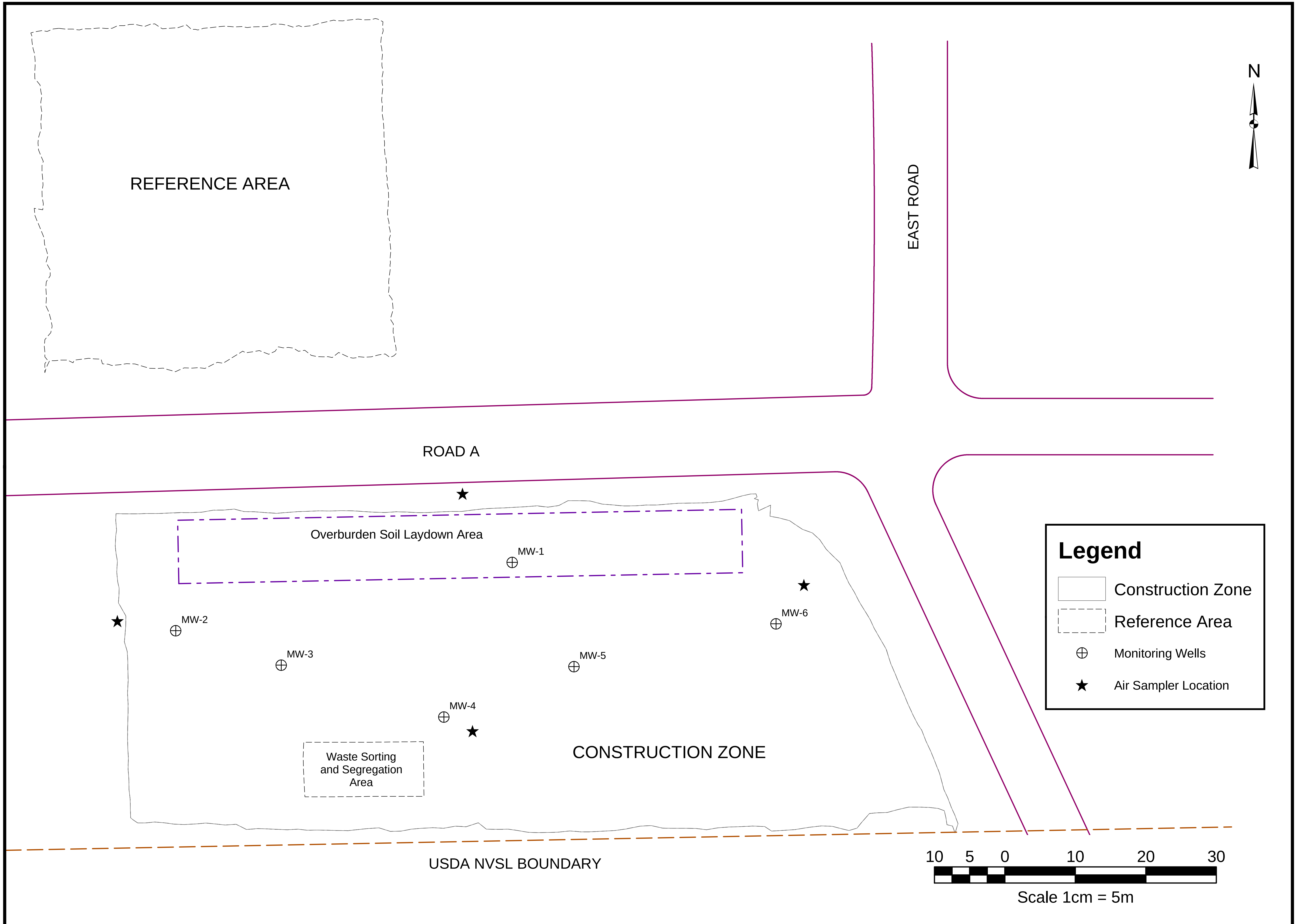
(NRC, 2000) NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), U.S. Nuclear Regulatory Commission, August 2000.

(NRC, 2000b) NUREG-1727, NMSS Decommissioning Standard Review Plan, U.S. Nuclear Regulatory Commission, September 2000.

(USDA, 1989) Memorandum to Donald Tyler, from Donald T. Brayman; "Investigation of Waste Radioisotope Burial Site at the National Animal Disease Center, Ames, Iowa." December 12, 1989.

Appendix A

Final Status Survey Forms and Maps



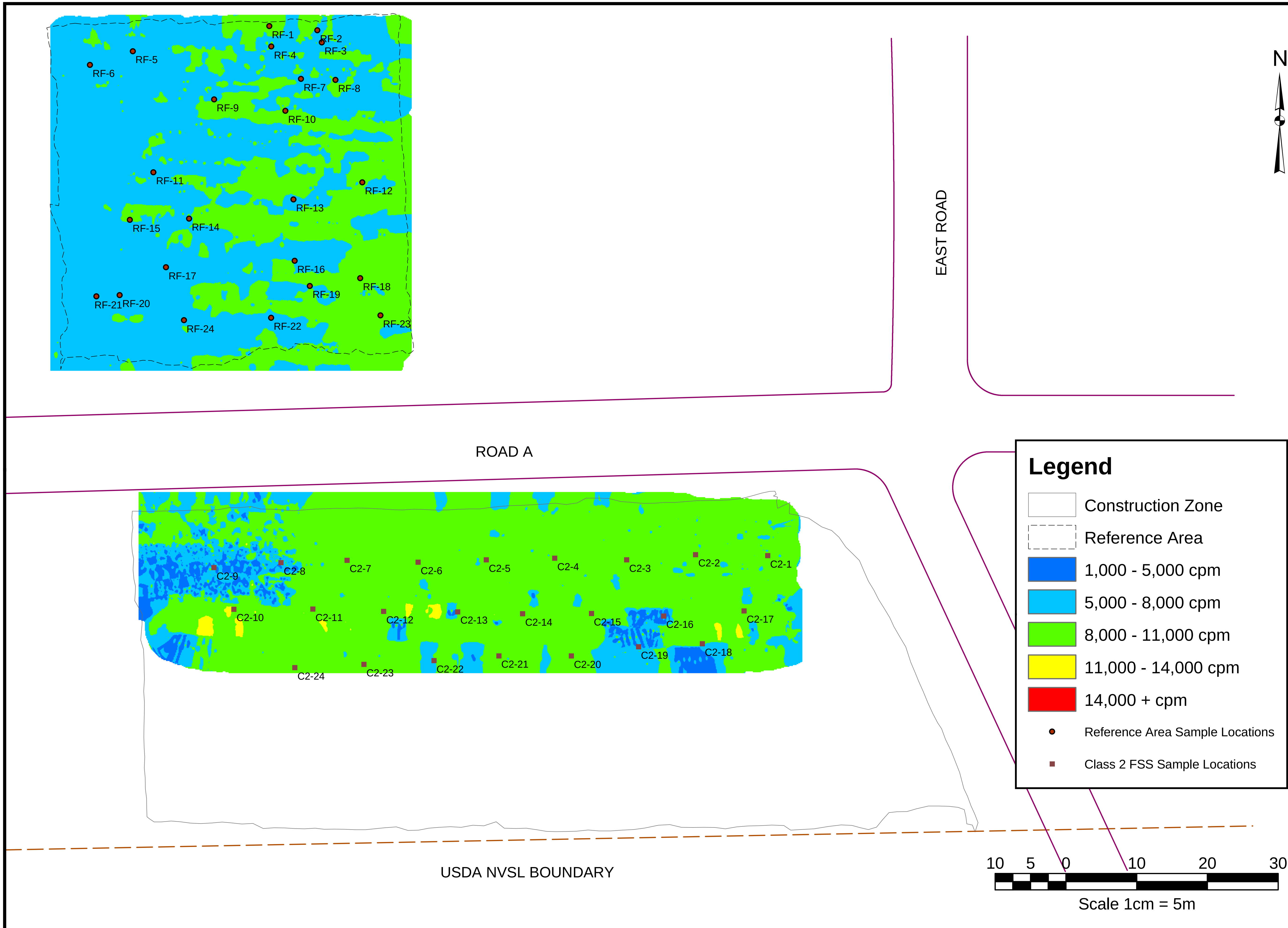
CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

Date: January 6, 2003
Project #: 03-3030.03
File Name: 03-3030.03.001
Prepared By: GEB

USDA Ames Phase II

SITE 1 GENERAL AREA

A-1



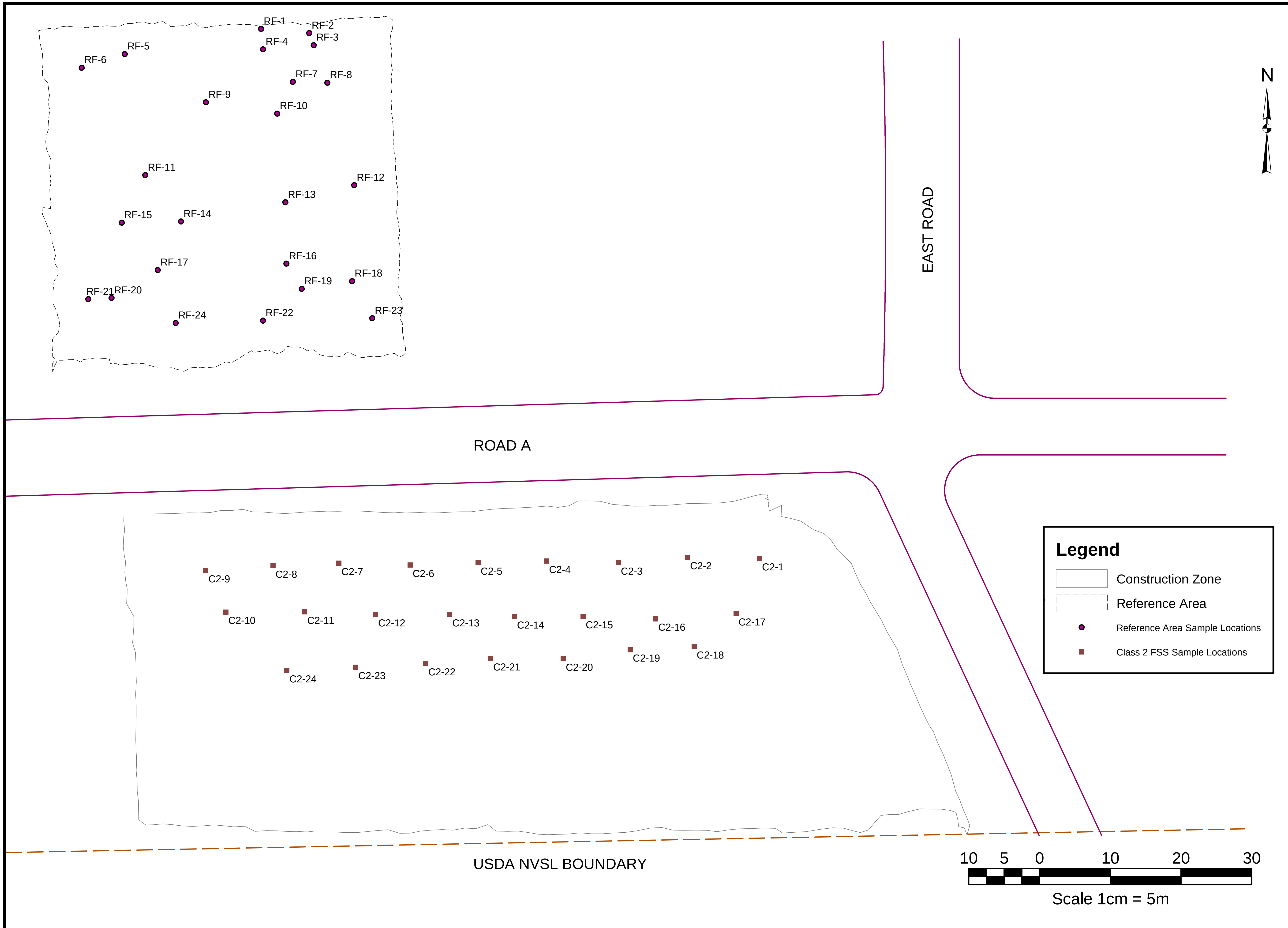
CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

Date: January 6, 2003
Project #: 03-3030.03
File Name: 03-3030.03.002
Prepared By: GEB

USDA Ames Phase II

GAMMA WALKOVER SURVEY AREA

A-2



CABRERA SERVICES
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Date: January 6, 2003
Project #: 03-3030.03
File Name: 03-3030.03.003
Prepared By: GEB

USDA Ames Phase II

Class 2 and Reference Area Sample Locations

A-3

Appendix B

Radiation Work Permits

Appendix C

Survey Data Sheets

H-3
Class 1 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
H-3	RP1S01-CO	0.01	0.06	0.11	110	pCi/g	< MDC
H-3	RP1S01-GB	-0.03	0.07	0.12	110	pCi/g	< MDC
H-3	RP1S02-GB	-0.02	0.05	0.09	110	pCi/g	< MDC
H-3	RP1S03-GB	0.00	0.05	0.09	110	pCi/g	< MDC
H-3	RP1S04-GB	-0.03	0.05	0.09	110	pCi/g	< MDC
H-3	RP2S01-CO	0.00	0.05	0.09	110	pCi/g	< MDC
H-3	RP2S01-GB	0.03	0.07	0.12	110	pCi/g	< MDC
H-3	RP2S02-GB	0.01	0.05	0.09	110	pCi/g	< MDC
H-3	RP2S03-GB	-0.02	0.05	0.09	110	pCi/g	< MDC
H-3	RP2S04-GB	0.00	0.07	0.12	110	pCi/g	< MDC
H-3	RP3S01-CO	0.01	0.05	0.09	110	pCi/g	< MDC
H-3	RP3S01-GB-D	0.01	0.05	0.09	110	pCi/g	< MDC
H-3	RP3S01-GB	-0.02	0.04	0.08	110	pCi/g	< MDC
H-3	RP3S02-GB	0.02	0.06	0.10	110	pCi/g	< MDC
H-3	RP3S03-GB	0.01	0.05	0.09	110	pCi/g	< MDC
H-3	RP3S04-GB	0.05	0.04	0.07	110	pCi/g	< MDC
H-3	RP3S01-CO-D	-0.03	0.05	0.08	110	pCi/g	< MDC
H-3	RP4S01-CO	0.04	0.05	0.08	110	pCi/g	< MDC
H-3	RP4S01-GB	-0.01	0.05	0.09	110	pCi/g	< MDC
H-3	RP4S02-GB	0.01	0.05	0.09	110	pCi/g	< MDC
H-3	RP4S03-GB	0.02	0.05	0.09	110	pCi/g	< MDC
H-3	RP4S04-GB	0.02	0.06	0.10	110	pCi/g	< MDC
H-3	RP5S01-CO	0.05	0.60	0.10	110	pCi/g	< MDC
H-3	RP5S01-GB	-0.02	0.09	0.15	110	pCi/g	< MDC
H-3	RP5S02-GB	0.01	0.06	0.10	110	pCi/g	< MDC
H-3	RP5S03-GB	0.00	0.07	0.12	110	pCi/g	< MDC
H-3	RP5S04-GB	0.02	0.07	0.11	110	pCi/g	< MDC
H-3	RP6S01-CO	0.02	0.06	0.09	110	pCi/g	< MDC
H-3	RP6S01-GB	0.04	0.07	0.11	110	pCi/g	< MDC
H-3	RP6S02-GB	0.02	0.07	0.11	110	pCi/g	< MDC
H-3	RP6S03-GB	0.04	0.06	0.10	110	pCi/g	< MDC
H-3	RP6S04-GB	0.04	0.07	0.01	110	pCi/g	< DCGLw
H-3	RP7S01-CO	0.19	0.08	0.11	110	pCi/g	< DCGLw
H-3	RP7S01-GB	0.28	0.08	0.10	110	pCi/g	< DCGLw
H-3	RP7S02-GB	0.01	0.07	0.11	110	pCi/g	< MDC
H-3	RP7S03-GB	0.09	0.06	0.10	110	pCi/g	< MDC
H-3	RP7S04-GB	0.10	0.09	0.15	110	pCi/g	< MDC
H-3	RP8S01-CO	0.23	0.08	0.10	110	pCi/g	< DCGLw
H-3	RP8S01-GB	0.16	0.07	0.10	110	pCi/g	< DCGLw
H-3	RP8S02-GB	0.16	0.07	0.10	110	pCi/g	< DCGLw
H-3	RP8S03-GB	0.08	0.07	0.11	110	pCi/g	< MDC
H-3	RP8S04-GB	0.14	0.07	0.11	110	pCi/g	< DCGLw
H-3	RP8S01-CO-D	0.25	0.08	0.09	110	pCi/g	< DCGLw
H-3	RP9S02-CO	0.17	0.07	0.09	110	pCi/g	< DCGLw
H-3	RP9S01-GB	0.55	0.11	0.15	110	pCi/g	< DCGLw

H-3
Class 1 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
H-3	RP9S02-GB	0.49	0.11	0.11	110	pCi/g	< DCGLw
H-3	RP9S03-GB	0.32	0.09	0.10	110	pCi/g	< DCGLw
H-3	RP9S04-GB	0.20	0.07	0.10	110	pCi/g	< DCGLw
H-3	RP9S01-CO-D	0.14	0.07	0.10	110	pCi/g	< DCGLw
H-3	RP10S01-CO	0.67	0.13	0.09	110	pCi/g	< DCGLw
H-3	RP10S01-GB	0.33	0.09	0.11	110	pCi/g	< DCGLw
H-3	RP10S02-GB	0.30	0.08	0.09	110	pCi/g	< DCGLw
H-3	RP10S03-GB	1.31	0.22	0.10	110	pCi/g	< DCGLw
H-3	RP10S04-GB	0.78	0.15	0.11	110	pCi/g	< DCGLw
H-3	RP10S01-GB-D	0.52	0.11	0.11	110	pCi/g	< DCGLw
H-3	RP11S01-CO	0.91	0.16	0.09	110	pCi/g	< DCGLw
H-3	RP11S01-GB	0.09	0.07	0.11	110	pCi/g	< MDC
H-3	RP11S02-GB	0.08	0.07	0.11	110	pCi/g	< MDC
H-3	RP11S03-GB	0.19	0.08	0.11	110	pCi/g	< DCGLw
H-3	RP11S04-GB	0.35	0.09	0.11	110	pCi/g	< DCGLw
H-3	RP11S03-GB-D	0.15	0.08	0.11	110	pCi/g	< DCGLw
H-3	RP12S01-CO	0.15	0.05	0.07	110	pCi/g	< DCGLw
H-3	RP12S01-GB	0.08	0.05	0.09	110	pCi/g	< MDC
H-3	RP12S02-GB	0.06	0.06	0.10	110	pCi/g	< MDC
H-3	RP12S03-GB	0.10	0.06	0.09	110	pCi/g	< DCGLw
H-3	RP12S04-GB	0.10	0.06	0.08	110	pCi/g	< DCGLw
H-3	RP13S01-CO	0.00	0.05	0.09	110	pCi/g	< MDC
H-3	RP13S01-CO-D	0.06	0.05	0.09	110	pCi/g	< MDC
H-3	RP13S01-GB	0.03	0.05	0.09	110	pCi/g	< MDC
H-3	RP13S02-GB	0.08	0.05	0.09	110	pCi/g	< MDC
H-3	RP13S03-GB	0.10	0.05	0.08	110	pCi/g	< DCGLw
H-3	RP13S04-GB	0.15	0.05	0.06	110	pCi/g	< DCGLw
H-3	RP14S01-CO	0.58	0.11	0.08	110	pCi/g	< DCGLw
H-3	RP14S01-GB	0.32	0.07	0.08	110	pCi/g	< DCGLw
H-3	RP14S02-GB	0.32	0.08	0.08	110	pCi/g	< DCGLw
H-3	RP14S03-GB	0.45	0.09	0.09	110	pCi/g	< DCGLw
H-3	RP14S04-GB	0.27	0.07	0.08	110	pCi/g	< DCGLw
H-3	RP15S01-CO	0.64	0.11	0.07	110	pCi/g	< DCGLw
H-3	RP15S01-GB	0.71	0.13	0.10	110	pCi/g	< DCGLw
H-3	RP15S02-GB	0.15	0.06	0.09	110	pCi/g	< DCGLw
H-3	RP15S03-GB	3.16	0.50	0.12	110	pCi/g	< DCGLw
H-3	RP15S04-GB	1.18	0.21	0.12	110	pCi/g	< DCGLw

H-3
Class 1 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
H-3	RP16S01-CO	1.16	0.19	0.06	110	pCi/g	< DCGLw
H-3	RP16S01-GB	0.14	0.08	0.13	110	pCi/g	< DCGLw
H-3	RP16S02-GB	0.24	0.09	0.12	110	pCi/g	< DCGLw
H-3	RP16S03-GB	0.26	0.08	0.10	110	pCi/g	< DCGLw
H-3	RP16S04-GB	0.25	0.08	0.11	110	pCi/g	< DCGLw

Survey Unit Statistics					
N	87				
Max	3.2	pCi/g	Mean + 2σ	1.1	pCi/g
Mean	0.2	pCi/g	Mean + 3σ	1.5	pCi/g
Median	0.1	pCi/g			
1σ	0.4	pCi/g			
2σ	0.8	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration
4. DCGLw = Derived Concentration Guideline Level (or Cleanup Goal)

C-14
Class 1 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
C-14	RP1S01-CO	0.8	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP1S01-GB	1.5	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP1S02-GB	1.2	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP1S03-GB	0.8	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP1S04-GB	0.6	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP2S01-CO	0.8	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP2S01-GB	0.8	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP2S02-GB	1.3	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP2S03-GB	2.5	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP2S04-GB	2.4	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP3S01-CO	0.3	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP3S01-GB-D	-0.2	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP3S01-GB	1.0	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP3S02-GB	1.9	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP3S03-GB	1.8	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP3S04-GB	0.3	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP3S01-CO-D	-1.1	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP4S01-CO	0.6	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP4S01-GB	1.6	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP4S02-GB	2.9	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP4S03-GB	-0.2	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP4S04-GB	-0.6	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP5S01-CO	1.7	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP5S01-GB	1.4	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP5S02-GB	0.9	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP5S03-GB	1.6	1.8	2.8	5.57	pCi/g	< MDC
C-14	RP5S04-GB	0.9	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP6S01-CO	-0.1	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP6S01-GB	1.4	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP6S02-GB	1.2	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP6S03-GB	2.1	1.8	2.8	5.57	pCi/g	< MDC
C-14	RP6S04-GB	0.5	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP7S01-CO	0.3	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP7S01-GB	0.3	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP7S02-GB	-0.1	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP7S03-GB	-0.4	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP7S04-GB	0.9	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP8S01-CO	-0.3	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP8S01-GB	1.1	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP8S02-GB	0.0	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP8S03-GB	-0.5	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP8S04-GB	1.5	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP8S01-CO-D	0.3	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP9S01-CO	1.0	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP9S01-GB	-1.1	1.7	2.8	5.57	pCi/g	< MDC

C-14
Class 1 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
C-14	RP9S02-GB	2.2	1.8	2.8	5.57	pCi/g	< MDC
C-14	RP9S03-GB	0.4	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP9S04-GB	1.6	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP9S01-CO-D	1.1	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP10S01-CO	4.6	1.9	2.8	5.57	pCi/g	< DCGLw
C-14	RP10S01-GB	0.8	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP10S02-GB	0.9	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP10S03-GB	1.8	1.8	2.8	5.57	pCi/g	< MDC
C-14	RP10S04-GB	4.4	1.9	2.8	5.57	pCi/g	< DCGLw
C-14	RP10S01-GB-D	0.7	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP11S01-CO	0.2	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP11S01-GB	0.4	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP11S02-GB	3.0	1.8	2.9	5.57	pCi/g	< DCGLw
C-14	RP11S03-GB	2.3	1.8	2.8	5.57	pCi/g	< MDC
C-14	RP11S04-GB	3.5	1.8	2.8	5.57	pCi/g	< DCGLw
C-14	RP11S03-GB-D	3.5	1.8	2.9	5.57	pCi/g	< DCGLw
C-14	RP12S01-CO	1.2	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP12S01-GB	0.3	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP12S02-GB	-0.8	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP12S03-GB	-0.6	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP12S04-GB	0.4	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP13S01-CO	2.1	1.8	2.8	5.57	pCi/g	< MDC
C-14	RP13S01-CO-D	0.6	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP13S01-GB	2.4	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP13S02-GB	0.6	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP13S03-GB	1.1	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP13S04-GB	0.0	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP14S01-CO	1.0	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP14S01-GB	1.8	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP14S02-GB	-0.1	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP14S03-GB	2.0	1.8	2.8	5.57	pCi/g	< MDC
C-14	RP14S04-GB	1.3	1.7	2.8	5.57	pCi/g	< MDC
C-14	RP15S01-CO	1.2	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP15S01-GB	5.2	1.9	2.8	5.57	pCi/g	< DCGLw
C-14	RP15S02-GB	3.2	1.8	2.8	5.57	pCi/g	< DCGLw
C-14	RP15S03-GB	10.1	2.4	2.8	5.57	pCi/g	> DCGLw
C-14	RP15S04-GB	2.4	1.8	2.8	5.57	pCi/g	< MDC

C-14
Class 1 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
C-14	RP16S01-CO	2.4	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP16S01-GB	2.5	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP16S02-GB	2.8	1.8	2.9	5.57	pCi/g	< MDC
C-14	RP16S03-GB	0.1	1.7	2.9	5.57	pCi/g	< MDC
C-14	RP16S04-GB	1.3	1.7	2.9	5.57	pCi/g	< MDC

Survey Unit Statistics					
N	87				
Max	10.1	pCi/g	Mean + 2σ	4.4	pCi/g
Mean	1.3	pCi/g	Mean + 3σ	6.0	pCi/g
Median	1.0	pCi/g			
1σ	1.6	pCi/g			
2σ	3.1	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration
4. DCGLw = Derived Concentration Guideline Level (or Cleanup Goal)

Ni-63
Class 1 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
Ni-63	RP1S01-CO	-1.2	2.0	3.3	2100	pCi/g	< MDC
Ni-63	RP1S01-GB	-1.2	2.2	3.7	2100	pCi/g	< MDC
Ni-63	RP1S02-GB	-2.3	1.8	3.0	2100	pCi/g	< MDC
Ni-63	RP1S03-GB	-1.4	2.1	3.6	2100	pCi/g	< MDC
Ni-63	RP1S04-GB	-1.7	1.7	2.9	2100	pCi/g	< MDC
Ni-63	RP2S01-CO	-2.0	2.1	3.5	2100	pCi/g	< MDC
Ni-63	RP2S01-GB	-0.7	2.1	3.5	2100	pCi/g	< MDC
Ni-63	RP2S02-GB	1.1	2.2	3.7	2100	pCi/g	< MDC
Ni-63	RP2S03-GB	-1.7	2.0	3.4	2100	pCi/g	< MDC
Ni-63	RP2S04-GB	-1.3	1.8	3.0	2100	pCi/g	< MDC
Ni-63	RP3S01-CO	-1.1	1.3	2.2	2100	pCi/g	< MDC
Ni-63	RP3S01-GB-D	-0.4	1.4	2.3	2100	pCi/g	< MDC
Ni-63	RP3S01-GB	0.2	1.3	2.2	2100	pCi/g	< MDC
Ni-63	RP3S02-GB	0.1	1.3	2.2	2100	pCi/g	< MDC
Ni-63	RP3S03-GB	0.1	1.4	2.3	2100	pCi/g	< MDC
Ni-63	RP3S04-GB	-0.9	1.2	2.1	2100	pCi/g	< MDC
Ni-63	RP3S01-CO-D	-0.4	1.6	2.6	2100	pCi/g	< MDC
Ni-63	RP4S01-CO	-0.4	1.3	2.2	2100	pCi/g	< MDC
Ni-63	RP4S01-GB	0.3	1.4	2.3	2100	pCi/g	< MDC
Ni-63	RP4S02-GB	-1.3	1.3	2.3	2100	pCi/g	< MDC
Ni-63	RP4S03-GB	-0.1	1.4	2.3	2100	pCi/g	< MDC
Ni-63	RP4S04-GB	-4.1	3.8	6.2	2100	pCi/g	< MDC
Ni-63	RP5S01-CO	-0.9	2.0	3.2	2100	pCi/g	< MDC
Ni-63	RP5S01-GB	-1.0	2.0	3.3	2100	pCi/g	< MDC
Ni-63	RP5S02-GB	-1.1	2.2	3.7	2100	pCi/g	< MDC
Ni-63	RP5S03-GB	-0.2	1.7	2.8	2100	pCi/g	< MDC
Ni-63	RP5S04-GB	0.1	1.7	2.9	2100	pCi/g	< MDC
Ni-63	RP6S01-CO	0.3	1.8	3.0	2100	pCi/g	< MDC
Ni-63	RP6S01-GB	-0.3	2.0	3.3	2100	pCi/g	< MDC
Ni-63	RP6S02-GB	-1.4	1.9	3.3	2100	pCi/g	< MDC
Ni-63	RP6S03-GB	-0.2	1.7	2.8	2100	pCi/g	< MDC
Ni-63	RP6S04-GB	0.5	1.8	3.0	2100	pCi/g	< MDC
Ni-63	RP7S01-CO	-0.7	2.0	3.4	2100	pCi/g	< MDC
Ni-63	RP7S01-GB	-2.8	4.0	6.8	2100	pCi/g	< MDC
Ni-63	RP7S02-GB	-2.9	4.3	7.2	2100	pCi/g	< MDC
Ni-63	RP7S03-GB	-4.2	5.7	9.6	2100	pCi/g	< MDC
Ni-63	RP7S04-GB	-4.7	5.4	9.1	2100	pCi/g	< MDC
Ni-63	RP8S01-CO	-1.3	1.9	3.2	2100	pCi/g	< MDC
Ni-63	RP8S01-GB	-2.1	2.1	3.5	2100	pCi/g	< MDC
Ni-63	RP8S02-GB	-1.9	1.9	3.2	2100	pCi/g	< MDC
Ni-63	RP8S03-GB	-1.7	2.0	3.3	2100	pCi/g	< MDC
Ni-63	RP8S04-GB	-0.9	2.2	3.7	2100	pCi/g	< MDC
Ni-63	RP8S01-CO-D	-1.1	1.6	2.6	2100	pCi/g	< MDC
Ni-63	RP9S01-CO	-2.3	1.7	2.9	2100	pCi/g	< MDC
Ni-63	RP9S01-GB	-1.2	2.0	3.4	2100	pCi/g	< MDC

Ni-63
Class 1 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
Ni-63	RP9S02-GB	-2.4	2.5	4.1	2100	pCi/g	< MDC
Ni-63	RP9S03-GB	-0.7	2.2	3.7	2100	pCi/g	< MDC
Ni-63	RP9S04-GB	-1.4	2.1	3.5	2100	pCi/g	< MDC
Ni-63	RP9S01-CO-D	-1.2	2.0	3.4	2100	pCi/g	< MDC
Ni-63	RP10S01-CO	-3.3	2.4	3.9	2100	pCi/g	< MDC
Ni-63	RP10S01-GB	-5.0	3.6	5.9	2100	pCi/g	< MDC
Ni-63	RP10S02-GB	-1.4	2.3	3.8	2100	pCi/g	< MDC
Ni-63	RP10S03-GB	-2.2	2.0	3.3	2100	pCi/g	< MDC
Ni-63	RP10S04-GB	-1.1	2.2	3.7	2100	pCi/g	< MDC
Ni-63	RP10S01-CO-D	-2.6	2.1	3.5	2100	pCi/g	< MDC
Ni-63	RP11S01-CO	-2.7	2.5	4.1	2100	pCi/g	< MDC
Ni-63	RP11S01-GB	-1.5	2.3	3.8	2100	pCi/g	< MDC
Ni-63	RP11S02-GB	-0.6	2.0	3.3	2100	pCi/g	< MDC
Ni-63	RP11S03-GB	-2.2	2.3	3.8	2100	pCi/g	< MDC
Ni-63	RP11S03-GB-D	-2.2	2.0	3.3	2100	pCi/g	< MDC
Ni-63	RP11S04-GB	-1.3	-2.3	3.8	2100	pCi/g	< MDC
Ni-63	RP12S01-CO	-1.3	2.6	4.4	2100	pCi/g	< MDC
Ni-63	RP12S01-GB	-0.5	2.6	4.4	2100	pCi/g	< MDC
Ni-63	RP12S02-GB	-2.4	2.7	4.6	2100	pCi/g	< MDC
Ni-63	RP12S03-GB	-1.6	2.7	4.6	2100	pCi/g	< MDC
Ni-63	RP12S04-GB	-0.7	2.3	3.9	2100	pCi/g	< MDC
Ni-63	RP13S01-CO	-0.8	3.4	5.7	2100	pCi/g	< MDC
Ni-63	RP13S01-CO-D	0.3	2.4	4.0	2100	pCi/g	< MDC
Ni-63	RP13S01-GB	-0.9	2.3	3.9	2100	pCi/g	< MDC
Ni-63	RP13S02-GB	-1.0	3.1	5.3	2100	pCi/g	< MDC
Ni-63	RP13S03-GB	-1.1	2.6	4.3	2100	pCi/g	< MDC
Ni-63	RP13S04-GB	-2.4	2.9	4.9	2100	pCi/g	< MDC
Ni-63	RP14S01-CO	0.3	1.8	3.1	2100	pCi/g	< MDC
Ni-63	RP14S01-GB	0.2	1.6	2.7	2100	pCi/g	< MDC
Ni-63	RP14S02-GB	-0.4	1.7	2.9	2100	pCi/g	< MDC
Ni-63	RP14S03-GB	-0.1	1.6	2.6	2100	pCi/g	< MDC
Ni-63	RP14S04-GB	0.7	1.6	2.7	2100	pCi/g	< MDC
Ni-63	RP15S01-CO	0.5	1.7	2.9	2100	pCi/g	< MDC
Ni-63	RP15S01-GB	1.0	2.0	3.2	2100	pCi/g	< MDC
Ni-63	RP15S02-GB	0.6	1.7	2.8	2100	pCi/g	< MDC
Ni-63	RP15S03-GB	1.8	2.2	3.6	2100	pCi/g	< MDC
Ni-63	RP15S04-GB	0.7	2.5	4.1	2100	pCi/g	< MDC

Ni-63
Class 1 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
Ni-63	RP16S01-CO	-0.3	1.8	3.0	2100	pCi/g	< MDC
Ni-63	RP16S01-GB	0.6	2.1	3.6	2100	pCi/g	< MDC
Ni-63	RP16S02-GB	1.7	3.2	3.6	2100	pCi/g	< MDC
Ni-63	RP16S03-GB	-1.1	2.1	3.6	2100	pCi/g	< MDC
Ni-63	RP16S04-GB	-0.3	1.9	3.2	2100	pCi/g	< MDC

Survey Unit Statistics					
N	87				
Max	1.8	pCi/g	Mean + 2σ	1.6	pCi/g
Mean	-1.0	pCi/g	Mean + 3σ	2.9	pCi/g
Median	-1.1	pCi/g			
1σ	1.3	pCi/g			
2σ	2.6	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration
4. DCGLw = Derived Concentration Guideline Level (or Cleanup Goal)

Ni-63
Class 2 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
Ni-63	RC2S01-GB	-2.2	2.5	4.1	2100	pCi/g	< MDC
Ni-63	RC2S02-GB	-3.7	2.5	4.1	2100	pCi/g	< MDC
Ni-63	RC2S03-GB	-2.7	2.6	4.4	2100	pCi/g	< MDC
Ni-63	RC2S04-GB	-5	3.1	5	2100	pCi/g	< MDC
Ni-63	RC2S05-GB	-0.7	2.7	4.5	2100	pCi/g	< MDC
Ni-63	RC2S06-GB	-1.6	2.4	4.1	2100	pCi/g	< MDC
Ni-63	RC2S07-GB	-3	2.9	4.8	2100	pCi/g	< MDC
Ni-63	RC2S08-GB	-2.4	2.6	4.4	2100	pCi/g	< MDC
Ni-63	RC2S09-GB	-2.1	2.5	4.1	2100	pCi/g	< MDC
Ni-63	RC2S10-GB	-1.9	2.4	4	2100	pCi/g	< MDC
Ni-63	RC2S11-GB	-3	2.5	4.1	2100	pCi/g	< MDC
Ni-63	RC2S12-GB	-2.4	2.4	4	2100	pCi/g	< MDC
Ni-63	RC2S13-GB	-3.4	2.5	4.1	2100	pCi/g	< MDC
Ni-63	RC2S14-GB	-3.2	2.6	4.4	2100	pCi/g	< MDC
Ni-63	RC2S15-GB	-2.3	2.5	4.2	2100	pCi/g	< MDC
Ni-63	RC2S16-GB	-2.6	5.5	9.2	2100	pCi/g	< MDC
Ni-63	RC2S17-GB	-5.2	3.1	5	2100	pCi/g	< MDC
Ni-63	RC2S18-GB	-2.8	3.3	5.5	2100	pCi/g	< MDC
Ni-63	RC2S19-GB	-3.4	2.7	4.4	2100	pCi/g	< MDC
Ni-63	RC2S20-GB	-3.7	4.9	8.2	2100	pCi/g	< MDC
Ni-63	RC2S21-GB	-0.3	2.1	3.5	2100	pCi/g	< MDC
Ni-63	RC2S22-GB	-0.8	1.8	3	2100	pCi/g	< MDC
Ni-63	RC2S23-GB	-0.1	1.7	2.9	2100	pCi/g	< MDC
Ni-63	RC2S24-GB	0.7	2.1	3.4	2100	pCi/g	< MDC
Ni-63	RC2S01-GB-D	-1.1	1.8	3.1	2100	pCi/g	< MDC
Ni-63	RC2S08-GB-D	1.1	1.9	3.2	2100	pCi/g	< MDC

Survey Unit Statistics					
N	26				
Max	1.100	pCi/g	Mean + 2σ	0.889	pCi/g
Mean	-2.223	pCi/g	Mean + 3σ	2.446	pCi/g
Median	-2.400	pCi/g			
1σ	1.556	pCi/g			
2σ	3.112	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration

C-14
Class 2 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
C-14	RC2S01-GB	2.4	1.8	2.8	5.57	pCi/g	< MDC
C-14	RC2S02-GB	1.7	1.8	2.9	5.57	pCi/g	< MDC
C-14	RC2S03-GB	0.8	1.7	2.9	5.57	pCi/g	< MDC
C-14	RC2S04-GB	0.9	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S05-GB	1.2	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S06-GB	-0.9	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S07-GB	-0.3	1.7	2.9	5.57	pCi/g	< MDC
C-14	RC2S08-GB	0.3	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S09-GB	-0.4	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S10-GB	1.2	1.7	2.9	5.57	pCi/g	< MDC
C-14	RC2S11-GB	0.2	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S12-GB	0.0	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S13-GB	0.3	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S14-GB	0.3	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S15-GB	0.9	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S16-GB	1.7	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S17-GB	-0.1	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S18-GB	0.4	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S19-GB	2.6	1.8	2.8	5.57	pCi/g	< MDC
C-14	RC2S20-GB	0.9	1.7	2.8	5.57	pCi/g	< MDC
C-14	RC2S21-GB	-0.3	2.1	3.5	5.57	pCi/g	< MDC
C-14	RC2S22-GB	-0.8	1.8	3	5.57	pCi/g	< MDC
C-14	RC2S23-GB	-0.1	1.7	2.9	5.57	pCi/g	< MDC
C-14	RC2S24-GB	0.7	2.1	3.4	5.57	pCi/g	< MDC
C-14	RC2S01-GB-D	-1.1	1.8	3.1	5.57	pCi/g	< MDC
C-14	RC2S08-GB-D	1.1	1.9	3.2	5.57	pCi/g	< MDC

Survey Unit Statistics					
N	26				
Max	2.600	pCi/g	Mean + 2σ	2.413	pCi/g
Mean	0.523	pCi/g	Mean + 3σ	3.358	pCi/g
Median	0.350	pCi/g			
1σ	0.945	pCi/g			
2σ	1.890	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration

H-3
Class 2 Surface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
H-3	RC2S01-GB	0.02	0.03	0.05	110	pCi/g	< MDC
H-3	RC2S02-GB	0.02	0.04	0.07	110	pCi/g	< MDC
H-3	RC2S03-GB	0.00	0.04	0.06	110	pCi/g	< MDC
H-3	RC2S04-GB	0.03	0.05	0.08	110	pCi/g	< MDC
H-3	RC2S05-GB	-0.02	0.03	0.06	110	pCi/g	< MDC
H-3	RC2S06-GB	-0.01	0.04	0.07	110	pCi/g	< MDC
H-3	RC2S07-GB	0.02	0.05	0.08	110	pCi/g	< MDC
H-3	RC2S08-GB	0.02	0.06	0.11	110	pCi/g	< MDC
H-3	RC2S09-GB	0.02	0.06	0.10	110	pCi/g	< MDC
H-3	RC2S10-GB	0.23	0.08	0.10	110	pCi/g	< DCGLw
H-3	RC2S11-GB	0.08	0.04	0.07	110	pCi/g	< DCGLw
H-3	RC2S12-GB	0.22	0.06	0.07	110	pCi/g	< DCGLw
H-3	RC2S13-GB	0.14	0.05	0.07	110	pCi/g	< DCGLw
H-3	RC2S14-GB	0.04	0.04	0.07	110	pCi/g	< MDC
H-3	RC2S15-GB	0.04	0.10	0.16	110	pCi/g	< MDC
H-3	RC2S16-GB	0.32	0.06	0.11	110	pCi/g	< DCGLw
H-3	RC2S17-GB	0.06	0.05	0.08	110	pCi/g	< MDC
H-3	RC2S18-GB	0.00	0.05	0.11	110	pCi/g	< MDC
H-3	RC2S19-GB	0.01	0.07	0.11	110	pCi/g	< MDC
H-3	RC2S20-GB	0.02	0.07	0.11	110	pCi/g	< MDC
H-3	RC2S21-GB	-0.3	2.1	3.5	110	pCi/g	< MDC
H-3	RC2S22-GB	-0.8	1.8	3	110	pCi/g	< MDC
H-3	RC2S23-GB	-0.1	1.7	2.9	110	pCi/g	< MDC
H-3	RC2S24-GB	0.7	2.1	3.4	110	pCi/g	< MDC
H-3	RC2S01-GB-D	-1.1	1.8	3.1	110	pCi/g	< MDC
H-3	RC2S08-GB-D	1.1	1.9	3.2	110	pCi/g	< MDC

Survey Unit Statistics					
N	26				
Max	1.100	pCi/g	Mean + 2σ	0.816	pCi/g
Mean	0.029	pCi/g	Mean + 3σ	1.209	pCi/g
Median	0.021	pCi/g			
1σ	0.393	pCi/g			
2σ	0.787	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration

Ni-63
Subsurface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	Units	Flag
Ni-63	RP1S02-CO	-1.6	1.9	3.3	pCi/g	< MDC
Ni-63	RP2S02-CO	-1.6	2.1	3.6	pCi/g	< MDC
Ni-63	RP3S02-CO	-0.5	1.3	2.2	pCi/g	< MDC
Ni-63	RP4S02-CO	-0.7	1.4	2.3	pCi/g	< MDC
Ni-63	RP5S02-CO	-0.4	2.0	3.3	pCi/g	< MDC
Ni-63	RP6S02-CO	-0.3	1.8	3.0	pCi/g	< MDC
Ni-63	RP7S02-CO	-0.5	2.0	3.4	pCi/g	< MDC
Ni-63	RP8S02-CO	-0.8	2.0	3.4	pCi/g	< MDC
Ni-63	RP9S02-CO	0.2	1.7	2.7	pCi/g	< MDC
Ni-63	RP10S02-CO	-2.3	3.2	5.4	pCi/g	< MDC
Ni-63	RP11S02-CO	-1.8	2.1	3.5	pCi/g	< MDC
Ni-63	RP12S02-CO	-1.4	2.8	4.7	pCi/g	< MDC
Ni-63	RP12S02-CO-D	-0.3	2.5	4.3	pCi/g	< MDC
Ni-63	RP13S02-CO	0.0	2.4	4.0	pCi/g	< MDC
Ni-63	RP14S02-CO	1.0	1.8	2.9	pCi/g	< MDC
Ni-63	RP15S02-CO	0.0	1.8	3.0	pCi/g	< MDC
Ni-63	RP16S02-CO	1.2	1.9	3.0	pCi/g	< MDC

Statistics					
N	17				
Max	1.2	pCi/g	Mean + 2σ	1.3	pCi/g
Mean	-0.6	pCi/g	Mean + 3σ	2.3	pCi/g
Median	-0.5	pCi/g			
1σ	0.9	pCi/g			
2σ	1.9	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration

C-14
Subsurface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	Units	Flag
C-14	RP1S02-CO	0.5	1.7	2.9	pCi/g	< MDC
C-14	RP2S02-CO	1.6	1.8	2.9	pCi/g	< MDC
C-14	RP3S02-CO	0.0	1.7	2.9	pCi/g	< MDC
C-14	RP4S02-CO	0.0	1.7	2.9	pCi/g	< MDC
C-14	RP5S02-CO	0.1	1.7	2.8	pCi/g	< MDC
C-14	RP6S02-CO	0.0	1.7	2.8	pCi/g	< MDC
C-14	RP7S02-CO	0.0	1.7	2.8	pCi/g	< MDC
C-14	RP8S02-CO	1.6	1.7	2.8	pCi/g	< MDC
C-14	RP9S02-CO	0.3	1.7	2.9	pCi/g	< MDC
C-14	RP10S02-CO	0.7	1.7	2.8	pCi/g	< MDC
C-14	RP11S02-CO	0.3	1.7	2.8	pCi/g	< MDC
C-14	RP12S02-CO	0.0	1.7	2.8	pCi/g	< MDC
C-14	RP12S02-CO-D	1.0	1.7	2.8	pCi/g	< MDC
C-14	RP13S02-CO	2.3	1.8	2.8	pCi/g	< MDC
C-14	RP14S02-CO	1.7	1.7	2.8	pCi/g	< MDC
C-14	RP15S02-CO	2.9	1.8	2.8	pCi/g	
C-14	RP16S02-CO	1.7	1.7	2.8	pCi/g	< MDC

Statistics					
N	17				
Max	2.90	pCi/g	Mean + 2σ	2.72	pCi/g
Mean	0.86	pCi/g	Mean + 3σ	3.65	pCi/g
Median	0.50	pCi/g			
1σ	0.93	pCi/g			
2σ	1.86	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration

H-3
Subsurface Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	Units	Flag
H-3	RP1S02-CO	-0.02	0.06	0.10	pCi/g	< MDC
H-3	RP2S02-CO	0.01	0.07	0.12	pCi/g	< MDC
H-3	RP3S02-CO	0.00	0.05	0.08	pCi/g	< MDC
H-3	RP4S02-CO	0.02	0.06	0.10	pCi/g	< MDC
H-3	RP5S02-CO	0.03	0.05	0.09	pCi/g	< MDC
H-3	RP6S02-CO	0.03	0.05	0.09	pCi/g	< MDC
H-3	RP7S02-CO	0.31	0.08	0.09	pCi/g	
H-3	RP8S02-CO	0.16	0.07	0.10	pCi/g	
H-3	RP9S02-CO	0.17	0.07	0.09	pCi/g	
H-3	RP10S02-CO	0.55	0.11	0.10	pCi/g	
H-3	RP11S02-CO	0.40	0.10	0.11	pCi/g	
H-3	RP12S02-CO	0.14	0.05	0.07	pCi/g	
H-3	RP12S02-CO-D	0.15	0.06	0.08	pCi/g	
H-3	RP13S02-CO	0.03	0.05	0.08	pCi/g	< MDC
H-3	RP14S02-CO	0.64	0.12	0.08	pCi/g	
H-3	RP15S02-CO	0.79	0.14	0.08	pCi/g	
H-3	RP16S02-CO	0.92	0.15	0.07	pCi/g	

Statistics					
N	17				
Max	0.92	pCi/g	Mean + 2σ	0.85	pCi/g
Mean	0.25	pCi/g	Mean + 3σ	1.15	pCi/g
Median	0.15	pCi/g			
1σ	0.30	pCi/g			
2σ	0.60	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration

H-3
Reference Area Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
H-3	RRFS01-GB	0.007	0.083	0.14	110	pCi/g	< MDC
H-3	RRFS02-GB	-0.007	0.079	0.13	110	pCi/g	< MDC
H-3	RRFS03-GB	0.038	0.082	0.14	110	pCi/g	< MDC
H-3	RRFS04-GB	-0.047	0.089	0.15	110	pCi/g	< MDC
H-3	RRFS05-GB	0.024	0.083	0.14	110	pCi/g	< MDC
H-3	RRFS06-GB	0.013	0.072	0.12	110	pCi/g	< MDC
H-3	RRFS07-GB	-0.019	0.084	0.14	110	pCi/g	< MDC
H-3	RRFS08-GB	-0.025	0.071	0.12	110	pCi/g	< MDC
H-3	RRFS09-GB	-0.024	0.083	0.14	110	pCi/g	< MDC
H-3	RRFS10-GB	-0.007	0.082	0.14	110	pCi/g	< MDC
H-3	RRFS11-GB	0.022	0.08	0.13	110	pCi/g	< MDC
H-3	RRFS12-GB	-0.053	0.081	0.14	110	pCi/g	< MDC
H-3	RRFS13-GB	0.053	0.086	0.14	110	pCi/g	< MDC
H-3	RRFS14-GB	-0.017	0.088	0.15	110	pCi/g	< MDC
H-3	RRFS15-GB	-0.005	0.094	0.16	110	pCi/g	< MDC
H-3	RRFS16-GB	0.044	0.09	0.15	110	pCi/g	< MDC
H-3	RRFS17-GB	-0.009	0.073	0.12	110	pCi/g	< MDC
H-3	RRFS18-GB	0.016	0.088	0.15	110	pCi/g	< MDC
H-3	RRFS19-GB	-0.021	0.086	0.15	110	pCi/g	< MDC
H-3	RRFS20-GB	-0.008	0.007	0.13	110	pCi/g	< MDC
H-3	RRFS21-GB	0.015	0.076	0.13	110	pCi/g	< MDC
H-3	RRFS22-GB	0.033	0.08	0.13	110	pCi/g	< MDC
H-3	RRFS23-GB	0.043	0.088	0.15	110	pCi/g	< MDC
H-3	RRFS24-GB	0.071	0.085	0.14	110	pCi/g	< MDC
H-3	RRFS05-GB-D	0.026	0.081	0.13	110	pCi/g	< MDC
H-3	RRFS20-GB-D	0.036	0.088	0.15	110	pCi/g	< MDC

Survey Unit Statistics

N	26				
Max	0.071	pCi/g	Mean + 2σ	0.070	pCi/g
Mean	0.008	pCi/g	Mean + 3σ	0.101	pCi/g
Median	0.010	pCi/g			
1σ	0.031	pCi/g			
2σ	0.062	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration

C-14
Reference Area Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
C-14	RRFS01-GB	2.7	1.8	2.8	5.57	pCi/g	< MDC
C-14	RRFS02-GB	1.9	1.8	2.8	5.57	pCi/g	< MDC
C-14	RRFS03-GB	2.9	1.8	2.9	5.57	pCi/g	< DCGLw
C-14	RRFS04-GB	1.1	1.7	2.8	5.57	pCi/g	< MDC
C-14	RRFS05-GB	3.0	1.8	2.8	5.57	pCi/g	< DCGLw
C-14	RRFS06-GB	2.2	1.8	2.8	5.57	pCi/g	< MDC
C-14	RRFS07-GB	2.4	1.8	2.9	5.57	pCi/g	< MDC
C-14	RRFS08-GB	2.7	1.8	2.8	5.57	pCi/g	< MDC
C-14	RRFS09-GB	3.5	1.8	2.9	5.57	pCi/g	< DCGLw
C-14	RRFS10-GB	2.5	1.8	2.9	5.57	pCi/g	< MDC
C-14	RRFS11-GB	2.0	1.8	2.8	5.57	pCi/g	< MDC
C-14	RRFS12-GB	2.6	1.8	2.9	5.57	pCi/g	< MDC
C-14	RRFS13-GB	2.0	1.8	2.8	5.57	pCi/g	< MDC
C-14	RRFS14-GB	3.7	1.8	2.8	5.57	pCi/g	< DCGLw
C-14	RRFS15-GB	2.6	1.8	2.9	5.57	pCi/g	< MDC
C-14	RRFS16-GB	0.8	1.7	2.9	5.57	pCi/g	< MDC
C-14	RRFS17-GB	0.5	1.7	2.9	5.57	pCi/g	< MDC
C-14	RRFS18-GB	-0.1	1.7	2.8	5.57	pCi/g	< MDC
C-14	RRFS19-GB	1.5	1.8	2.9	5.57	pCi/g	< MDC
C-14	RRFS20-GB	1.1	1.7	2.9	5.57	pCi/g	< MDC
C-14	RRFS21-GB	1.3	1.7	2.9	5.57	pCi/g	< MDC
C-14	RRFS22-GB	2.7	1.8	2.8	5.57	pCi/g	< MDC
C-14	RRFS23-GB	1.6	1.7	2.8	5.57	pCi/g	< MDC
C-14	RRFS24-GB	3.1	1.8	2.9	5.57	pCi/g	< DCGLw
C-14	RRFS05-GB-D	3.1	1.8	2.8	5.57	pCi/g	< DCGLw
C-14	RRFS20-GB-D	2.3	1.8	2.9	5.57	pCi/g	< MDC

Survey Unit Statistics

N	26				
Max	3.700	pCi/g	Mean + 2σ	4.027	pCi/g
Mean	2.142	pCi/g	Mean + 3σ	4.970	pCi/g
Median	2.350	pCi/g			
1σ	0.942	pCi/g			
2σ	1.885	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration

Ni-63
Reference Area Soil Samples

ROC	Sample ID	Net Result	TPU	MDC	DCGLw	Units	Flag
Ni-63	RRFS01-GB	-1.8	2.9	4.8	2100	pCi/g	< MDC
Ni-63	RRFS02-GB	-5.8	4.5	7.4	2100	pCi/g	< MDC
Ni-63	RRFS03-GB	-1.1	2.8	4.8	2100	pCi/g	< MDC
Ni-63	RRFS04-GB	-1.3	2.8	4.8	2100	pCi/g	< MDC
Ni-63	RRFS05-GB	-2.0	2.8	4.7	2100	pCi/g	< MDC
Ni-63	RRFS06-GB	-3.5	3.2	5.4	2100	pCi/g	< MDC
Ni-63	RRFS07-GB	-0.7	2.7	4.5	2100	pCi/g	< MDC
Ni-63	RRFS08-GB	-1.7	2.6	4.4	2100	pCi/g	< MDC
Ni-63	RRFS09-GB	-1.2	2.5	4.2	2100	pCi/g	< MDC
Ni-63	RRFS10-GB	-2.8	3.3	5.5	2100	pCi/g	< MDC
Ni-63	RRFS11-GB	-1.4	3.9	6.6	2100	pCi/g	< MDC
Ni-63	RRFS12-GB	-2.7	3.5	5.9	2100	pCi/g	< MDC
Ni-63	RRFS13-GB	-2.6	3.4	5.7	2100	pCi/g	< MDC
Ni-63	RRFS14-GB	-1.1	2.6	4.4	2100	pCi/g	< MDC
Ni-63	RRFS15-GB	-0.1	2.5	4.2	2100	pCi/g	< MDC
Ni-63	RRFS16-GB	-1.5	2.1	3.6	2100	pCi/g	< MDC
Ni-63	RRFS17-GB	-0.9	2.2	3.8	2100	pCi/g	< MDC
Ni-63	RRFS18-GB	-1.0	2.5	4.2	2100	pCi/g	< MDC
Ni-63	RRFS19-GB	-0.5	2.2	3.8	2100	pCi/g	< MDC
Ni-63	RRFS20-GB	-2.1	2.7	4.6	2100	pCi/g	< MDC
Ni-63	RRFS21-GB	-0.1	2.3	3.8	2100	pCi/g	< MDC
Ni-63	RRFS22-GB	-2.3	2.5	4.1	2100	pCi/g	< MDC
Ni-63	RRFS23-GB	-1.1	2.5	4.2	2100	pCi/g	< MDC
Ni-63	RRFS24-GB	-1.8	2.4	4.0	2100	pCi/g	< MDC
Ni-63	RRFS05-GB-D	-2.8	2.3	3.8	2100	pCi/g	< MDC
Ni-63	RRFS20-GB-D	-2.7	2.3	3.9	2100	pCi/g	< MDC

Survey Unit Statistics					
N	26				
Max	-0.100	pCi/g	Mean + 2σ	0.608	pCi/g
Mean	-1.792	pCi/g	Mean + 3σ	1.808	pCi/g
Median	-1.600	pCi/g			
1σ	1.200	pCi/g			
2σ	2.400	pCi/g			

Notes:
1. "-D" in the sample ID indicates duplicate sample.
2. TPU = Total Propagated Uncertainty
3. MDC = Minimum Detectable Concentration

Appendix D

Air Sample Worksheets

Appendix E

Wastewater Evaluation and Release Information

Appendix F

Instrument Quality Assurance / Quality Control (QA/QC)

1.0 SURVEY INSTRUMENT QUALITY CONTROL (QC)

1.1 Instrument Calibration

All instruments used during the course of the survey were in current calibration traceable to the National Institute of Standards and Technology ("NIST").

1.2 Quality Control Tracking

Quality Control (QC) measurements were performed daily prior to any survey data being collected. A controlled area was used to perform these checks. The QC criteria for the instruments used during daily surveys were defined as follows:

Very tight quality controls were administered to ensure that the data reported is of the highest quality. If any single measurement were found to be outside of 2σ (Investigation Level), the measurement was repeated. If the second count was also found to be outside of 2σ, the instrument was investigated to assess if any external biases or instrument physical damage was present. If any single point was found to be outside of a 3σ boundary (Action Level), the instrument was immediately taken out of service and the situation was investigated.

1.2.1 Quantitative Instruments

Instruments in this category were the Ludlum model 2929 smear counter and the Ludlum model 2224 scaler/ratemeter. These instruments were designated as 'quantitative,' meaning that activity determinations (i.e. dpm/100cm^2) could be made using these instruments. Daily performance checks of these instruments included daily background and source checks with Technetium-99 (Tc-99) and Thorium-230 (Th-230) were plotted on control charts and compared with ±2σ and ±3σ boundary markers.

Administration of QC for the Ludlum 2929 was handled in the following manner. Each daily background and source measurement was recorded and the resulting counts plotted on the control chart. The 2σ and 3σ tolerance bands on each control chart were determined from repeated baseline measurements taken at the beginning of the survey effort. If any point was found to reside outside of 2σ, the instrument could still be used provided that the condition did not occur on two consecutive days. The policy is supported by the statistical fact that 2 failures are expected per every 100 measurements at the 95% confidence level (±1.96σ). However, if any single QC measurement was found to be outside of ±3σ, the situation was instantly investigated. Control charts for each instrument are shown in Figures E-1 through E-8.

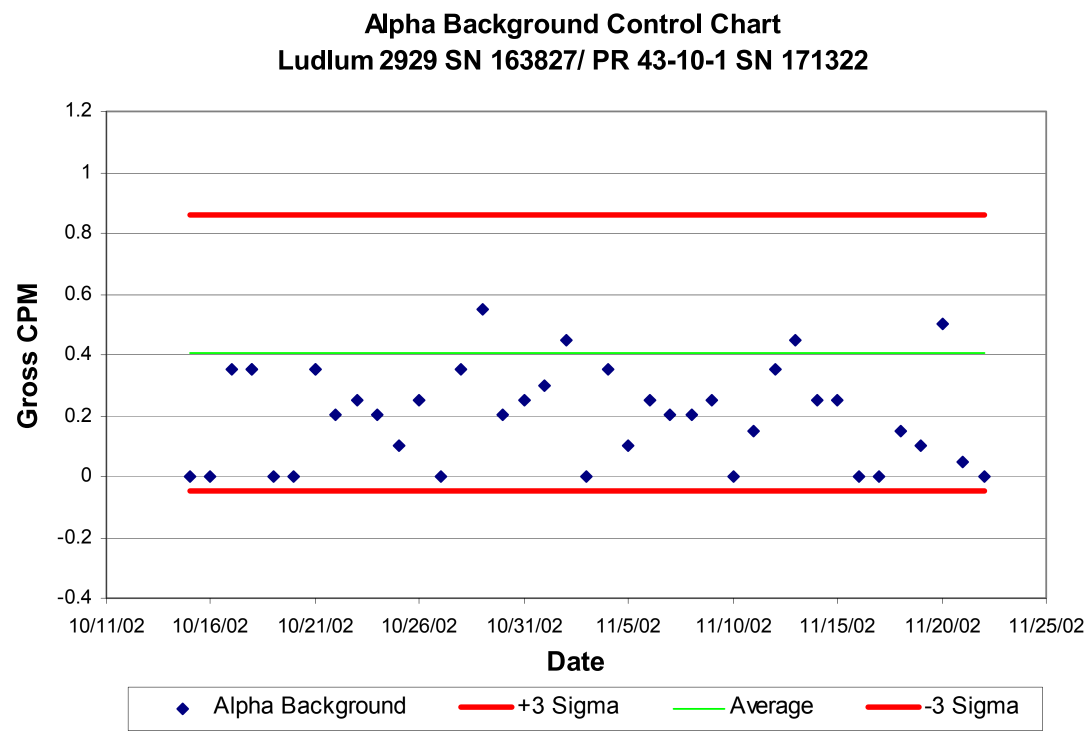


Figure E-1: Alpha background control chart for Ludlum model 2929

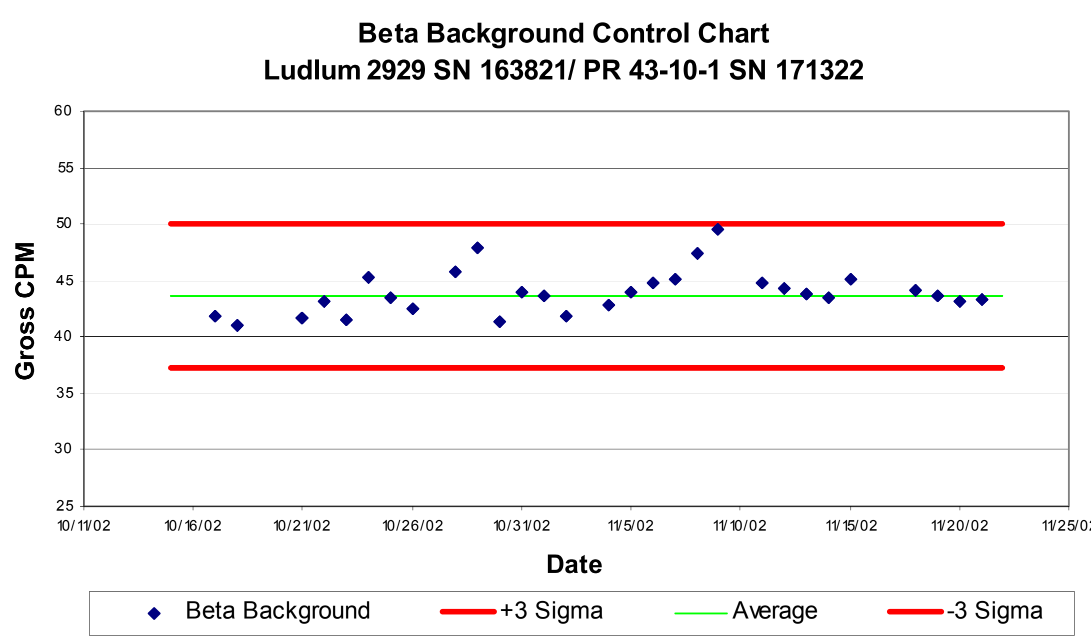


Figure E- 2: Beta background control chart for Ludlum model 2929

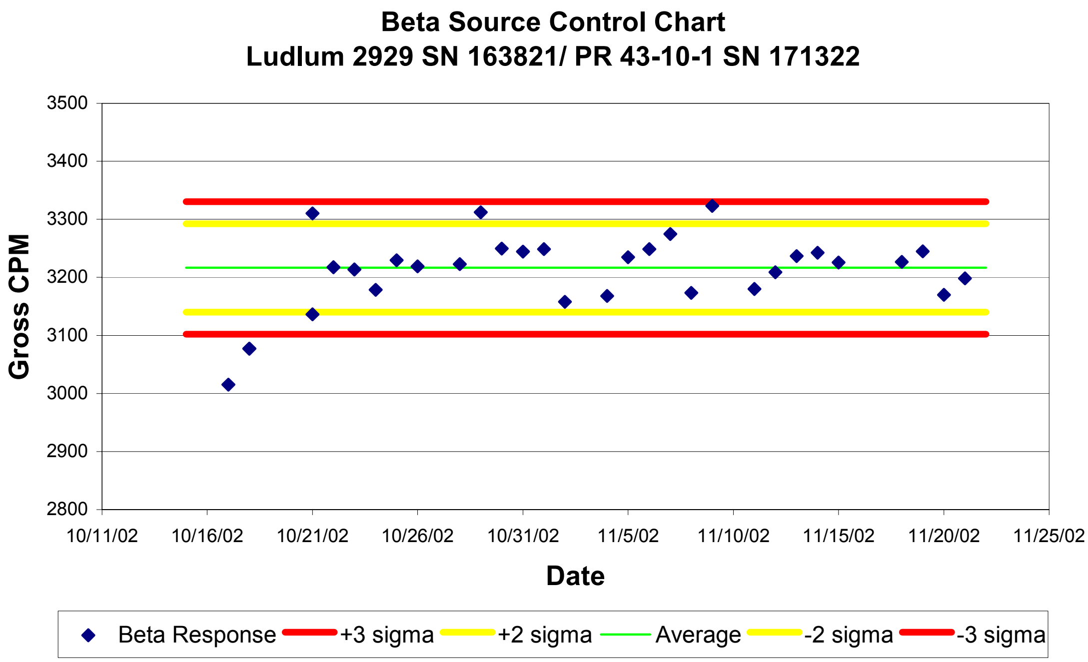


Figure E- 3: Tc-99 beta source control chart for Ludlum model 2929

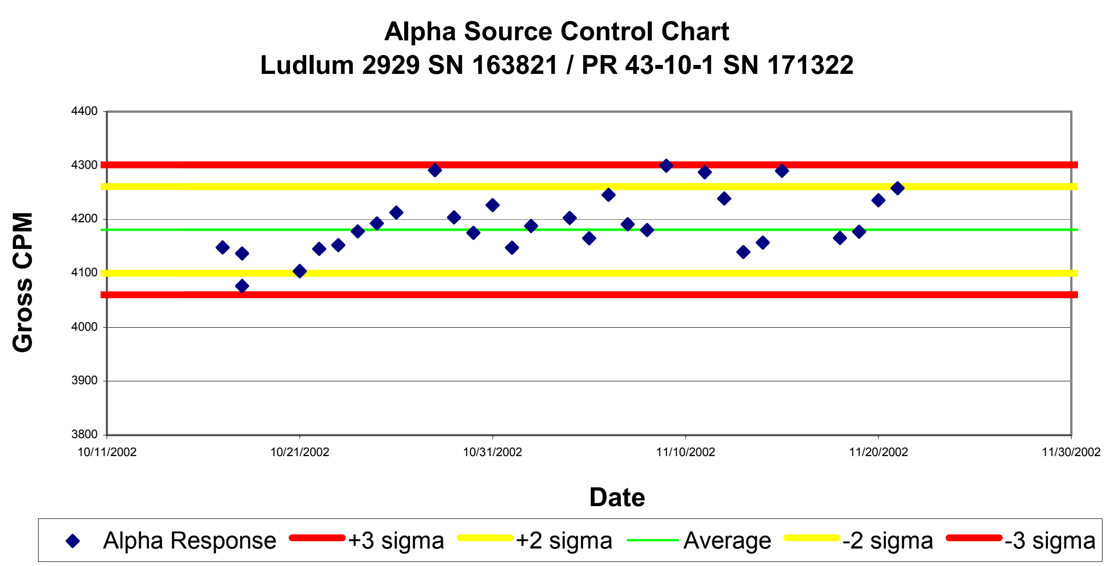


Figure E- 4: Th-230 alpha source control chart for Ludlum model 2929

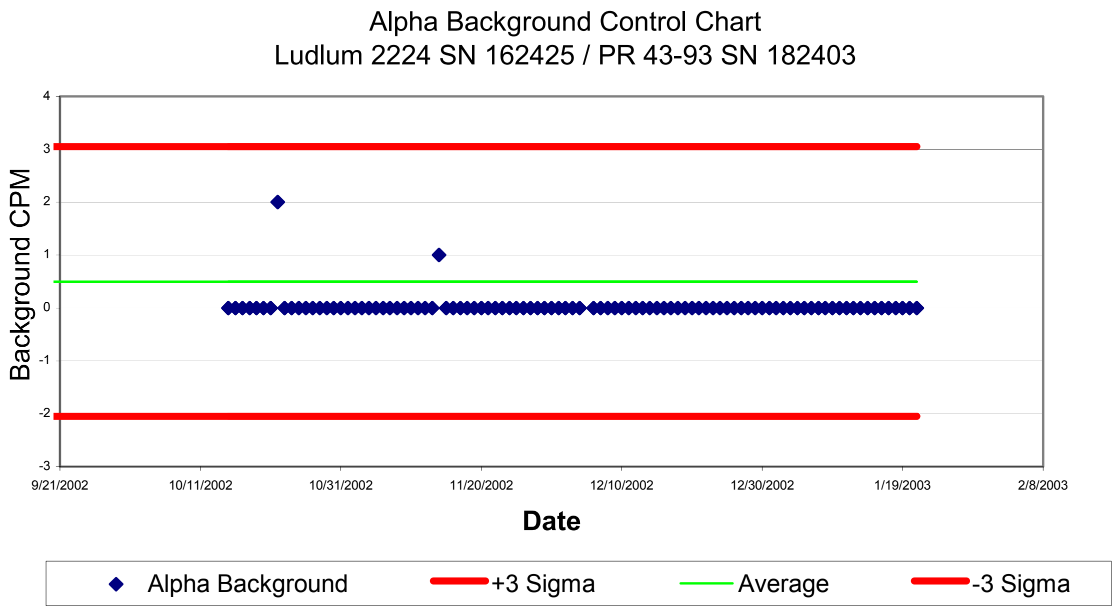


Figure E- 5: Alpha background control chart for Ludlum model 2224

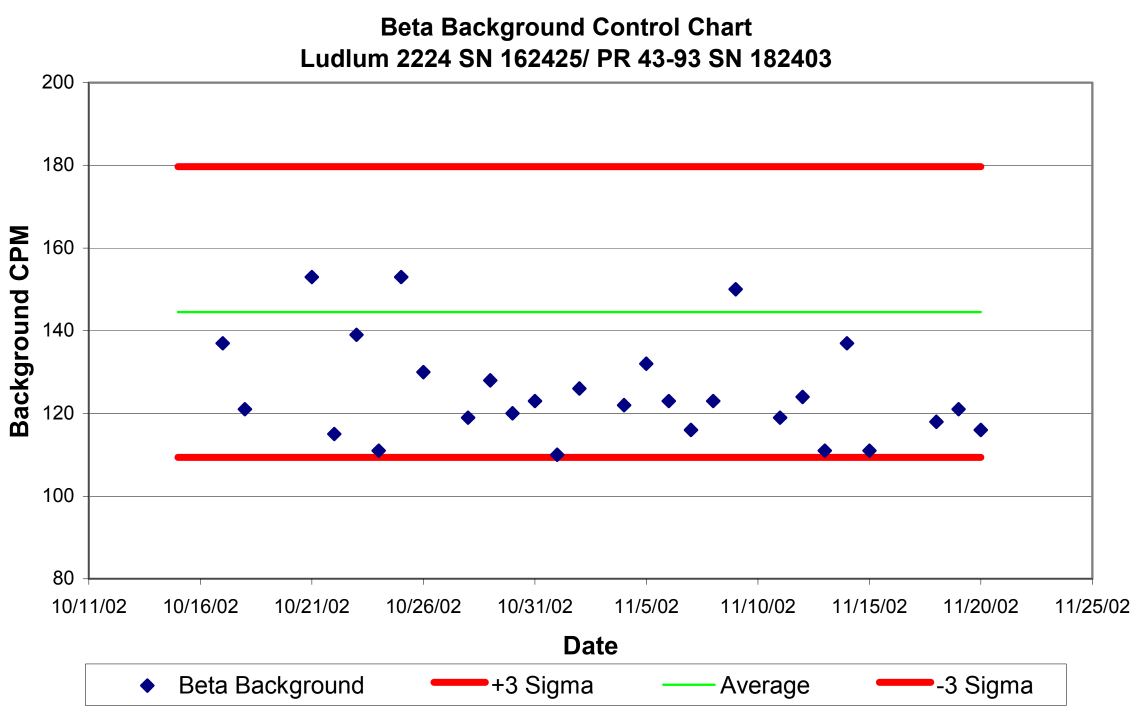


Figure E- 6: Beta background control chart for Ludlum model 2224

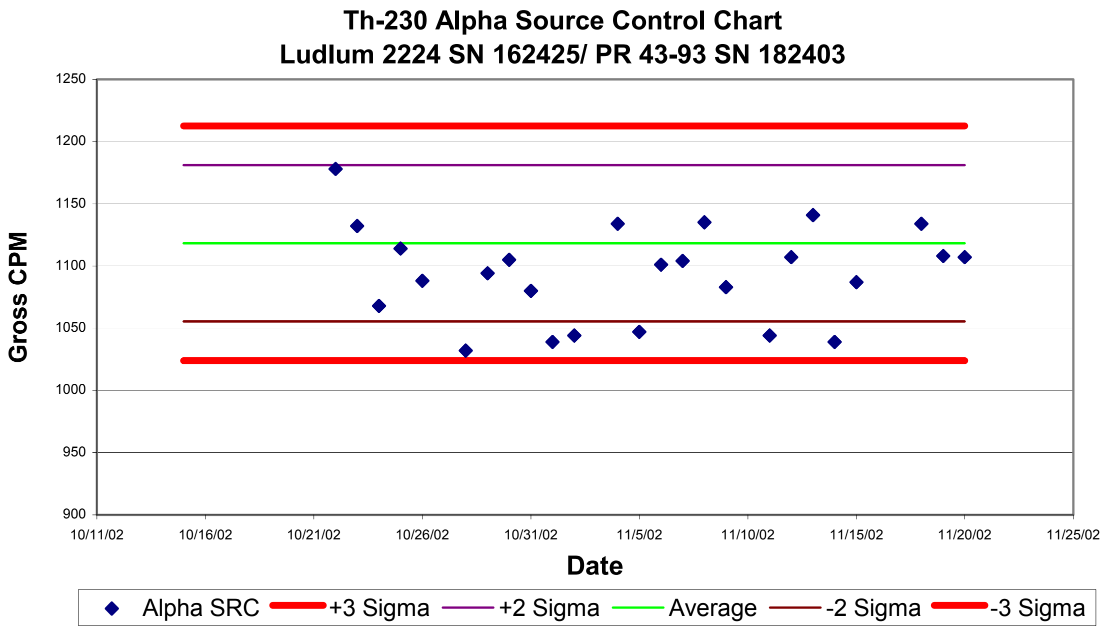


Figure E- 7: Th-230 alpha source control chart for Ludlum model 2224

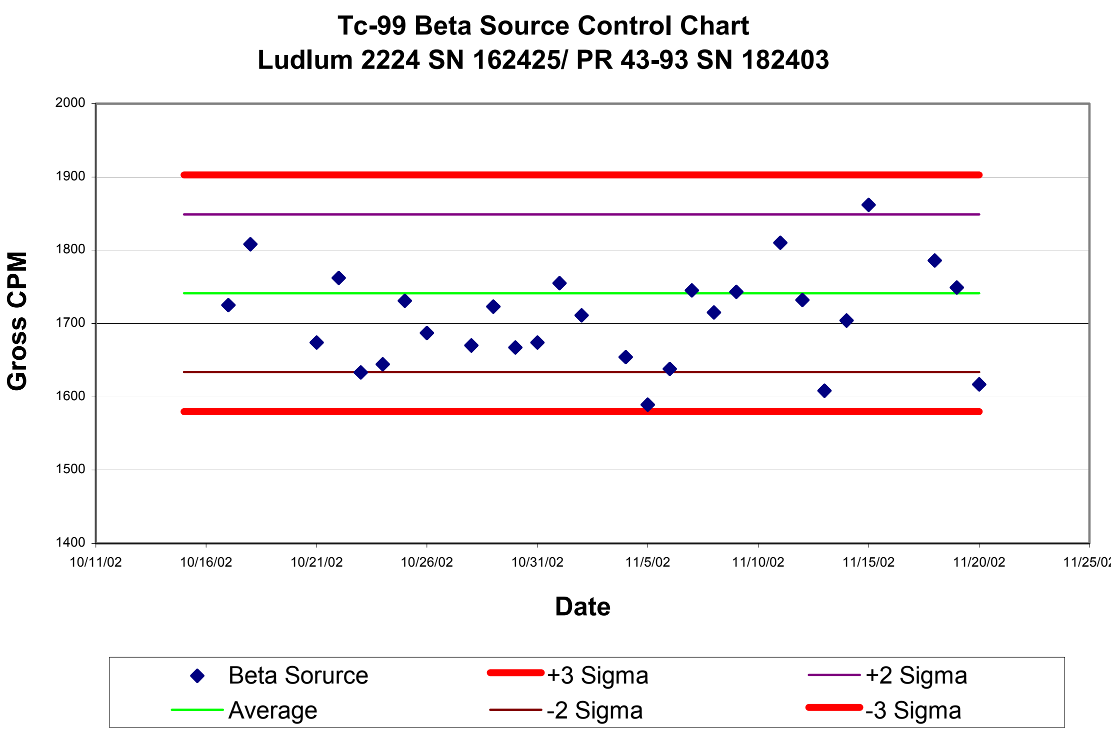


Figure E- 8: Tc-99 beta source control chart for Ludlum model 2224

1.2.2 Qualitative Instruments

This category includes all hand-held survey instruments. These instruments were checked daily against a ±20% performance criteria established at the beginning of the survey. If any single measurement was found outside of ±20%, the instrument was taken out of service and investigated. The instruments in this category were those used for gamma walkover surveys, surveillance control and frisking. Instruments in this category were the Ludlum model 2221 equipped with a 44-94 multiple GM-tube array probe; a Ludlum model 2221 with 44-10 NaI probe; and (2) Ludlum model-3's with 44-9 GM probes.

The daily QC data forms and charts for each of these instruments are included ...As described for the quantitative instruments, the daily measurements were compared to a set of baseline data collected at the beginning of the survey.

1.2.3 Effects of Weather

The variations in weather conditions at Site 1 had a direct impact on instrument QC during the remediation effort. On mornings with low-lying fog and high humidity due to atmospheric inversion, the NaI detector would show biases due to increased Radon-222 contributions. The background count rates on inversion days was observed to be 3000 to 4000 cpm higher than on clear sunny days. A normal clear day background was typically 6,000 – 7,000 cpm. To account for this, the initial QC counts for the control chart was expanded to 20, with 10 from a clear day and 10 from a foggy day. This approach prevented instrument failures due to radon biases.

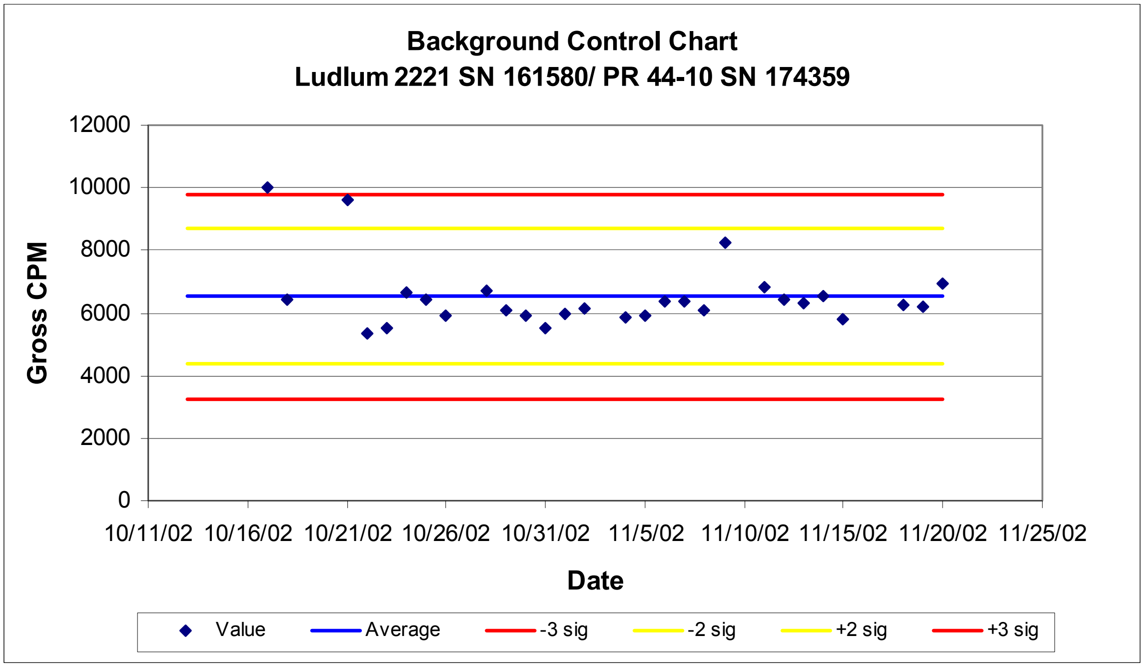


Figure E- 9: Background control chart for Ludlum model 2221 SN 161580

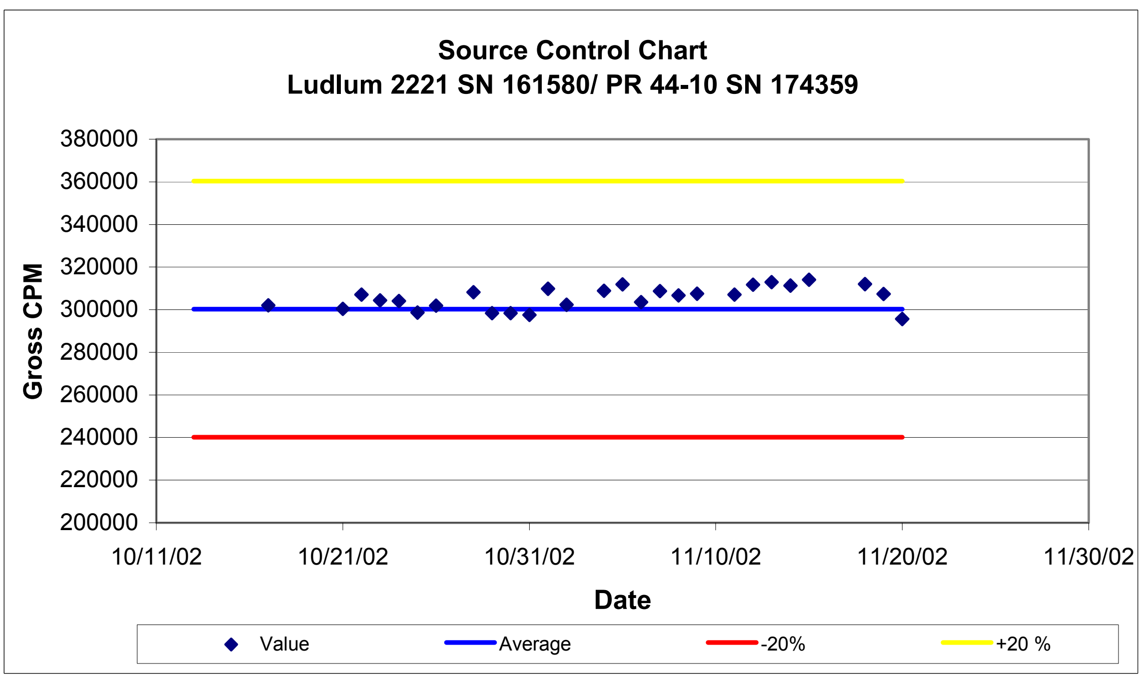


Figure E- 10: Cs-137 source control chart for Ludlum model 2221 SN 161580

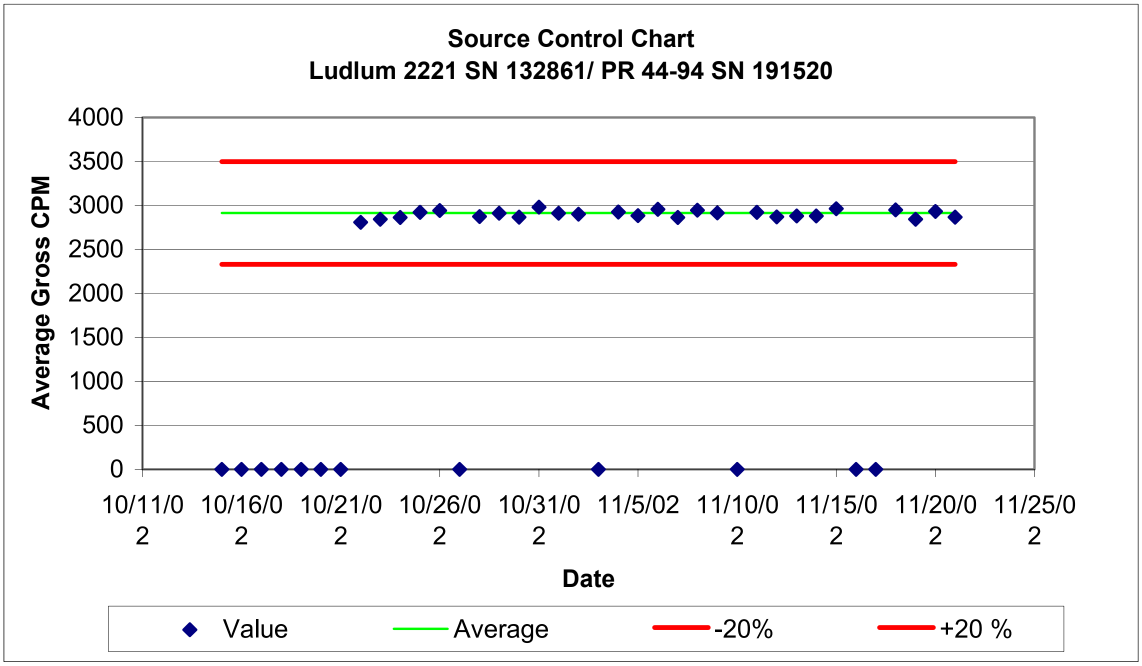


Figure E- 11: Tc-99 source control chart for Ludlum model 2221 SN 132861

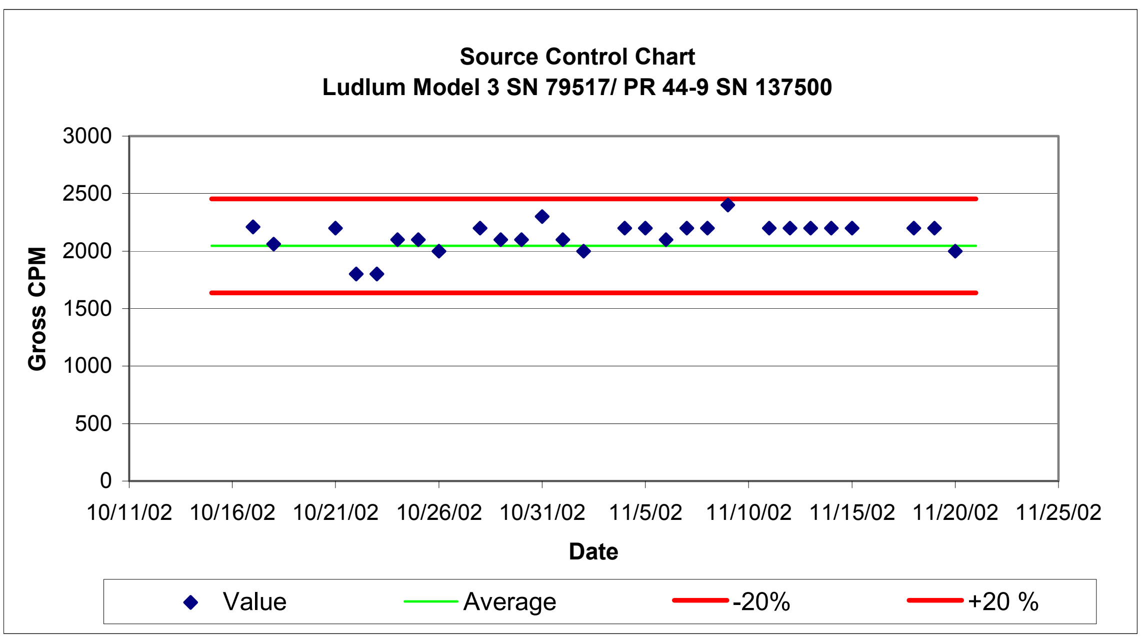


Figure E-12: Tc-99 source control chart for Ludlum model 3 SN 79517

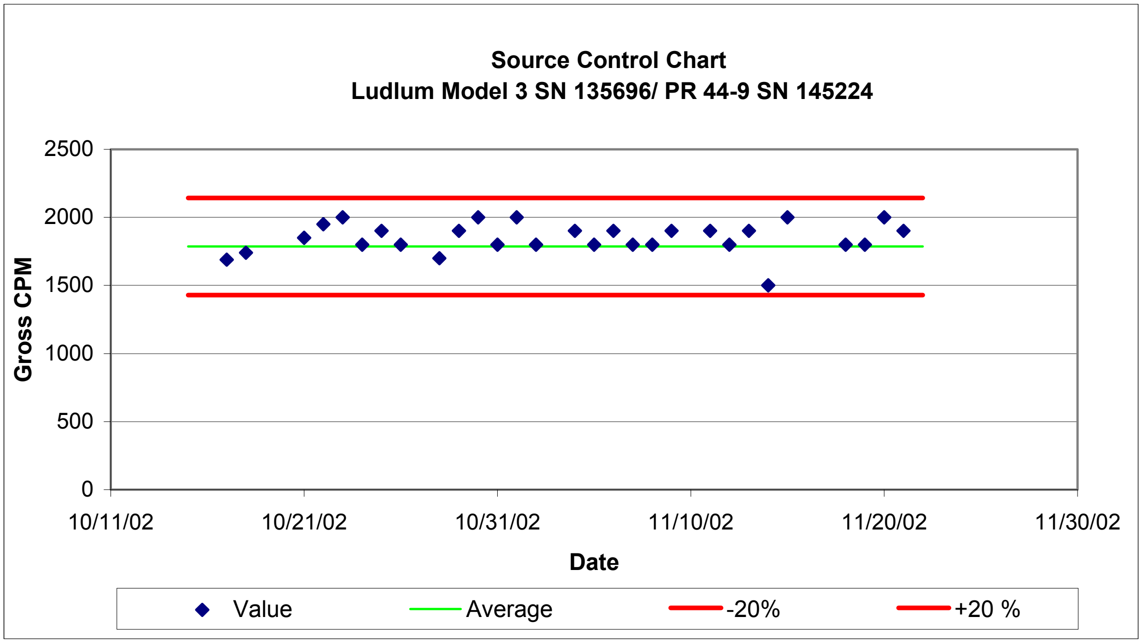


Figure E-13: Tc-99 source control chart for Ludlum model 3 SN 135696

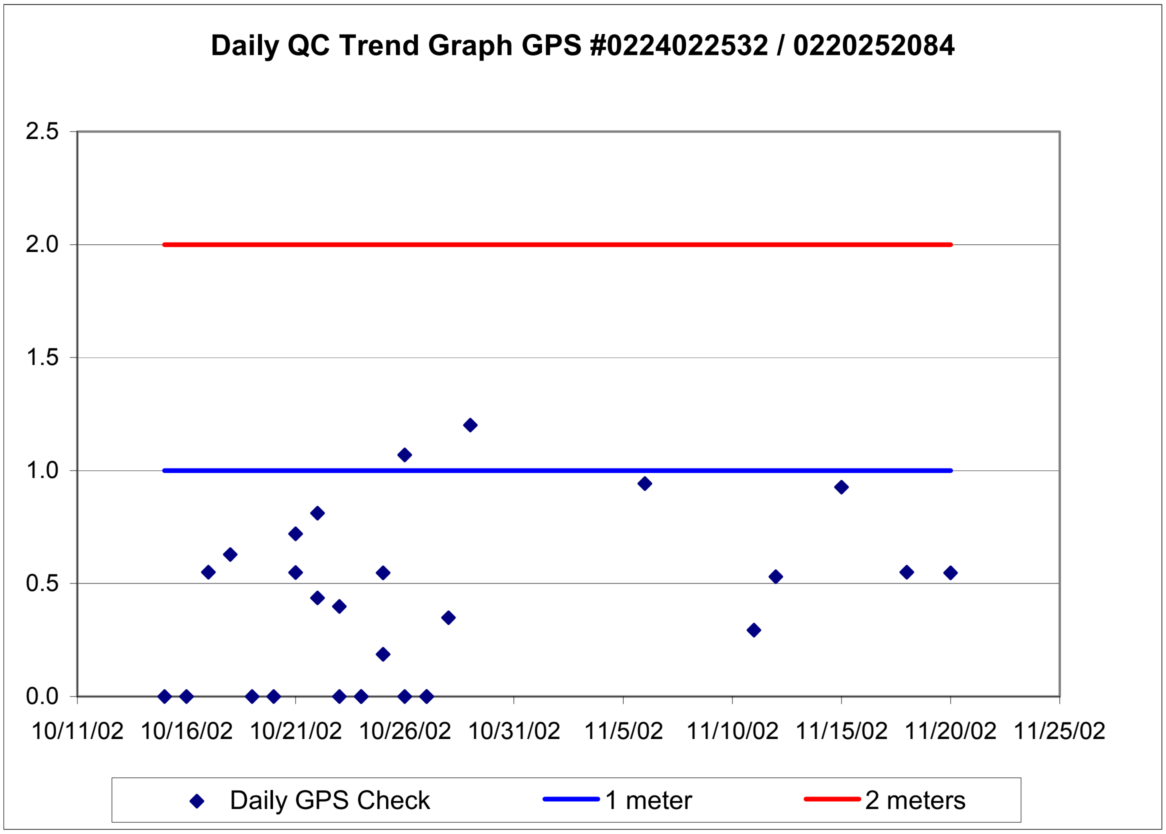
2.0 GLOBAL POSITIONING SYSTEM (GPS) QUALITY CONTROL

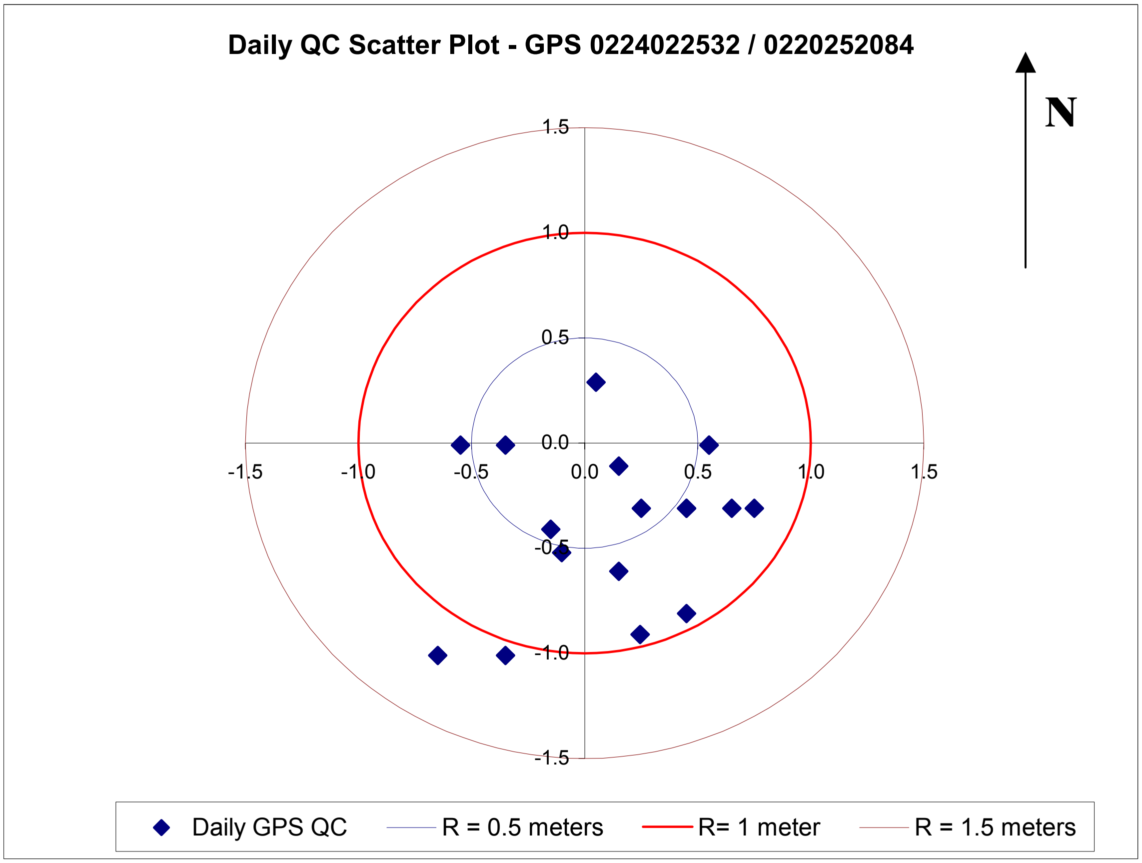
The GPS unit used at Site 1 was checked daily for positional accuracy. A static count was taken at a common location for a minimum of 60 seconds every morning prior to the start of work. The QC location was located to the east of the field trailer outside of any line of sight obstructions (shown in the Figure 1 below).

Figure 1: GPS QC location

The QC control charts for the GPS are provided below. The data is shown in both linear format with error bars at 1 meter and 2 meters, and on a scatter plot, which shows position trend information.

The operability criteria for the GPS was < 1 meter from the average of ten initial counts performed at the beginning of the project. If any single measurement was found to be outside of 1 meter, the measurement was immediately repeated. QC measurements were allowed to skipped if the GPS unit was planned to be inactive for that day.


Daily QC Trend Graph GPS #0224022532 / 0220252084
2.5
2.0
1.5
1.0
0.5
0.0
10/11/02
10/16/02
10/21/02
10/26/02
10/31/02
11/5/02
11/10/02
11/15/02
11/20/02
11/25/02
Daily GPS Check
1 meter
2 meters


Daily QC Scatter Plot - GPS 0224022532 / 0220252084
N
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Daily GPS QC
R = 0.5 meters
R= 1 meter
R = 1.5 meters

3.0 ANALYSIS OF FIELD DUPLICATE SAMPLES

Analyses of field and laboratory duplicates were compared to the initial analytical results by determining a normalized absolute difference (NAD) value for each data set by the following equation (WP Section 7.5):

$$Normalized\_Absolute\_Difference_{Duplicate} = \frac{|(Sample - Duplicate)|}{\sqrt{\sigma^2_{Sample} + \sigma^2_{Duplicate}}}$$

The calculated NAD results were compared to a performance criteria of less than or equal to 1.96. The results are shown in the Table below:

Pit / Survey Unit	Sample ID	Net Result (pCi/g)	2s Uncert (pCi/g)	NAD	PASS /FAIL?
Pit 3	RP3S01-GB	1.0	1.7		
	RP3S01-GB-D	-0.2	1.7	0.50	PASS
Pit 3	RP3S01-CO	0.3	1.7		
	RP3S01-CO-D	-1.1	1.7	0.58	PASS
Pit 8	RP8S01-CO	-0.3	1.7		
	RP8S01-CO-D	0.3	1.7	0.25	PASS
Pit 9	RP9S01-CO	1.0	1.7		
	RP9S01-CO-D	1.1	1.7	0.04	PASS
Pit 10	RP10S01-GB	0.8	1.7		
	RP10S01-GB-D	0.7	1.7	0.04	PASS
Pit 11	RP11S03-GB	2.3	1.8		
	RP11S03-GB-D	3.5	1.8	0.47	PASS
Pit 12	RP12S02-CO	0.0	1.7		
	RP12S02-CO-D	1.0	1.7	0.42	PASS
Pit 13	RP13S01-CO	2.1	1.8		
	RP13S01-CO-D	0.6	1.7	0.61	PASS
Class 2	RC2S01-GB	2.4	1.8		
	RC2S01-GB-D	-1.1	1.8	1.37	PASS
Class 2	RC2S08-GB	0.3	1.7		
	RC2S08-GB-D	1.1	1.9	0.31	PASS
Reference Area	RRFS05-GB	3.0	1.8		
	RRFS05-GB-D	3.1	1.8	0.04	PASS
Reference Area	RRFS20-GB	1.1	1.7		
	RRFS20-GB-D	2.3	1.8	0.48	PASS

Appendix G

Wilcoxon Rank Sum Test Calculation Worksheets

Class 1 SOR Summary

#	Sample ID	SOR	Area	Adjusted Data	Overall Rank	Reference Area Rank
R1	RRFS01-GB	0.484	R	1.484	8	8
R2	RRFS02-GB	0.338	R	1.338	95	95
R3	RRFS03-GB	0.520	R	1.520	107	107
R4	RRFS04-GB	0.196	R	1.196	91	91
R5	RRFS05-GB	0.538	R	1.538	108	108
R6	RRFS06-GB	0.393	R	1.393	98	98
R7	RRFS07-GB	0.430	R	1.430	100	100
R8	RRFS08-GB	0.484	R	1.484	104	104
R9	RRFS09-GB	0.628	R	1.628	111	111
R10	RRFS10-GB	0.447	R	1.447	101	101
R11	RRFS11-GB	0.359	R	1.359	97	97
R12	RRFS12-GB	0.465	R	1.465	102	102
R13	RRFS13-GB	0.358	R	1.358	96	96
R14	RRFS14-GB	0.664	R	1.664	112	112
R15	RRFS15-GB	0.467	R	1.467	103	103
R16	RRFS16-GB	0.143	R	1.143	89	89
R17	RRFS17-GB	0.089	R	1.089	88	88
R18	RRFS18-GB	-0.018	R	0.982	87	87
R19	RRFS19-GB	0.269	R	1.269	93	93
R20	RRFS20-GB	0.196	R	1.196	90	90
R21	RRFS21-GB	0.233	R	1.233	92	92
R22	RRFS22-GB	0.484	R	1.484	105	105
R23	RRFS23-GB	0.287	R	1.287	94	94
R24	RRFS24-GB	0.556	R	1.556	110	110
R25	RRFS05-GB-D	0.555	R	1.555	109	109
R26	RRFS20-GB-D	0.412	R	1.412	99	99
1	RP1S01-CO	0.144	S	0.144	35	0
2	RP1S01-GB	0.269	S	0.269	57	0
3	RP1S02-GB	0.215	S	0.215	48	0
4	RP1S03-GB	0.144	S	0.144	34	0
5	RP1S04-GB	0.108	S	0.108	28	0
6	RP2S01-CO	0.144	S	0.144	33	0
7	RP2S01-GB	0.144	S	0.144	36	0
8	RP2S02-GB	0.234	S	0.234	52	0
9	RP2S03-GB	0.449	S	0.449	76	0
10	RP2S04-GB	0.431	S	0.431	72	0
11	RP3S01-CO	0.054	S	0.054	18	0
12	RP3S01-GB-D	0.000	S	0.000	3	0
13	RP3S01-GB	0.180	S	0.180	42	0
14	RP3S02-GB	0.341	S	0.341	66	0
15	RP3S03-GB	0.323	S	0.323	63	0
16	RP3S04-GB	0.054	S	0.054	19	0
17	RP3S01-CO-D	0.000	S	0.000	1	0
18	RP4S01-CO	0.108	S	0.108	29	0
19	RP4S01-GB	0.287	S	0.287	60	0
20	RP4S02-GB	0.521	S	0.521	79	0

Class 1 SOR Summary

#	Sample ID	SOR	Area	Adjusted Data	Overall Rank	Reference Area Rank
21	RP4S03-GB	0.000	S	0.000	4	0
22	RP4S04-GB	0.000	S	0.000	5	0
23	RP5S01-CO	0.306	S	0.306	62	0
24	RP5S01-GB	0.251	S	0.251	55	0
25	RP5S02-GB	0.162	S	0.162	38	0
26	RP5S03-GB	0.287	S	0.287	59	0
27	RP5S04-GB	0.162	S	0.162	39	0
28	RP6S01-CO	0.000	S	0.000	6	0
29	RP6S01-GB	0.252	S	0.252	56	0
30	RP6S02-GB	0.216	S	0.216	49	0
31	RP6S03-GB	0.377	S	0.377	69	0
32	RP6S04-GB	0.090	S	0.090	27	0
33	RP7S01-CO	0.056	S	0.056	21	0
34	RP7S01-GB	0.056	S	0.056	23	0
35	RP7S02-GB	0.000	S	0.000	2	0
36	RP7S03-GB	0.001	S	0.001	9	0
37	RP7S04-GB	0.162	S	0.162	40	0
38	RP8S01-CO	0.002	S	0.002	13	0
39	RP8S01-GB	0.199	S	0.199	47	0
40	RP8S02-GB	0.001	S	0.001	12	0
41	RP8S03-GB	0.001	S	0.001	8	0
42	RP8S04-GB	0.271	S	0.271	58	0
43	RP8S01-CO-D	0.056	S	0.056	22	0
44	RP9S02-CO	0.181	S	0.181	43	0
45	RP9S01-GB	0.005	S	0.005	15	0
46	RP9S02-GB	0.399	S	0.399	70	0
47	RP9S03-GB	0.075	S	0.075	26	0
48	RP9S04-GB	0.289	S	0.289	61	0
49	RP9S01-CO-D	0.199	S	0.199	46	0
50	RP10S01-CO	0.832	S	0.832	85	0
51	RP10S01-GB	0.147	S	0.147	37	0
52	RP10S02-GB	0.164	S	0.164	41	0
53	RP10S03-GB	0.335	S	0.335	65	0
54	RP10S04-GB	0.797	S	0.797	84	0
55	RP10S01-GB-D	0.130	S	0.130	32	0
56	RP11S01-CO	0.044	S	0.044	17	0
57	RP11S01-GB	0.073	S	0.073	24	0
58	RP11S02-GB	0.539	S	0.539	80	0
59	RP11S03-GB	0.415	S	0.415	71	0
60	RP11S04-GB	0.632	S	0.632	83	0
61	RP11S03-GB-D	0.630	S	0.630	82	0
62	RP12S01-CO	0.217	S	0.217	50	0
63	RP12S01-GB	0.055	S	0.055	20	0
64	RP12S02-GB	0.001	S	0.001	7	0
65	RP12S03-GB	0.001	S	0.001	10	0
66	RP12S04-GB	0.073	S	0.073	25	0
67	RP13S01-CO	0.377	S	0.377	68	0

Class 1 SOR Summary

#	Sample ID	SOR	Area	Adjusted Data	Overall Rank	Reference Area Rank
68	RP13S01-CO-D	0.108	S	0.108	30	0
69	RP13S01-GB	0.431	S	0.431	73	0
70	RP13S02-GB	0.108	S	0.108	31	0
71	RP13S03-GB	0.198	S	0.198	45	0
72	RP13S04-GB	0.001	S	0.001	11	0
73	RP14S01-CO	0.185	S	0.185	44	0
74	RP14S01-GB	0.326	S	0.326	64	0
75	RP14S02-GB	0.003	S	0.003	14	0
76	RP14S03-GB	0.363	S	0.363	67	0
77	RP14S04-GB	0.236	S	0.236	54	0
78	RP15S01-CO	0.221	S	0.221	51	0
79	RP15S01-GB	0.941	S	0.941	86	0
80	RP15S02-GB	0.576	S	0.576	81	0
81	RP15S03-GB	1.843	S	1.843	113	0
82	RP15S04-GB	0.442	S	0.442	75	0
83	RP16S01-CO	0.441	S	0.441	74	0
84	RP16S01-GB	0.450	S	0.450	77	0
85	RP16S02-GB	0.506	S	0.506	78	0
86	RP16S03-GB	0.020	S	0.020	16	0
87	RP16S04-GB	0.236	S	0.236	53	0
				Sum =	**6343**	**2489**
				Critical Value =		**1723**
				Pass/Fail?		**PASS**

R = Reference Area Measurement; S = Survey Unit Measurement
Adjusted Data = Reference Area Measurement SOR + SOR of "1"
Ranks are obtained by pooling all R and S Measurements and ranking them in order of increasing size from 1 to 113.
Critical Value = Minimum Rank Sum for all Reference Area measurements to reject the Null Hypothesis.

Class 2 SOR Summary

#	Sample ID	SOR	Area	Adjusted Data	Overall Rank	Reference Area Rank
R1	RRFS01-GB	0.484	R	1.484	7	7
R2	RRFS02-GB	0.338	R	1.338	35	35
R3	RRFS03-GB	0.520	R	1.520	47	47
R4	RRFS04-GB	0.196	R	1.196	31	31
R5	RRFS05-GB	0.538	R	1.538	48	48
R6	RRFS06-GB	0.393	R	1.393	38	38
R7	RRFS07-GB	0.430	R	1.430	40	40
R8	RRFS08-GB	0.484	R	1.484	44	44
R9	RRFS09-GB	0.628	R	1.628	51	51
R10	RRFS10-GB	0.447	R	1.447	41	41
R11	RRFS11-GB	0.359	R	1.359	37	37
R12	RRFS12-GB	0.465	R	1.465	42	42
R13	RRFS13-GB	0.358	R	1.358	36	36
R14	RRFS14-GB	0.664	R	1.664	52	52
R15	RRFS15-GB	0.467	R	1.467	43	43
R16	RRFS16-GB	0.143	R	1.143	29	29
R17	RRFS17-GB	0.089	R	1.089	28	28
R18	RRFS18-GB	-0.018	R	0.982	27	27
R19	RRFS19-GB	0.269	R	1.269	33	33
R20	RRFS20-GB	0.196	R	1.196	30	30
R21	RRFS21-GB	0.233	R	1.233	32	32
R22	RRFS22-GB	0.484	R	1.484	45	45
R23	RRFS23-GB	0.287	R	1.287	34	34
R24	RRFS24-GB	0.556	R	1.556	50	50
R25	RRFS05-GB-D	0.555	R	1.555	49	49
R26	RRFS20-GB-D	0.412	R	1.412	39	39
C2-1	RC2S01-GB	0.430	C2	0.430	25	0
C2-2	RC2S02-GB	0.304	C2	0.304	23	0
C2-3	RC2S03-GB	0.142	C2	0.142	16	0
C2-4	RC2S04-GB	0.159	C2	0.159	17	0
C2-5	RC2S05-GB	0.215	C2	0.215	21	0
C2-6	RC2S06-GB	-0.162	C2	-0.162	2	0
C2-7	RC2S07-GB	-0.055	C2	-0.055	6	0
C2-8	RC2S08-GB	0.053	C2	0.053	12	0
C2-9	RC2S09-GB	-0.073	C2	-0.073	4	0
C2-10	RC2S10-GB	0.217	C2	0.217	22	0
C2-11	RC2S11-GB	0.035	C2	0.035	10	0
C2-12	RC2S12-GB	0.001	C2	0.001	9	0
C2-13	RC2S13-GB	0.053	C2	0.053	13	0
C2-14	RC2S14-GB	0.053	C2	0.053	11	0
C2-15	RC2S15-GB	0.161	C2	0.161	19	0
C2-16	RC2S16-GB	0.307	C2	0.307	24	0
C2-17	RC2S17-GB	-0.020	C2	-0.020	7	0
C2-18	RC2S18-GB	0.070	C2	0.070	14	0
C2-19	RC2S19-GB	0.465	C2	0.465	26	0
C2-20	RC2S20-GB	0.160	C2	0.160	18	0

Class 2 SOR Summary

#	Sample ID	SOR	Area	Adjusted Data	Overall Rank	Reference Area Rank
C2-21	RC2S21-GB	-0.057	C2	-0.057	5	0
C2-22	RC2S22-GB	-0.151	C2	-0.151	3	0
C2-23	RC2S23-GB	-0.019	C2	-0.019	8	0
C2-24	RC2S24-GB	0.132	C2	0.132	15	0
C2-25	RC2S01-GB-D	-0.208	C2	-0.208	1	0
C2-26	RC2S08-GB-D	0.208	C2	0.208	20	0
				Sum =	**1339**	**988**
				Critical Value =		**779**
				Pass/Fail?		**PASS**

R = Reference Area Measurement; C2 = Class 2 Survey Unit Measurement
Adjusted Data = Reference Area Measurement SOR + SOR of "1"
Ranks are obtained by pooling all R and C2 Measurements and ranking them in order of increasing size from 1 to 52.
Critical Value = Minimum Rank Sum for all Reference Area measurements to reject the Null Hypothesis.

Class 1 Survey Unit SOR Calculations

DCGLw (pCi/g)	110	5.57	2100				
	H-3	C-14	Ni-63	H-3	C-14	Ni-63	
	Mean Pit Results (R, pCi/g)			Ratio R / DCGLw			SOR
RP1S01-CO	0.01	0.8	-1.2	0.0	0.1	0.0	0.14
RP1S01-GB	-0.03	1.5	-1.2	0.0	0.3	0.0	0.27
RP1S02-GB	-0.02	1.2	-2.3	0.0	0.2	0.0	0.22
RP1S03-GB	0.00	0.8	-1.4	0.0	0.1	0.0	0.14
RP1S04-GB	-0.03	0.6	-1.7	0.0	0.1	0.0	0.11
RP2S01-CO	0.00	0.8	-2.0	0.0	0.1	0.0	0.14
RP2S01-GB	0.03	0.8	-0.7	0.0	0.1	0.0	0.14
RP2S02-GB	0.01	1.3	1.1	0.0	0.2	0.0	0.23
RP2S03-GB	-0.02	2.5	-1.7	0.0	0.4	0.0	0.45
RP2S04-GB	0.00	2.4	-1.3	0.0	0.4	0.0	0.43
RP3S01-CO	0.01	0.3	-1.1	0.0	0.1	0.0	0.05
RP3S01-GB-D	0.01	-0.2	-0.4	0.0	0.0	0.0	0.00
RP3S01-GB	-0.02	1.0	0.2	0.0	0.2	0.0	0.18
RP3S02-GB	0.02	1.9	0.1	0.0	0.3	0.0	0.34
RP3S03-GB	0.01	1.8	0.1	0.0	0.3	0.0	0.32
RP3S04-GB	0.05	0.3	-0.9	0.0	0.1	0.0	0.05
RP3S01-CO-D	-0.03	-1.1	-0.4	0.0	0.0	0.0	0.00
RP4S01-CO	0.04	0.6	-0.4	0.0	0.1	0.0	0.11
RP4S01-GB	-0.01	1.6	0.3	0.0	0.3	0.0	0.29
RP4S02-GB	0.01	2.9	-1.3	0.0	0.5	0.0	0.52
RP4S03-GB	0.02	-0.2	-0.1	0.0	0.0	0.0	0.00
RP4S04-GB	0.02	-0.6	-4.1	0.0	0.0	0.0	0.00
RP5S01-CO	0.05	1.7	-0.9	0.0	0.3	0.0	0.31
RP5S01-GB	-0.02	1.4	-1.0	0.0	0.3	0.0	0.25
RP5S02-GB	0.01	0.9	-1.1	0.0	0.2	0.0	0.16
RP5S03-GB	0.00	1.6	-0.2	0.0	0.3	0.0	0.29
RP5S04-GB	0.02	0.9	0.1	0.0	0.2	0.0	0.16
RP6S01-CO	0.02	-0.1	0.3	0.0	0.0	0.0	0.00
RP6S01-GB	0.04	1.4	-0.3	0.0	0.3	0.0	0.25
RP6S02-GB	0.02	1.2	-1.4	0.0	0.2	0.0	0.22
RP6S03-GB	0.04	2.1	-0.2	0.0	0.4	0.0	0.38
RP6S04-GB	0.04	0.5	0.5	0.0	0.1	0.0	0.09
RP7S01-CO	0.19	0.3	-0.7	0.0	0.1	0.0	0.06
RP7S01-GB	0.28	0.3	-2.8	0.0	0.1	0.0	0.06
RP7S02-GB	0.01	-0.1	-2.9	0.0	0.0	0.0	0.00
RP7S03-GB	0.09	-0.4	-4.2	0.0	0.0	0.0	0.00
RP7S04-GB	0.10	0.9	-4.7	0.0	0.2	0.0	0.16
RP8S01-CO	0.23	-0.3	-1.3	0.0	0.0	0.0	0.00
RP8S01-GB	0.16	1.1	-2.1	0.0	0.2	0.0	0.20
RP8S02-GB	0.16	0.0	-1.9	0.0	0.0	0.0	0.00
RP8S03-GB	0.08	-0.5	-1.7	0.0	0.0	0.0	0.00
RP8S04-GB	0.14	1.5	-0.9	0.0	0.3	0.0	0.27
RP8S01-CO-D	0.25	0.3	-1.1	0.0	0.1	0.0	0.06
RP9S02-CO	0.17	1.0	-2.3	0.0	0.2	0.0	0.18

Class 1 Survey Unit SOR Calculations

DCGLw (pCi/g)	110	5.57	2100				
	H-3	C-14	Ni-63	H-3	C-14	Ni-63	
	Mean Pit Results (R, pCi/g)			Ratio R / DCGLw			SOR
RP9S01-GB	0.55	-1.1	-1.2	0.0	0.0	0.0	0.01
RP9S02-GB	0.49	2.2	-2.4	0.0	0.4	0.0	0.40
RP9S03-GB	0.32	0.4	-0.7	0.0	0.1	0.0	0.07
RP9S04-GB	0.20	1.6	-1.4	0.0	0.3	0.0	0.29
RP9S01-CO-D	0.14	1.1	-1.2	0.0	0.2	0.0	0.20
RP10S01-CO	0.67	4.6	-3.3	0.0	0.8	0.0	0.83
RP10S01-GB	0.33	0.8	-5.0	0.0	0.1	0.0	0.15
RP10S02-GB	0.30	0.9	-1.4	0.0	0.2	0.0	0.16
RP10S03-GB	1.31	1.8	-2.2	0.0	0.3	0.0	0.34
RP10S04-GB	0.78	4.4	-1.1	0.0	0.8	0.0	0.80
RP10S01-GB-D	0.52	0.7	-2.6	0.0	0.1	0.0	0.13
RP11S01-CO	0.91	0.2	-2.7	0.0	0.0	0.0	0.04
RP11S01-GB	0.09	0.4	-1.5	0.0	0.1	0.0	0.07
RP11S02-GB	0.08	3.0	-0.6	0.0	0.5	0.0	0.54
RP11S03-GB	0.19	2.3	-2.2	0.0	0.4	0.0	0.41
RP11S04-GB	0.35	3.5	-2.2	0.0	0.6	0.0	0.63
RP11S03-GB-D	0.15	3.5	-1.3	0.0	0.6	0.0	0.63
RP12S01-CO	0.15	1.2	-1.3	0.0	0.2	0.0	0.22
RP12S01-GB	0.08	0.3	-0.5	0.0	0.1	0.0	0.05
RP12S02-GB	0.06	-0.8	-2.4	0.0	0.0	0.0	0.00
RP12S03-GB	0.10	-0.6	-1.6	0.0	0.0	0.0	0.00
RP12S04-GB	0.10	0.4	-0.7	0.0	0.1	0.0	0.07
RP13S01-CO	0.00	2.1	-0.8	0.0	0.4	0.0	0.38
RP13S01-CO-D	0.06	0.6	0.3	0.0	0.1	0.0	0.11
RP13S01-GB	0.03	2.4	-0.9	0.0	0.4	0.0	0.43
RP13S02-GB	0.08	0.6	-1.0	0.0	0.1	0.0	0.11
RP13S03-GB	0.10	1.1	-1.1	0.0	0.2	0.0	0.20
RP13S04-GB	0.15	0.0	-2.4	0.0	0.0	0.0	0.00
RP14S01-CO	0.58	1.0	0.3	0.0	0.2	0.0	0.18
RP14S01-GB	0.32	1.8	0.2	0.0	0.3	0.0	0.33
RP14S02-GB	0.32	-0.1	-0.4	0.0	0.0	0.0	0.00
RP14S03-GB	0.45	2.0	-0.1	0.0	0.4	0.0	0.36
RP14S04-GB	0.27	1.3	0.7	0.0	0.2	0.0	0.24
RP15S01-CO	0.64	1.2	0.5	0.0	0.2	0.0	0.22
RP15S01-GB	0.71	5.2	1.0	0.0	0.9	0.0	0.94
RP15S02-GB	0.15	3.2	0.6	0.0	0.6	0.0	0.58
RP15S03-GB	3.16	10.1	1.8	0.0	1.8	0.0	1.84
RP15S04-GB	1.18	2.4	0.7	0.0	0.4	0.0	0.44
RP16S01-CO	1.16	2.4	-0.3	0.0	0.4	0.0	0.44
RP16S01-GB	0.14	2.5	0.6	0.0	0.4	0.0	0.45
RP16S02-GB	0.24	2.8	1.7	0.0	0.5	0.0	0.51
RP16S03-GB	0.26	0.1	-1.1	0.0	0.0	0.0	0.02
RP16S04-GB	0.25	1.3	-0.3	0.0	0.2	0.0	0.24

Class 2 Survey Unit SOR Calculations

DCGLw (pCi/g)	110	5.57	2100				
	H-3	C-14	Ni-63	H-3	C-14	Ni-63	
	Mean Pit Results (R, pCi/g)			Ratio R / DCGLw			SOR
RC2S01-GB	0.023	2.4	-2.2	0.0	0.4	0.0	0.43
RC2S02-GB	0.016	1.7	-3.7	0.0	0.3	0.0	0.30
RC2S03-GB	0.003	0.8	-2.7	0.0	0.1	0.0	0.14
RC2S04-GB	0.031	0.9	-5.0	0.0	0.2	0.0	0.16
RC2S05-GB	-0.020	1.2	-0.7	0.0	0.2	0.0	0.21
RC2S06-GB	-0.010	-0.9	-1.6	0.0	-0.2	0.0	-0.16
RC2S07-GB	0.018	-0.3	-3.0	0.0	-0.1	0.0	-0.06
RC2S08-GB	0.015	0.3	-2.4	0.0	0.1	0.0	0.05
RC2S09-GB	0.024	-0.4	-2.1	0.0	-0.1	0.0	-0.07
RC2S10-GB	0.230	1.2	-1.9	0.0	0.2	0.0	0.22
RC2S11-GB	0.082	0.2	-3.0	0.0	0.0	0.0	0.04
RC2S12-GB	0.215	0.0	-2.4	0.0	0.0	0.0	0.00
RC2S13-GB	0.138	0.3	-3.4	0.0	0.1	0.0	0.05
RC2S14-GB	0.036	0.3	-3.2	0.0	0.1	0.0	0.05
RC2S15-GB	0.044	0.9	-2.3	0.0	0.2	0.0	0.16
RC2S16-GB	0.320	1.7	-2.6	0.0	0.3	0.0	0.31
RC2S17-GB	0.062	-0.1	-5.2	0.0	0.0	0.0	-0.02
RC2S18-GB	-0.001	0.4	-2.8	0.0	0.1	0.0	0.07
RC2S19-GB	0.011	2.6	-3.4	0.0	0.5	0.0	0.47
RC2S20-GB	0.017	0.9	-3.7	0.0	0.2	0.0	0.16
RC2S21-GB	-0.300	-0.3	-0.3	0.0	-0.1	0.0	-0.06
RC2S22-GB	-0.800	-0.8	-0.8	0.0	-0.1	0.0	-0.15
RC2S23-GB	-0.100	-0.1	-0.1	0.0	0.0	0.0	-0.02
RC2S24-GB	0.700	0.7	0.7	0.0	0.1	0.0	0.13
RC2S01-GB-D	-1.100	-1.1	-1.1	0.0	-0.2	0.0	-0.21
RC2S08-GB-D	1.100	1.1	1.1	0.0	0.2	0.0	0.21

Reference Area SOR Calculations

DCGLw (pCi/g)	110	5.57	2100				
	H-3	C-14	Ni-63	H-3	C-14	Ni-63	
	Mean Pit Results (R, pCi/g)			Ratio R / DCGLw			SOR
RRFS01-GB	0.007	2.7	-1.8	0.0	0.5	0.0	0.48
RRFS02-GB	-0.007	1.9	-5.8	0.0	0.3	0.0	0.34
RRFS03-GB	0.038	2.9	-1.1	0.0	0.5	0.0	0.52
RRFS04-GB	-0.047	1.1	-1.3	0.0	0.2	0.0	0.20
RRFS05-GB	0.024	3.0	-2.0	0.0	0.5	0.0	0.54
RRFS06-GB	0.013	2.2	-3.5	0.0	0.4	0.0	0.39
RRFS07-GB	-0.019	2.4	-0.7	0.0	0.4	0.0	0.43
RRFS08-GB	-0.025	2.7	-1.7	0.0	0.5	0.0	0.48
RRFS09-GB	-0.024	3.5	-1.2	0.0	0.6	0.0	0.63
RRFS10-GB	-0.007	2.5	-2.8	0.0	0.4	0.0	0.45
RRFS11-GB	0.022	2.0	-1.4	0.0	0.4	0.0	0.36
RRFS12-GB	-0.053	2.6	-2.7	0.0	0.5	0.0	0.47
RRFS13-GB	0.053	2.0	-2.6	0.0	0.4	0.0	0.36
RRFS14-GB	-0.017	3.7	-1.1	0.0	0.7	0.0	0.66
RRFS15-GB	-0.005	2.6	-0.1	0.0	0.5	0.0	0.47
RRFS16-GB	0.044	0.8	-1.5	0.0	0.1	0.0	0.14
RRFS17-GB	-0.009	0.5	-0.9	0.0	0.1	0.0	0.09
RRFS18-GB	0.016	-0.1	-1.0	0.0	0.0	0.0	-0.02
RRFS19-GB	-0.021	1.5	-0.5	0.0	0.3	0.0	0.27
RRFS20-GB	-0.008	1.1	-2.1	0.0	0.2	0.0	0.20
RRFS21-GB	0.015	1.3	-0.1	0.0	0.2	0.0	0.23
RRFS22-GB	0.033	2.7	-2.3	0.0	0.5	0.0	0.48
RRFS23-GB	0.043	1.6	-1.1	0.0	0.3	0.0	0.29
RRFS24-GB	0.071	3.1	-1.8	0.0	0.6	0.0	0.56
RRFS05-GB-D	0.026	3.1	-2.8	0.0	0.6	0.0	0.56
RRFS20-GB-D	0.036	2.3	-2.7	0.0	0.4	0.0	0.41