Nevada
Environmental
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Project

DOE/NV--1320

Corrective Action Decision Document/ Closure Report for Corrective Action Unit 370: T-4 Atmospheric Test Site Nevada Test Site, Nevada

Controlled Copy No.:
Revision No.: 0

May 2009

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Environmental Restoration
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U.S. Department of Energy
National Nuclear Security Administration
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CORRECTIVE ACTION DECISION DOCUMENT/ CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 370: T-4 ATMOSPHERIC TEST SITE NEVADA TEST SITE, NEVADA

U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office
Las Vegas, Nevada

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CORRECTIVE ACTION DECISION DOCUMENT/CLOSURE REPORT
FOR CORRECTIVE ACTION UNIT 370:
T-4 ATMOSPHERIC TEST SITE
NEVADA TEST SITE, NEVADA

Approved by: /s/ Kevin J. Cabble Date: 5/21/2009

Kevin J. Cabble
Acting Federal Sub-Project Director
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Approved by: /s/Robert F. Boehlecke Date: 5/21/2009

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Federal Project Director
Environmental Restoration Project

Table of Contents

Table of Contents *(Continued)*

Table of Contents *(Continued)*

Appendix B - Data Assessment

Appendix C - Risk Assessment

Table of Contents *(Continued)*

List of Figures

List of Figures *(Continued)*

List of Tables

List of Tables *(Continued)*

List of Tables *(Continued)*

List of Tables *(Continued)*

List of Tables *(Continued)*

List of Tables *(Continued)*

List of Tables *(Continued)*

List of Acronyms and Abbreviations

Am	Americium
ASTM	American Society for Testing and Materials
bgs	Below ground surface
CAA	Corrective action alternative
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAS	Corrective action site
CAU	Corrective action unit
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
cm	Centimeter
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
Counts/sec	Counts per second
CR	Closure report
Cs	Cesium
CSM	Conceptual site model
CZ	Contamination zone
DOE	U.S. Department of Energy
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics

List of Acronyms and Abbreviations *(Continued)*

EPA	U.S. Environmental Protection Agency
Eu	Europium
FADL	Field Activity Daily Log
FAL	Final action level
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FSR	Field-screening result
ft	Foot
g/m^3	Grams per cubic meter
g/yr	Grams per year
GPS	Global Positioning System
GWS	Gamma walkover survey
GZ	Ground zero
in.	Inch
LCS	Laboratory control sample
m	Meter
m^2	Square meter
m/sec	Meters per second
m/yr	Meters per year
MB	Method blank
MDC	Minimum detectable concentration
mg/kg	Milligrams per kilogram
mrem	Millirem
mrem/hr	Millirem per hour
mrem/yr	Millirem per year

List of Acronyms and Abbreviations *(Continued)*

MS	Matrix spike
mSv/yr	Millisieverts per year
N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum
NCRP	National Council on Radiation Protection and Measurements
NDEP	Nevada Division of Environmental Protection
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NSTec	National Security Technologies, LLC
NTS	Nevada Test Site
PAL	Preliminary action level
Pb	Lead
PB	Preparation blank
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PPE	Personal protective equipment
PRG	Preliminary remediation goal
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control

List of Acronyms and Abbreviations *(Continued)*

R^2	Correlation coefficient
RBCA	Risk-based corrective action
RBSL	Risk-based screening level
RCRA	*Resource Conservation and Recovery Act*
RESRAD	Residual Radioactive
RIDP	Radiological Inventory Distribution Program
RMA	Radioactive material area
ROTC	Record of Technical Change
RPD	Relative percent difference
RRMG	Residual Radioactive Material Guidelines
SCL	Sample collection log
SD	Standard deviation
SDG	Sample delivery group
SoF	Sum of Fractions
Sr	Strontium
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
SW	Southwest
TEDE	Total effective dose equivalent
Th	Thorium
TLD	Thermoluminescent dosimeter
TPH	Total petroleum hydrocarbons
U	Uranium
UCL	Upper confidence limit
UTM	Universal Transverse Mercator

List of Acronyms and Abbreviations *(Continued)*

VSP	Visual Sample Plan
VOC	Volatile organic compound
yr	Year
%R	Percent recovery
µrem/hr	Microrem per hour

Executive Summary

This Corrective Action Decision Document/Closure Report has been prepared for Corrective Action Unit (CAU) 370, T-4 Atmospheric Test Site, located in Area 4 at the Nevada Test Site, Nevada, in accordance with the *Federal Facility Agreement and Consent Order* (FFACO). Corrective Action Unit 370 is comprised of Corrective Action Site (CAS) 04-23-01, Atmospheric Test Site T-4.

The purpose of this Corrective Action Decision Document/Closure Report is to provide justification and documentation supporting the recommendation that no further corrective action is needed for CAU 370 due to the implementation of the corrective action of closure in place with administrative controls. To achieve this, corrective action investigation (CAI) activities were performed from June 25, 2008, through April 2, 2009, as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 370: T-4 Atmospheric Test Site* and Record of Technical Change No. 1.

The approach for the CAI was divided into two facets: investigation of the annular distribution of radionuclides and investigation of other releases (americium plumes, migration in washes, and chemical releases). The purpose of the CAI was to fulfill the following data needs as defined during the data quality objective (DQO) process:

- Determine whether contaminants of concern (COCs) are present by collecting samples (a) in areas most likely to contain a COC (judgmental sampling) or (b) that properly represent contamination within a sampled area (probabilistic sampling).
- Use an analytical suite that is sufficient to identify COCs present in samples.
- Establish a decreasing trend of total effective dose equivalent rates from more than 25 millirem per year (mrem/yr) to less than 25 mrem/yr in three directions (vectors) from ground zero that sufficiently determines a boundary around the area posing a dose rate of more than 25 mrem/yr (annular distribution).
- Determine extent of contamination by collecting samples in areas contiguous to contamination but where contaminant concentrations are below final action levels (FALs) (other releases).
- Determine potential remediation waste types by sampling the relevant waste or environmental media.

A data quality assessment was performed on the CAU 370 dataset. This assessment demonstrated the quality and acceptability of the dataset for use in fulfilling the DQO data needs.

Analytes detected during the CAI were evaluated against FALs established in this document. Radiological doses were found to be present in the surface soil at levels exceeding the FAL of 25 mrem/yr, and lead was present exceeding potential source material criteria.

Due to the identification of lead objects and the determination of radiological dose exceeding the FALs, corrective actions were undertaken that consist of:

- Implementing a use restriction (i.e., posting use restriction signs on the existing fence).
- Recording the use restriction for the site in the FFACO and Facility Information Management System.

A use restriction boundary was established that encompasses the locations where the 95 percent upper confidence limit of the average for the total effective dose equivalent that exceeds the FAL and locations of potential lead contamination.

No further corrective action (based on risk to human receptors) is necessary. Therefore, the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office provides the following recommendations:

- No further corrective action is required at CAU 370.
- A Notice of Completion to the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office is requested from the Nevada Division of Environmental Protection for closure of CAU 370.
- Move CAU 370 from Appendix III to Appendix IV of the FFACO.

1.0 Introduction

This Corrective Action Decision Document (CADD)/Closure Report (CR) presents information supporting closure of Corrective Action Unit (CAU) 370, T-4 Atmospheric Test Site, Nevada Test Site (NTS), Nevada. The corrective actions described in this document were implemented in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the State of Nevada; U.S. Department of Energy (DOE), Environmental Management; U.S. Department of Defense; and DOE, Legacy Management (FFACO, 1996; as amended February 2008). The NTS is approximately 65 miles northwest of Las Vegas, Nevada (Figure 1-1).

Corrective Action Unit 370 is comprised of Corrective Action Site (CAS) 04-23-01, Atmospheric Test Site T-4, shown on Figure 1-2.

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan* (CAIP) *for Corrective Action Unit 370: T-4 Atmospheric Test Site* (NNSA/NSO, 2008). This document provides or references the specific information necessary to support closure of this CAU.

1.1 Purpose

This CADD/CR provides justification why no further corrective action beyond implementation of a corrective action of closure in place with use restriction is necessary, how and why the use restriction will be applied, and the technical rationale for implemented closure activities. This justification is based on the corrective actions implemented and the results of investigative activities that were conducted in accordance with the CAIP for CAU 370 (NNSA/NSO, 2008).

Corrective Action Unit 370, T-4 Atmospheric Test Site consists of one inactive site located in the central portion of Area 4. This site consists of contamination of the soil in and around the T-4 ground zero (GZ) that was impacted in the 1950s by releases from atmospheric tower testing of four nuclear devices at the T-4 site. Features at the site include remnants of the tower used for the testing, the associated bunker and soil berm, and pieces of metal and concrete debris (Figure 1-3). The site is divided by the 4-04 Road. Several washes enter the area from the west/northwest and continue through the site while other, smaller washes originate on the site.

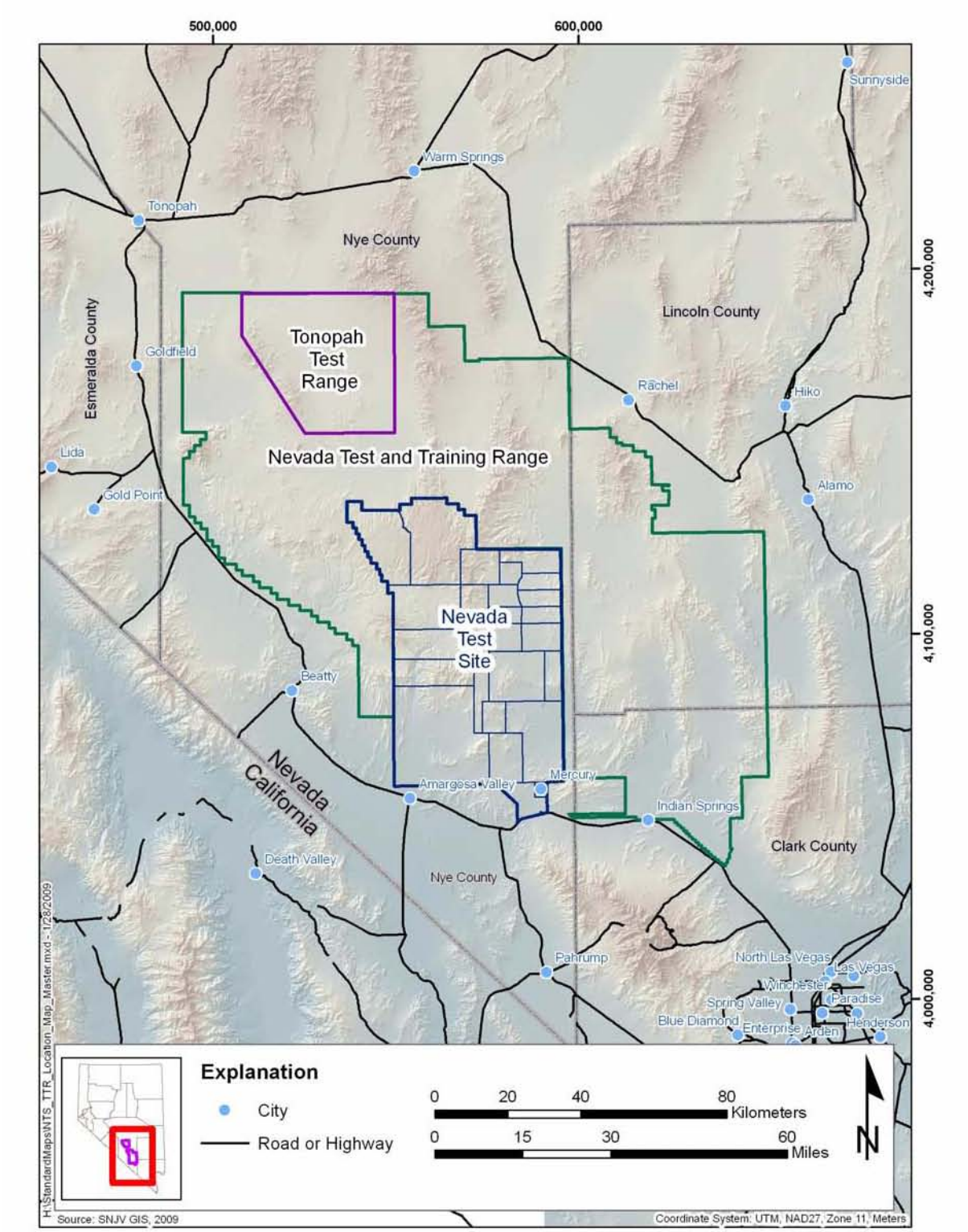

Figure 1-1
Nevada Test Site

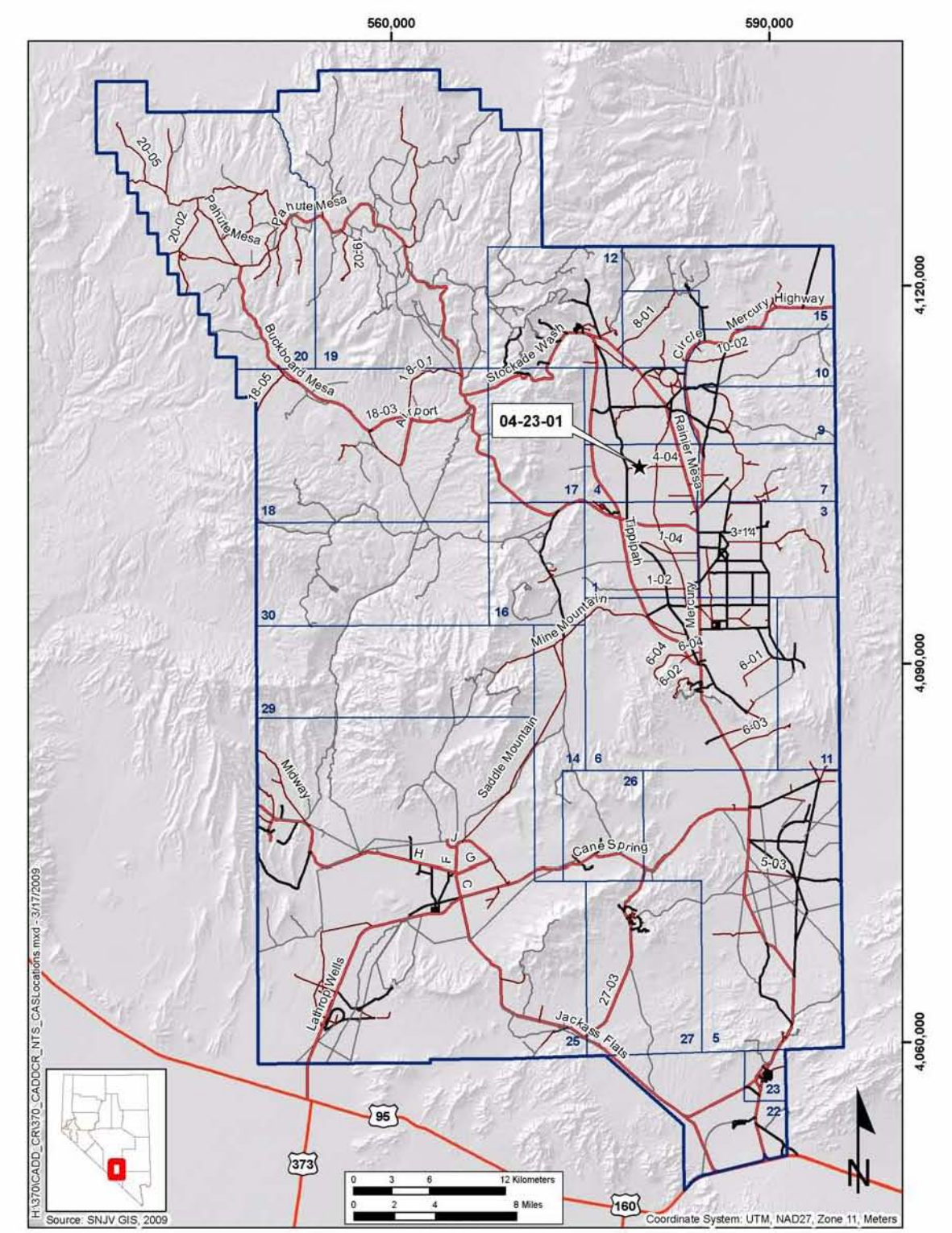

Figure 1-2
Corrective Action Unit 370 CAS Location Map

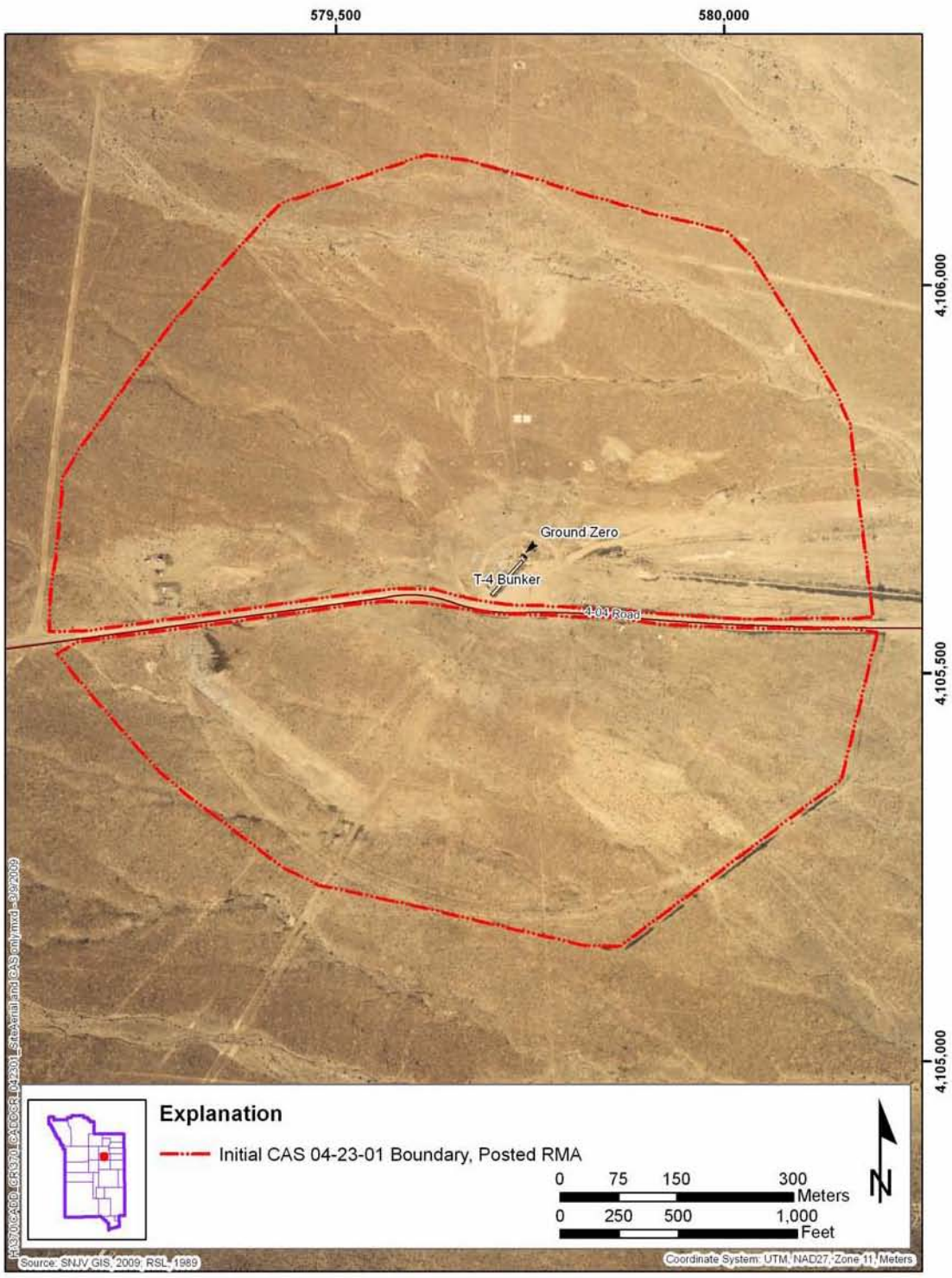

Figure 1-3
Corrective Action Site 04-23-01 Aerial View

1.2 Scope

The scope of this CADD/CR is to justify that no further corrective action is required at CAU 370, T-4 Atmospheric Test Site. The investigation activities conducted to accomplish this scope included the following:

- Radiological surveys
- Field screening
- Collection of environmental samples for laboratory analysis
- Collection of quality control (QC) samples

1.3 Corrective Action Decision Document/Closure Report Contents

This CADD/CR is divided into the following sections and appendices:

Section 1.0 – Introduction: Summarizes the purpose, scope, and contents of this CADD/CR.

Section 2.0 – Corrective Action Investigation (CAI) Summary: Summarizes the investigation field activities, the results of the investigation, and justifies that no further corrective action is needed.

Section 3.0 – Recommendation: Provides the basis for requesting that the CAU be moved from Appendix III to Appendix IV of the FFACO.

Section 4.0 – References: Provides a list of all referenced documents used in the preparation of this CADD/CR.

Appendix A – *Corrective Action Investigation Results:* Provides a description of the project objectives, field investigation and sampling activities, investigation results, waste management, and quality assurance (QA). Section A.2.0 provides specific information regarding field activities, and sampling methods. Section A.3.0 presents laboratory analytical results from the investigation.

Appendix B – *Data Assessment:* Provides a data quality assessment (DQA) that reconciles data quality objective (DQO) assumptions and requirements to the investigation results.

Appendix C – *Risk Assessment:* Presents an evaluation of risk associated with the establishment of final action levels (FALs).

Appendix D – *Closure Activity Summary:* Provides details on the completed closure activities and includes the required verification activities and supporting documentation.

Appendix E – *Evaluation of Corrective Action Alternatives:* Provides a discussion of the alternatives considered to address the results of the CAI, and the rationale for the recommended alternative.

Appendix F – *Composite Sample Plot Analytical Data:* Provides tabular compilations of validated analytical results upon which internal radiological dose estimates are based.

Appendix G – *Sample Location Coordinates:* Presents the northing and easting coordinates for each sample plot, the biased sample location, and other points of interest.

Appendix H - Nevada Division of Environmental Protection (NDEP) Comments: Contains NDEP comments on the draft version of this document.

1.3.1 Applicable Programmatic Plans and Documents

All investigation activities were performed in accordance with the following documents:

- The CAIP for CAU 370, T-4 Atmospheric Test Site (NNSA/NSO, 2008)
- Record of Technical Change (ROTC) No. 1 for the CAIP for CAU 370, T-4 Atmospheric Test Site
- *Industrial Sites Quality Assurance Project Plan* (QAPP) (NNSA/NV, 2002)
- The FFACO (1996, as amended February 2008)

1.3.2 Data Quality Assessment Summary

The DQA is presented in Appendix B and includes an evaluation of the data quality indicators (DQIs) to determine the degree of acceptability and usability of the reported data in the decision-making process. The DQO process ensures that the right type, quality, and quantity of data will be available

to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes help to ensure that DQO decisions are sound and defensible.

The DQA process as presented in Appendix B is comprised of the following steps:

- Step 1: Review DQOs and Sampling Design
- Step 2: Conduct a Preliminary Data Review
- Step 3: Select the Test
- Step 4: Verify the Assumptions
- Step 5: Draw Conclusions from the Data

Based on the results of the DQA presented in Appendix B, the nature and extent of contaminants of concern (COCs) at CAU 370 have been adequately identified to implement corrective actions. The DQA also determined that information generated during the investigation support the conceptual site model (CSM) assumptions and the data collected met the DQOs and support their intended use in the decision-making process.

2.0 Corrective Action Investigation Summary

The following sections summarize the investigation activities, investigation results, and justify why no further corrective action is required at CAU 370. Detailed investigation activities and results for CAU 370 are presented in Appendix A of this document.

2.1 Investigation Activities

Corrective action investigation activities were performed as set forth in the CAU 370 CAIP (NNSA/NSO, 2008) from June 25, 2008, through April 2, 2009. The purpose of the CAU 370 CAI was to address the decision statements in the project-specific DQOs by:

- Determining whether COCs are present in the soils associated with CAU 370.
- Determining the extent of identified COCs.
- Ensuring adequate data have been collected to close the site under the FFACO.

The scope of the CAI included the following activities:

- Performing radiological surveys.
- Field screening soil samples for total alpha and beta/gamma radiation.
- Collecting environmental samples for laboratory analyses.
- Staging thermoluminescent dosimeters (TLDs).
- Collecting QC samples for laboratory analyses.

The investigation of the site was divided into two facets: investigation of the annular distribution of radionuclides and investigation of other releases (possible chemical contamination).

Annular Distribution

The primary distribution of radiological material released at CAS 04-23-01 appears in aerial radiological surveys (flyover surveys) as rings or groupings of gamma radiation (i.e., each ring corresponded to a roughly circular ground extent between the inner and outer boundary of an isopleth). This appearance was designated as the annular distribution representing the release of radioactive material, both activated soil particles and immediate fallout, that occurred in a roughly annular pattern. An assumption was developed that dose rates at the site are generally correlated to the distribution patterns observed in the radiation surveys.

An investigation of contamination present in an annular distribution was implemented through a combination of judgmental and probabilistic sampling in the CAU 370 CAIP (NNSA/NSO, 2008). Five sample plots, each along three sampling vectors (i.e., 15 sample plots total) originating from GZ, were established judgmentally to lie within decreasing radiological isopleths determined by a 1994 flyover survey, and if possible, coincide with previously investigated locations (Radiological Inventory and Distribution Program [RIDP] points). Within each sample plot, the selection of sample (aliquot) locations were established using a probabilistic sampling approach.

Confidence in judgmental sampling scheme decisions was established qualitatively by validation of the CSM and justification that the selected plot locations are in areas that have dose rates which are both above and below the FAL. Confidence in probabilistic sampling scheme decisions was established by the validation of the CSM, justification that sampling locations are representative of the plot area, demonstration that a sufficient number of samples were collected, and that contaminant distribution assumptions are valid and appropriate to the statistical test being performed.

The final action level (FAL) that was established in the CAU 370 CAIP (NNSA/NSO, 2008) was expressed as a radiological dose of 25-millirem per year (mrem/yr) total effective dose equivalent (TEDE) under the Industrial Area exposure scenario. The TEDE is defined in 10 *Code of Federal Regulations* (CFR) Part 835 (CFR, 2009) as the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). The potential internal exposures at each CAU 370 sampling plot were determined by comparing the laboratory analytical results of soil samples taken at each plot to Residual Radioactive Material Guidelines (RRMGs) that were calculated with the Residual Radioactive (RESRAD) computer code (see Appendix C, Attachment 1). The potential external exposures at each planned sampling plot were determined by staging a thermoluminescent dosimeter (TLD) at a height of 1 m in the center of each plot for about 94 days. The potential external exposures at the americium plumes and plots in the wash were determined via dose-rate measurements with a Bicron micro-REM per hour (see Section A.2.4). The Bicron measurements were adjusted to match the 2,250 hours of the Industrial Area exposure scenario and normalized to the TLD data.

The separate methods for determining the internal and external dose components of the TEDE were implemented because of the presence of Trinity glass (i.e., fused soil). Trinity glass conglomerates,

while providing a significant contribution to external dose, are not considered to be respirable and, therefore, were not considered in calculating internal dose.

The TEDEs were calculated in units of mrem/yr based on the industrial area exposure scenario (i.e., on site for 2,250 hours per year) (NNSA/NSO, 2006). The calculated TEDE for each sample plot is an estimation of the true radiological dose (true TEDE). Because average TEDE is an estimate of the true (unknown) TEDE, it is uncertain how well the average TEDE represents the true TEDE. To reduce the probability of making a false negative decision error, the 95 percent upper confidence limit (UCL) of the average TEDE for each sample plot was compared to the FAL. Therefore, by definition, there would be a 95 percent probability that the true TEDE is less than the 95 percent UCL of the calculated average TEDE.

The CAU 370 CAIP (NNSA/NSO, 2008) designated the investigation of the three americium plumes and the washes as "other releases." However, the three americium plumes and a wash trending to the southeast from the site were sampled using 100-square meter (m^2) plots with nine aliquots per sample in the same manner as the investigation of the annular distribution. Because the investigation approach was similar to that for the annular distribution, the results for the americium plumes and washes are included in the discussion of the results for the annular distribution.

Other Releases

An area of stained soil in the western portion of the site (see Figures A.2-1 and A.2-4) was identified during the CAI. A judgmental sampling scheme was used at this site. As discussed in the CAIP for sampling other releases, individual sample results rather than average concentrations are used to compare to FALs. Therefore, statistical methods to generate site characteristics (averages) are not necessary (EPA, 2006). If good prior information is available on the target site of interest, then the sampling may be designed to collect samples only from areas known to have the highest concentration levels on the target site. If the observed concentrations from these samples are below the action level, then a decision can be made that the site contains safe levels of the contaminant without the samples being truly representative of the entire area.

The following sections describe specific investigation activities conducted at CAS 04-23-01. Additional information regarding the investigation is presented in Appendix A.

2.1.1 Radiological Surveys

Radiological surveys (i.e., gamma walkover and micro-REM Grid) were performed at CAS 04-23-01 during the CAI. These surveys were performed to provide information on the distribution of radiological contamination at the site.

***Gamma Walkover Surveys*:** Global Positioning System (GPS)-assisted gamma walkover surveys (GWSs) were conducted in the three most significant washes at CAS 04-23-01. These surveys were conducted to investigate the potential for the migration of radiological contamination. Surveys of the two washes closest to the 4-04 Road, one exiting the site north of the road and one exiting south of the road, identified no anomalous readings away from the GZ area. A survey of the third wash, exiting the far southeast side of the site, identified two areas of anomalous readings. This wash drains a significant portion of the south side of the site that is within the 25-mrem/yr area.

The GWSs were performed with the gamma radiation detector held at approximately 1 m above ground surface. Gross count-rate data were recorded (counts per second), along with GPS position information at 1-second intervals.

Transects across the wash and above the wash shoulders on each side were walked at 3-m intervals. Figures 2-1 and 2-2 present a color-coded graphic representations of the data that identifies locations along these drainage channels where the radioactivity is significantly greater than the surrounding soil.

The GWS readings for the two areas in the southeast wash were anomalous compared to readings at 10 m on either side of the wash. The areas of anomalous readings were established as 100-m^2 polygon-shaped sample plots adjusted to encompass the areas of highest elevated readings (Figure 2-2). Composite samples and dose-rate readings were collected at the plots. Section 2.2.1.1 discusses the results.

Micro-REM Grid Survey: The area within the initial CAS boundary (as shown in Figure 2-3) was divided into 50-m grids for a micro-REM Grid Survey. Survey points were established at the grid intersections. At each point a Bicron micro-REM/hour meter reading, (ten second measurement) was collected with the meter held at 1 m above ground surface.

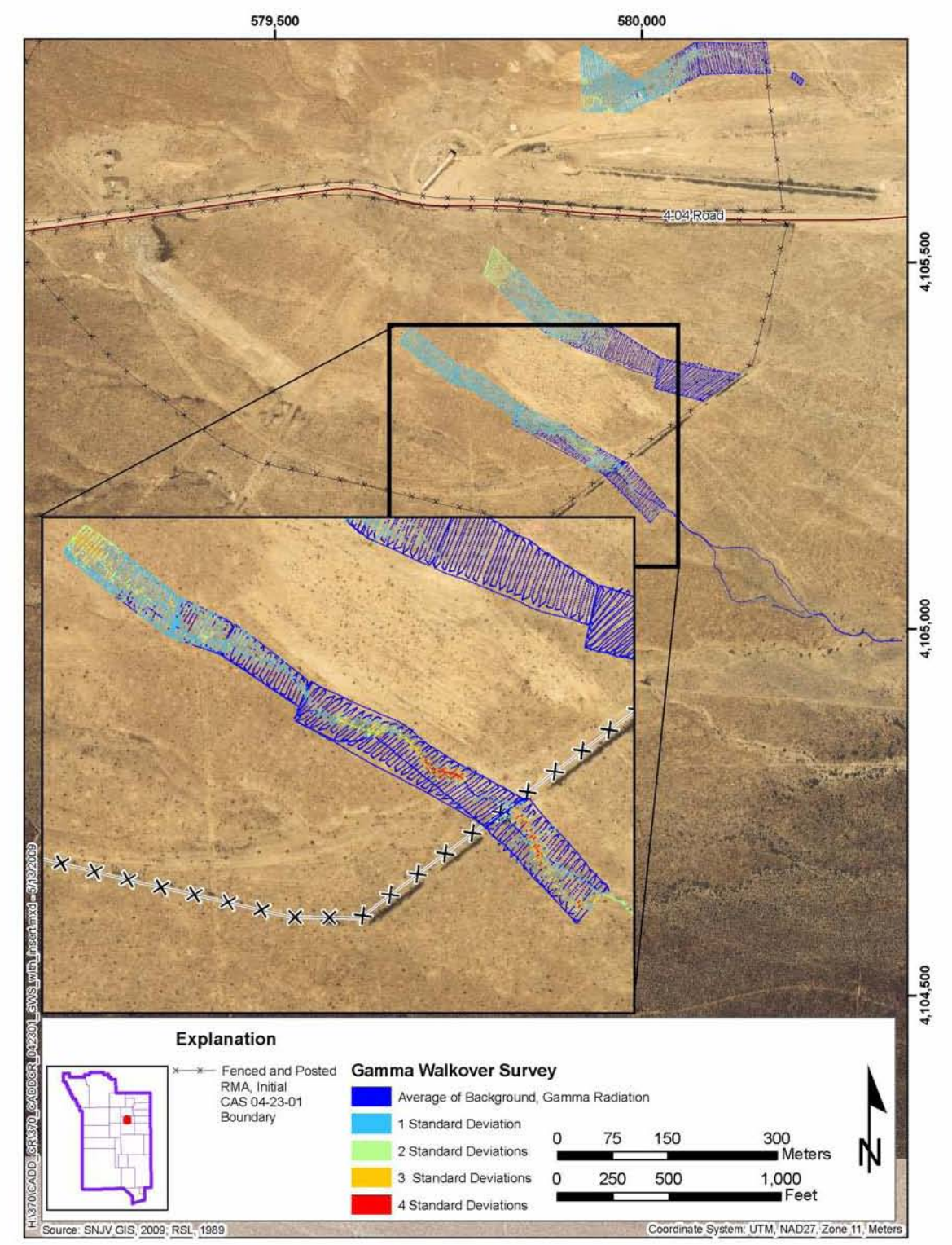

Figure 2-1
Gamma Walkover Surveys of Selected Washes at CAS 04-23-01, Atmospheric Test Site T-4

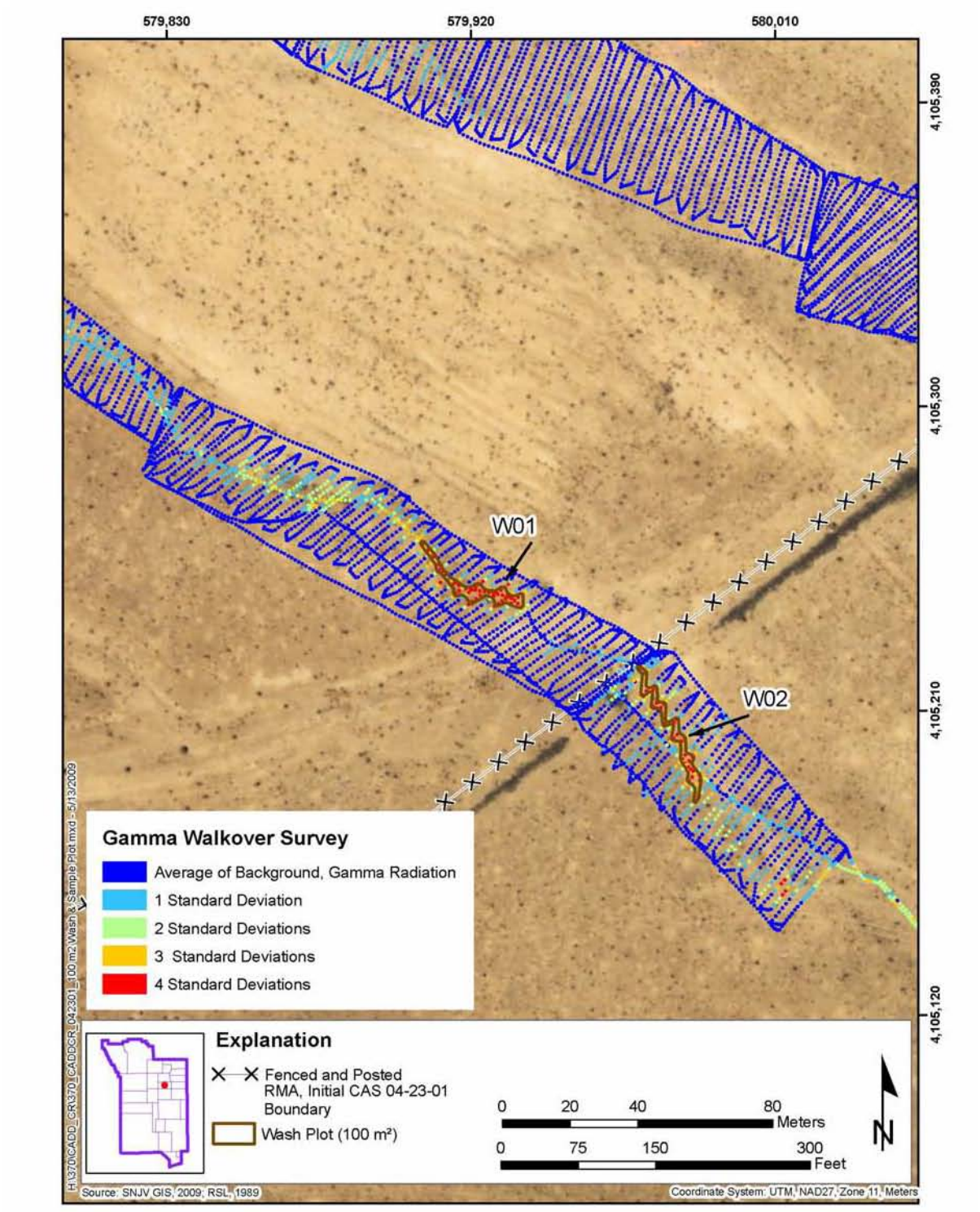

Figure 2-2
Sample Plots Established in Southeast Wash, CAS 04-23-01

2.1.2 Visual Inspection

Visual inspection of the T-4 site was conducted over the course of several site walks, sampling efforts, and during the radiological grid survey. While walking the various areas of the site, observances of physical hazards, the presence of debris, and potentially hazardous materials were recorded. Aside from the widespread distribution of Trinity glass and metallic debris, notable features of the site include:

- The locations of two underground bunker systems, with several entrances.
- Three occurrences of lead bricks.
- Two loose, and several attached, lead panels on top of Bunker 4-390.
- One lead sheet.
- Three lead-acid batteries.
- Several debris piles containing mostly metal and concrete.
- An area of orange and dark grayish-green stained soil.
- The presence of washes and gullies, including the portions of the site that they drain.

The locations of these features are shown in Figure A.2-9.

The two underground bunker systems were inspected for the presence of hazardous materials (i.e., potential source material [PSM]) and other indicators of potential contamination by lowering a video camera and lighting system into each entrance. Review of the recordings found nothing to indicate the presence of potential contamination. As a result, no further actions were taken.

The lead objects (i.e., three lead bricks, two loose lead panels, one lead sheet, and three lead-acid batteries [Figure A.2-9]) were collected, screened, and submitted for recycling. Section 2.2.1.3 discusses the potential for other lead objects at the site.

The metal and concrete piles gave no indication of hazardous material (i.e., PSM) during inspection. The potential exists, however, that metallic material remaining at the site (i.e., metal inside the T-4 bunker, metal used for the towers, the tower anchors and anchor cables, and the metal rebar inside concrete) became activated during the detonations, and that metal and concrete near GZ was contaminated by fallout.

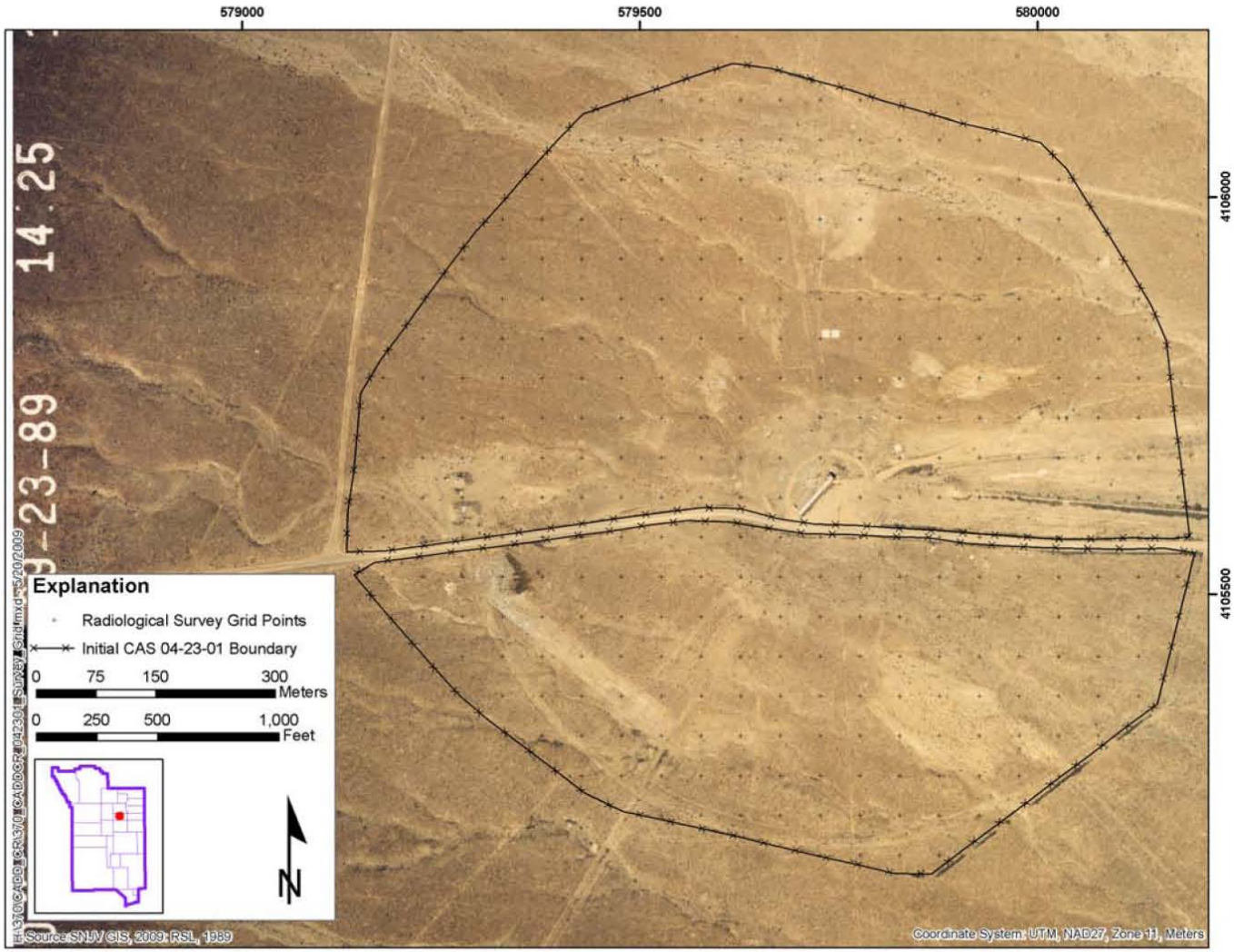

Figure 2-3
Radiological Grid Survey Points, CAS 04-23-01

The orange and dark-grayish green stained soil was identified as a potentially contaminated area. As a result, the soil was sampled to the depth of staining (4 inches [in.] below ground surface [bgs]) and the sample was submitted for chemical and radiological analysis. Section 2.2.1.2 discusses the analytical results

The several washes and gullies departing the site to the southeast were identified as potential routes for migration of contaminated soil. As a result, radiological surveys were conducted at the three most significant washes. Sections 2.1.1 and 2.2.1.1 contain the results from the survey and the wash sampling.

2.1.3 Field Screening

Field-screening activities for alpha and beta/gamma radiation were performed as specified in the CAU 370 CAIP (NNSA/NSO, 2008). Investigation samples were field screened for alpha and beta/gamma radiation. The field-screening results (FSRs) were not used for selection of samples submitted for analyses. Field-screening results are recorded on sample collection logs (SCLs), which are retained in project files.

2.1.4 TLD Measurements

The National Security Technologies, LLC (NSTec) Environmental Technical Services group provided environmental monitoring TLDs for CAU 370. The TLDs were staged at each vector sample plot and at 11 additional locations to measure external doses. The 11 additional TLDs were placed as part of the CAI, but were not used for the purpose of evaluating external dose at the planned or biased sample plots. The 11 additional TLDs corresponded with historical RIDP *in situ* measurements and were emplaced to collect additional information about the site and the RIDP measurements.

Each TLD was attached to rebar, T-post, or other fixed objects (i.e., fencing and tower remnants) at a height of 1 m in a manner similar to the NTS routine environmental monitoring program. The TLDs were installed on May 29, 2008, and removed on September 12, 2008, yielding a total exposure time of 2,544 hours.

The TLDs were submitted to the Environmental Technical Services group for inclusion in the quarterly read of the NST environmental monitoring TLDs. The TLDs were analyzed using

automated TLD readers that are calibrated and maintained by the NSTec Radiological Control Department. The data were reviewed and adjusted to an exposure time equivalent to the Industrial Area exposure scenario (NNSA/NSO, 2006). The TLD results are discussed in Section A.3.1.2.

Use of the TLDs and inclusion of the TLDs in the routine quarterly read-cycle allowed for the use of existing QC procedures for TLD processing. Details of the environmental monitoring TLD program and a summary of the routine environmental monitoring TLD quality control efforts and results are Section 5.2.1 of the Nevada Test Site Environmental Report (NNSA/NSO, 2007). In general, the average relative percent difference between pairs of environmental TLDs was 2.5 percent for 2006. Certification is maintained through the DOE Laboratory Accreditation Program for dosimetry.

Estimates of external dose, in mrem/yr, at the T-4 site are presented as net values (e.g., a natural background has been subtracted from the raw result). The value for the natural background at the T-4 site was obtained from an area that was determined to be unaffected by man-made activities at the NTS. Ten areas are identified in Section 5.0 of the Nevada Test Site Environmental Report (NNSA/NSO, 2007) and are routinely monitored for external radiation exposure via environmental monitoring TLDs. The average annual dose for one of the ten areas, at Stake P-3 in Area 16 of the NTS, was 122 mrem per calendar year with a standard deviation of 2 mrem/yr. The average for all ten background TLD locations was 124.8 mrem per calendar year, and the median value was 127 mrem per calendar year.

Scaling the value of 122 mrem per calendar year (Stake P-3) from 8,760 hours in a calendar year to the 2,250 hours in an Industrial Area year (e.g., the exposure scenario for CAU 370) yielded a background value of 31.3 mrem/yr ± 1.1 mrem. Therefore, 31.3 mrem/yr was subtracted from all CAU 370 TLD results.

The determination of the external dose component of the TEDE at CAU 370 by TLDs was determined to be defensible and the most accurate method because:

1. The use of a TLD to determine an individual's external exposure is the standard in radiation safety and serves as the "legal dose of record" when other measurements are available. Specifically, 10 CFR Part 835.402 (CFR, 2009) indicates that personal dosimeters shall be provided to monitor individual exposures and that the monitoring program that utilizes the dosimeters shall be

accredited in accordance with a DOE Laboratory Accreditation Program, as was the case for the TLDs utilized at CAU 370.

2. The TLDs would be exposed at the CAU 370 sample plots for an entire exposure duration exceeding the 2,250 hours of the Industrial Area exposure scenario. This precluded errors in dose-rate meter scale graduations and needle fluctuations that would be magnified when the as-read meter values were multiplied from units of "per hour" to 2, 250 hours.

2.1.5 Sample Collection

Decision I environmental sampling activities included the collection of:

- Sixty-three composite surface soil samples from 15 vector sample plots with each composite sample comprised of 9 randomly located (random-start, triangular grid) aliquot surface soil samples. The plot locations were selected so that plots would lie within decreasing radiological isopleths determined by a 1994 flyover survey and, if possible, coincide with previously investigated locations (RIDP points).
- Twelve composite surface soil samples from three americium plume plots. The plot locations were selected to lie in the highest americium plume isopleth.
- Two composite surface soil samples from two wash plots. The locations were selected based on the GWS (Section 2.1.1).
- Fifteen TLD measurements taken from staged TLDs at each of the vector sample plots for external dose measurements and eleven TLD measurements taken at other locations (Section 2.1.4).
- One biased surface soil sample (0.0 to 0.33 feet [ft] bgs) and a duplicate sample, at one location in an area of stained soil, in the western portion of the site.

Sample locations are shown on Figure 2-4. Results are reported in Section 2.2.

2.1.6 Conceptual Site Model Validation

The CSM and associated discussion for this CAS are provided in the CAU 370 CAIP (NNSA/NSO, 2008). The contamination pattern of the radionuclides distributed in an annular configuration is consistent with the CSM in that the radiological contamination decreases with distance from GZ regardless of the direction.

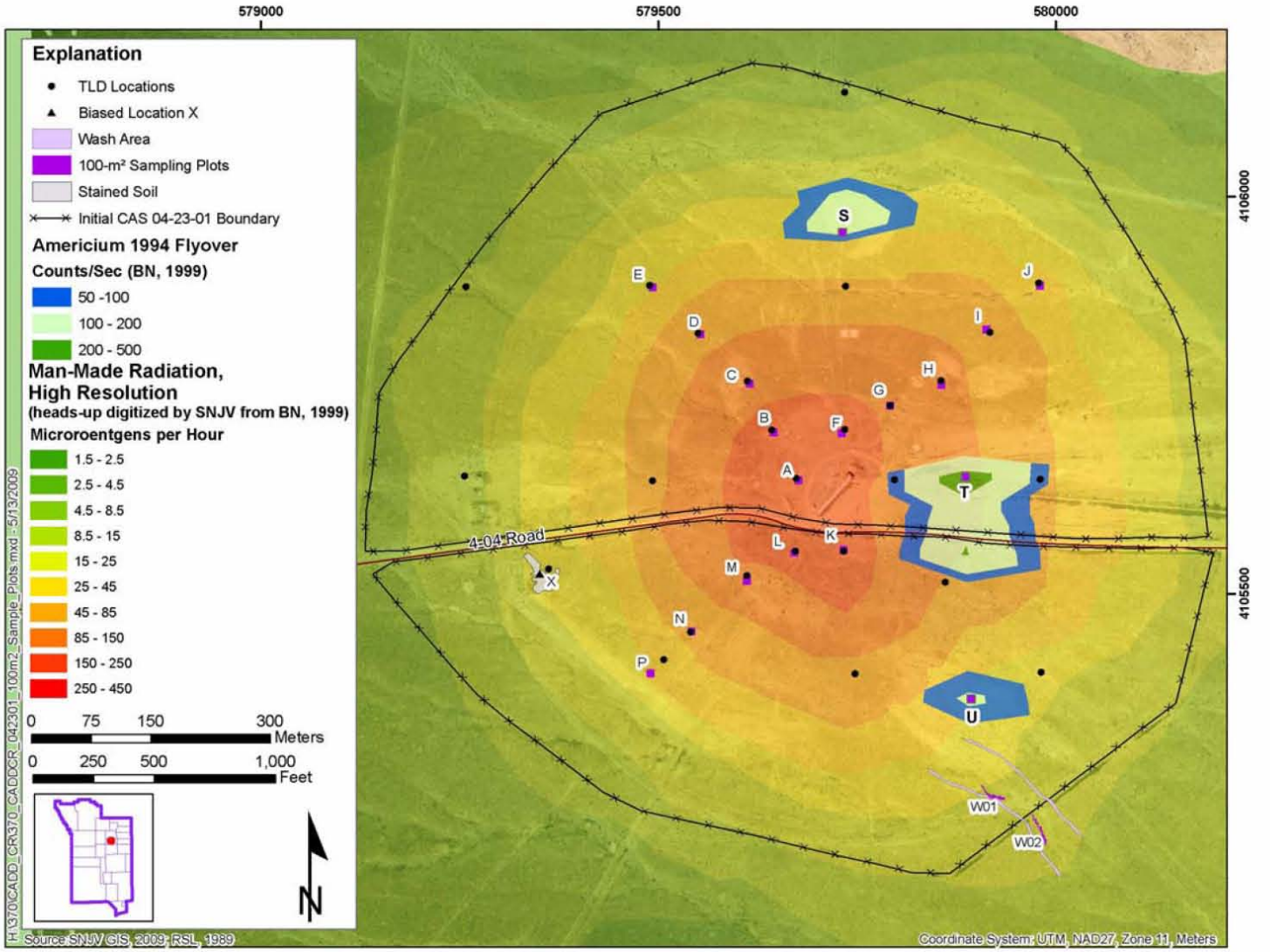

Figure 2-4
Corrective Action Site 04-23-01 Sample Locations

The results from sampling and dose measurements taken at the americium plumes demonstrated elevated relative amounts of americium and plutonium isotopes (i.e., preferential fractionation) that was consistent with the CSM. However, the 1994 flyover surveys did not identify the elevated levels of americium found in samples taken within the vicinity of GZ (see Figure A.2-1). The plausible explanation is that the radiological field created by other gamma emitters present masked the accurate detection of americium near the GZ.

The higher amounts of americium and plutonium isotopes in the plume, however, did not impact the overall annular distribution pattern of TEDE at the site.

The potential lateral migration of radiologically impacted soil in washes at the site was found to be consistent with the CSM in that migration away from the area of deposition was identified.

In conclusion, all information gathered during the CAI supports and validates the CSM as presented in the CAU 370 CAIP (NNSA/NSO, 2008). No modification to the CSM was needed.

2.2 Results

The data summary provided in Section 2.2.1 defines the COCs identified within the CAS, and the extent of identified COCs. Section 2.2.2 summarizes the data assessment made in Appendix B, which demonstrates that the investigation results satisfy the DQO data requirements.

2.2.1 Summary of Analytical Data

Results for the annular distribution, americium plumes, and wash samples presented in Section 2.2.1.1 are reported as dose rates that were directly compared to the dose action level of 25 mrem/yr. Results in the form of activities of individual radionuclides are reported in Appendix F. The chemical and radiological results from environmental samples for the other releases (i.e., stained soil) are summarized in Section 2.2.1.2. Environmental samples are evaluated against FALs to determine the presence of COCs and, if present, the extent of COC contamination.

The preliminary action levels (PALs) for the CAU 370 investigation were determined during the DQO process and are discussed in Section 3.3 of the CAU 370 CAIP (NNSA/NSO, 2008). The FALs used for determining the presence of COCs and for evaluating the need for additional corrective

action are defined in Section 2.3. Details of the methods used during this investigation and a comparison of environmental sample results to the FALs are presented in Appendix A.

With the exception of the TEDE, all concentrations of the reported parameters were compared to and were less than the PALs. The TEDE exceeded the FAL established in the CAU 370 CAIP.

Several lead objects were identified at the site, some loose and some attached to structures. All lead objects were considered to be PSM.

2.2.1.1 Annular Distribution, Americium Plumes, and Wash Data

The values for the estimated internal radiological doses, external radiological doses (TLD results), and TEDEs from all sample plots at CAS 04-23-01 are listed in Table 2-1.

Table 2-1
Dose and Distance Values for Sample Plots
CAS 04-23-01, Atmospheric Test Site T-4
(Page 1 of 2)

Plot Position	Plot	Maximum Value (mrem/yr)	Minimum Value (mrem/yr)	Average (mrem/yr)	95 Percent UCL (mrem/yr)	Distance from GZ (m)
Vector 1	A	**175.5**	**174.5**	**175**	**175.5**	83.1
	B	**120.4**	**119.1**	**119.6**	**120.3**	116.4
	C	**134.2**	**132.8**	**133.3**	**134**	176.1
	D	**45.3**	**45.1**	**45.2**	**45.2**	263.0
	E	10.1	10.1	10.1	10.1	347.8
Vector 2	F	**142.8**	**142**	**142.4**	**142.9**	57.9
	G	**101.8**	**101.2**	**101.4**	**101.7**	103.9
	H	**167.2**	**166.5**	**166.7**	**167.1**	158.0
	I	**30.1**	**30.1**	**30.1**	**30.1**	248.4
	J	10.1	10.1	10.1	10.1	343.3
Vector 3	K	**220.5**	**219.8**	**220.1**	**220.5**	102.4
	L	**183.6**	**179.8**	**180.8**	**183**	125.5
	M	**157.9**	**155.6**	**156.6**	**157.5**	192.9
	N	**28.1**	**28.1**	**28.1**	**28.1**	286.3
	P	21.1	21.1	21.1	21.1	367.7

Table 2-1
Dose and Distance Values for Sample Plots
CAS 04-23-01, Atmospheric Test Site T-4
(Page 2 of 2)

Plot Position	Plot	Maximum Value (mrem/yr)	Minimum Value (mrem/yr)	Average (mrem/yr)	95 Percent UCL (mrem/yr)	Distance from GZ (m)
Americium Plumes	S	3.2	3.1	3.2	3.2	303.6
	T	**53.1**	**49.6**	**51.1**	**52.8**	139.7
	U	3.3	3.1	3.2	3.3	319.2

The corrective action boundary for the annular distribution of radiological contamination was determined using:

- Information defining the pattern of distribution of radiological contamination. Flyover and grid radiation surveys were used to define contaminant release distribution patterns from the annular distribution of radionuclides.

- Measurements of TEDE from 15 test plots that were arranged in three vectors starting near GZ and extending radially outward through the radiation survey isopleths. The TEDE measurements from the sample plots defined a decreasing pattern of TEDE along each vector that was used to estimate a location along each vector equivalent to the 25-mrem/yr FAL.

The locations along each vector that exceeded the 95 percent UCL of the TEDE were determined based on a correlation of distance from GZ to the location along each vector where the 95 percent UCL of the average TEDE was estimated to be equivalent to the FAL. The measured distribution pattern associated with this release site showed generally decreasing dose rates with distance from GZ (see Figure 2-5). However, due to surface disturbances near GZ, this pattern is not consistent within the central portion of the site (see Figure A.3-3 and Section A.3.4 for further discussion). The outer three plots on each vector demonstrated a consistent pattern of decreasing dose rates with distance and encompassed the FAL of 25 mrem/yr. Therefore, the correlation to determine the location along each vector where the TEDE is equivalent to the FAL was based on the TEDEs from the outer three plots of each vector. The correlations of TEDE to distance from GZ are presented in Figure A.3-3. The distances corresponding to the 25-mrem/yr FAL along each vector are plotted in Figure A.3-4.

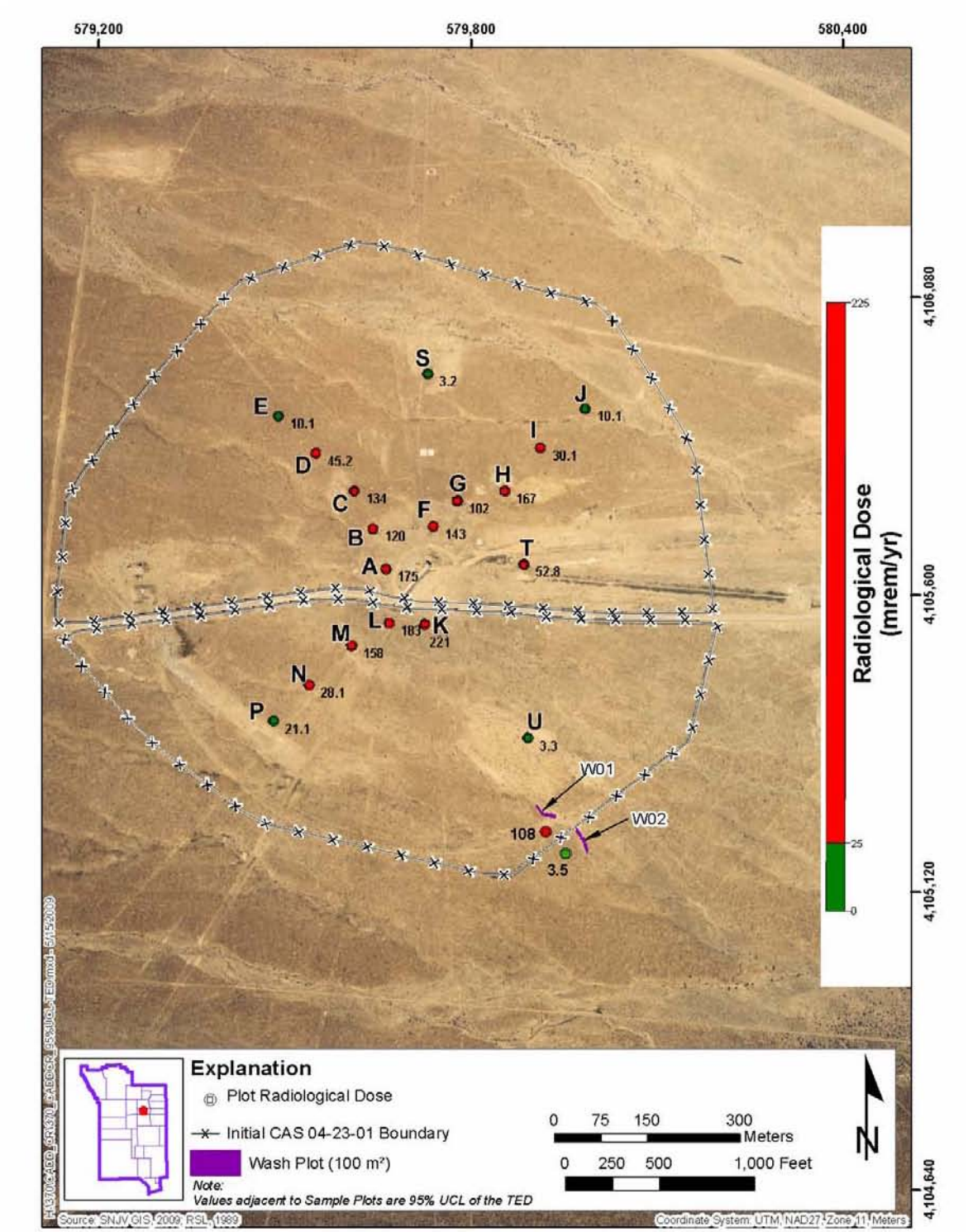

Figure 2-5
Values for the 95 percent UCL of the TEDE at CAS 04-23-01, Atmospheric Test Site T-4

Results for the sampling of the two plots in the southeast wash determined that the area of elevated radiological readings approximately 160 ft inside the initial CAS boundary had a TEDE of 108 mrem/yr, and the area of elevated radiological readings outside the initial CAS boundary had a TEDE of 3.5 (see Table A.3-7). These results indicate that in the past, contaminated material has migrated down the wash.

To meet the DQO criterion of encompassing all locations exceeding the FAL of 25 mrem/yr, the corrective action boundary for the annular distribution was defined as the fourth flyover survey isopleth (see Section A.3.4 for further discussion). The area of the southeast wash exceeding 25 mrem/yr within the fence was added to the use restricted area by an extension of the use restriction to the fence.

2.2.1.2 Other Releases

The only location meeting the criteria of other releases was the stained soil in the western portion of the site (location X, Figure 2-4). The soil concentrations of the reported constituents were compared to PALs and were less than PALs. The maximum concentration of each detected constituent at this biased location is listed in Table 2-2.

2.2.1.3 Potential Source Material

Lead objects, including three lead bricks, two lead panels, one lead sheet, and three lead-acid batteries, were also identified as PSM at the site and were removed for recycling. It is assumed that other lead objects may be present near GZ. Lead shielding may exist within the T-4 bunker and the potential presence of lead objects near the T-4 bunker is identified in an existing use restriction for CAU 357, CAS 04-26-03.

Soil beneath the lead objects removed during the CAI is also assumed to contain lead concentrations exceeding the FAL and is included within the use restriction boundary.

Table 2-2
Maximum Concentrations of Detected Contaminants at Sample Plot X

Contaminant	Maximum Result	Sample Number	Depth (ft)	Location	FAL	Units
Acetone	0.017 (J)	370X002A	0.0 - 0.33	X01	54,000	mg/kg
Am-241	0.55 (J)	370X002	0.0 - 0.33	X01	12.7	pCi/g
Barium	37	370X002	0.0 - 0.33	X01	67,000	mg/kg
Cs-137	2.01	370X001	0.0 - 0.33	X01	12.2	pCi/g
Chromium	12	370X002	0.0 - 0.33	X01	450	mg/kg
Lead	18	370X001	0.0 - 0.33	X01	800	mg/kg
Lead	18	370X002	0.0 - 0.33	X01	800	mg/kg
Pb-214	3.19 (J)	370X001	0.0 - 0.33	X01	5	pCi/g
Mercury	0.04	370X002	0.0 - 0.33	X01	310	mg/kg
Methylene Chloride	0.0019 (J)	370X002A	0.0 - 0.33	X01	21	mg/kg
Pu-238	1.33	370X002	0.0 - 0.33	X01	13	pCi/g
Pu-239/240	7.1	370X002	0.0 - 0.33	X01	12.7	pCi/g
Silver	1.5	370X002	0.0 - 0.33	X01	5,100	mg/kg
U-234	1.45	370X002	0.0 - 0.33	X01	143	pCi/g
U-238	1.39	370X001	0.0 - 0.33	X01	105	pCi/g

Am = Americium
cm = Centimeter
Cs = Cesium
mg/kg = Milligrams per kilogram
Pb = Lead
pCi/g = Picocuries per gram
Pu = Plutonium
U = Uranium

J = Estimated value

2.2.2 Data Assessment Summary

The DQA is presented in Appendix B and includes an evaluation of the DQIs to determine the degree of acceptability and usability of the reported data in the decision-making process. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes helps to ensure that DQO decisions are sound and defensible.

The DQA process as presented in Appendix B is comprised of the following steps:

- Step 1: Review DQOs and Sampling Design
- Step 2: Conduct a Preliminary Data Review
- Step 3: Select the Test
- Step 4: Verify the Assumptions
- Step 5: Draw Conclusions from the Data

The evidence that supports the presence and/or extent of contamination at each CAS is reviewed in Appendix B. Based on the results of the DQA presented in Appendix B, the DQO requirements have been met. The DQA also determined that information generated during the investigation support the CSM assumptions and the data collected support their intended use in the decision-making process.

2.3 Justification for No Further Action

No further corrective action beyond the implementation of the use restriction is justified based on an evaluation of risk to ensure protection of the public and the environment in accordance with *Nevada Administrative Code* (NAC) 445A (NAC, 2006a) feasibility, and cost effectiveness. The decision that no further corrective action is required was based upon implementation of the corrective actions of closure in place with a use restriction for radiological dose and lead, and the removal and recycling of the loose lead objects (i.e., three lead bricks, two lead panels, one lead sheet, and three lead-acid batteries). This corrective action was selected based on the evaluation of corrective action alternatives presented in Appendix E.

Additional factors justifying no further action include:

- Visual inspection of the southeast wash identified established, mature vegetation with no signs of recent wash erosion. The wash appears to be a swell in the topography.
- The use restriction was extended 160 ft beyond the radiological anomaly to the fence.
- The presence of large Trinity glass appears to be the major contribution to dose.
- Intrusive corrective actions (i.e., construction of a cobble or rip-wrap flow impediment) may do more harm to the stability of the natural topography.

The use restriction documentation is provided in Appendix D.

2.3.1 Final Action Levels

The CAU 370 FALs are risk-based cleanup goals that, if met, will ensure that each release site will not pose an unacceptable risk to human health and the environment and that conditions at each site are in compliance with all applicable laws and regulations. The risk-based corrective action (RBCA) process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2006b). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2006c) requires the use of American Society for Testing and Materials (ASTM) Method E 1739-95 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary."

This RBCA process defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses:

- Tier 1 evaluation – Sample results from source areas (highest concentrations) are compared to action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAU 370 CAIP [NNSA/NSO, 2008]). The FALs may then be established as the Tier 1 action levels or the FALs may be calculated using a Tier 2 evaluation.

- Tier 2 evaluation – Conducted by calculating Tier 2 Site-Specific Target Levels (SSTLs) using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Total petroleum hydrocarbons (TPH) concentrations will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemicals of concern will be compared to the SSTLs.

- Tier 3 evaluation – Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in Method E 1739-95 that consider site-, pathway-, and receptor-specific parameters.

A Tier 1 evaluation was conducted for contaminants detected in the investigation of other releases to determine whether contaminant levels satisfy the criteria for a quick regulatory closure or warrant a more site-specific assessment. This was accomplished by comparing individual source area contaminant concentration results to the Tier 1 action levels (the PALs established in the CAU 370 CAIP [NNSA/NSO, 2008]).

The only contaminant detected in the investigation of other releases that exceeded Tier 1 action levels was lead (present as PSM).

The FAL for radiological contamination of the annular distribution was established in the CAU 370 CAIP as 25 mrem/yr.

As it was determined that corrective actions based on the Tier 1 action levels are practical, all FALs were established as the Tier 1 action levels (i.e., PALs).

3.0 Recommendation

No further corrective action is required for CAU 370 based upon implementation of a corrective action of closure in place with a use restriction for radiological dose and lead contamination.

The 25 mrem/yr boundary is defined by the coordinates listed in the use restriction document (see Appendix D). As a radioactive material area (RMA) fence currently exists that encompasses the use restricted area, the use restriction warning signs were posted on the RMA fence. The larger area encompassed by the RMA fence provides increased protection from exposure. Should the RMA fence be moved or removed due to a change in the RMA boundary, the use restriction warning signs may be moved but must encompass the boundary defined by the use restriction coordinates listed.

The area being controlled by the use restriction is a polygon shape, and is approximately 399,592 m^2 (98.74 acres) in size. The use restricted area, including the extension for the southeast wash and the larger RMA fence, is depicted in Figure 3-1.

The use restriction is recorded in the FFACO database, the DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Facility Information Management System, and the NNSA/NSO CAU/CAS files. Permission to conduct the following restricted activities within this footprint (site) requires prior approval from the NDEP:

- Full-time work assignments to the site
- Construction of facilities at the site
- Any activity that would result in a worker being assigned to a regular work station within the use restricted area

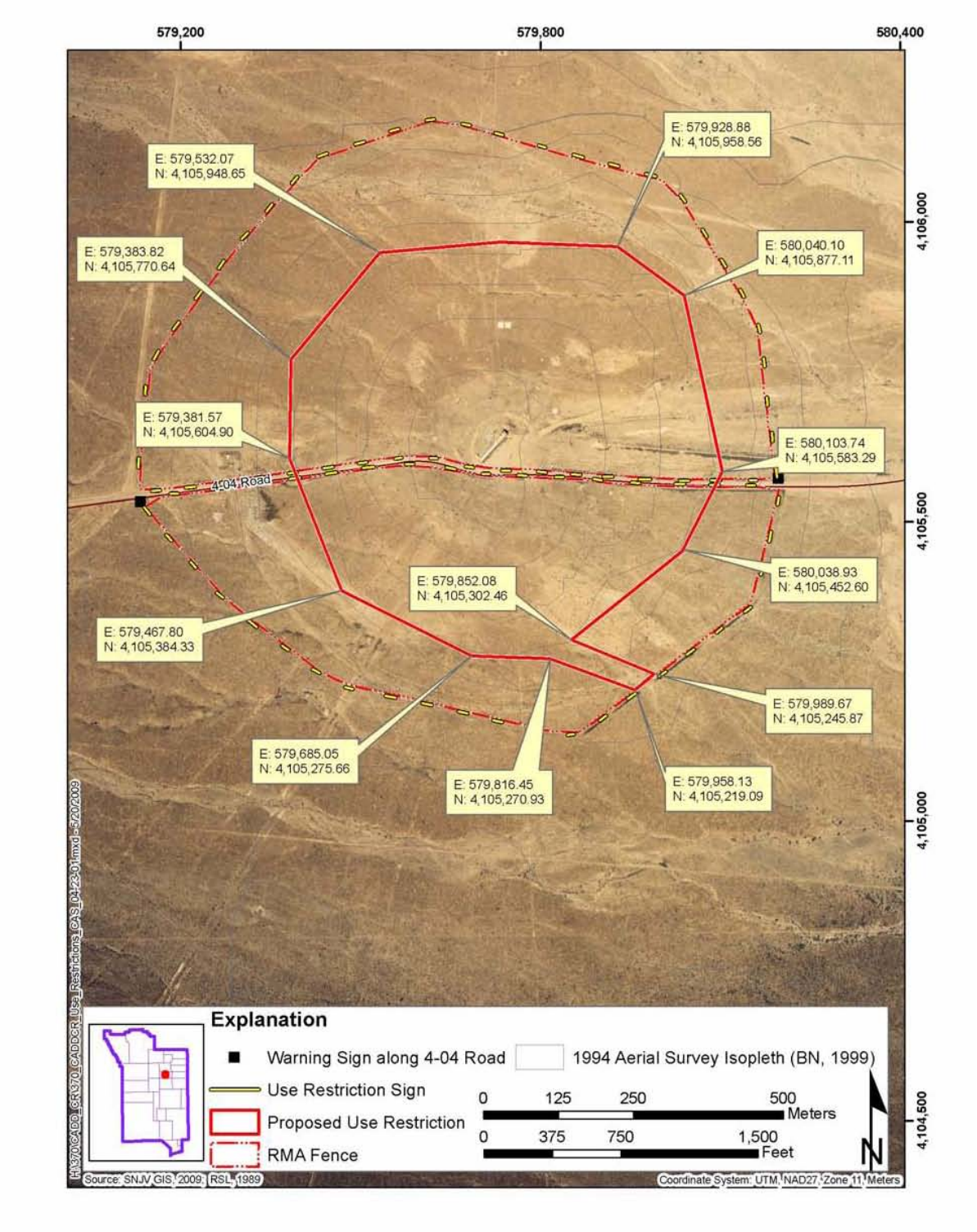

Figure 3-1
Corrective Action Unit 370, T-4 Atmospheric Test Site, CAS 04-23-01
Land Use Restriction Boundary

Permissible activities, without prior approval, include short duration activities such as:

- Site visits
- Travel along the 4-04 Road
- Maintenance of the fence and road
- Limited entry for non-intrusive activities in support of site operations.

Annual inspections are required of the use restriction and road sign postings.

The NNSA/NSO requests that the NDEP issue a Notice of Completion for this CAU and approve moving the CAU from Appendix III to Appendix IV of the FFACO."

4.0 References

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Appendix A

Corrective Action Investigation Results

A.1.0 Introduction

This appendix presents the CAI activities and analytical results for CAU 370, which is located in Area 4 of the NTS (Figure A.1-1), and is comprised of CAS 04-23-01.

Corrective Action Site 04-23-01, Atmospheric Test Site T-4, consists of contamination of the soil in and around the T-4 GZ that was impacted in the 1950s by releases from atmospheric tower testing of four nuclear devices at the T-4 site. The site is divided by the 4-04 Road. Several washes enter the area from the west/northwest and continue through the site, while other smaller washes originate on the site. Figure A.1-2 shows a aerial photograph of the site and an oblique photograph of GZ.

Additional information regarding the history of the site, planning, and the scope of the investigation is presented in the CAU 370 CAIP (NNSA/NSO, 2008).

A.1.1 Project Objectives

The primary objective of the investigation was to provide sufficient information and data to evaluate appropriate corrective action alternatives for CAS 04-23-01. This objective was achieved by identifying the nature and extent of COCs, and the evaluation and selection of an acceptable corrective action alternative.

The selection of soil characterization sample locations was based on site conditions and the strategy developed during the DQO process as presented in the CAU 370 CAIP (NNSA/NSO, 2008). The sampling strategy primarily involved judgmental selection of sample plot locations based upon historical activities and measurements (i.e., 1994 flyover survey, RIDP data) and the determination of a characteristic radiological dose at each sample plot. At each sample plot, the internal dose to a receptor was estimated based on analytical results from the composite soil samples, and the external dose to a receptor was determined from TLDs staged at each plot to represent the exposure to an industrial worker for one year. Sampling of three americium plumes and a wash at the site was conducted similar to the approach for sample plots, with the exceptions that the external dose was measured using a radiological instrument rather than staged TLDs, and only one composite sample was taken at each of the two wash plots.

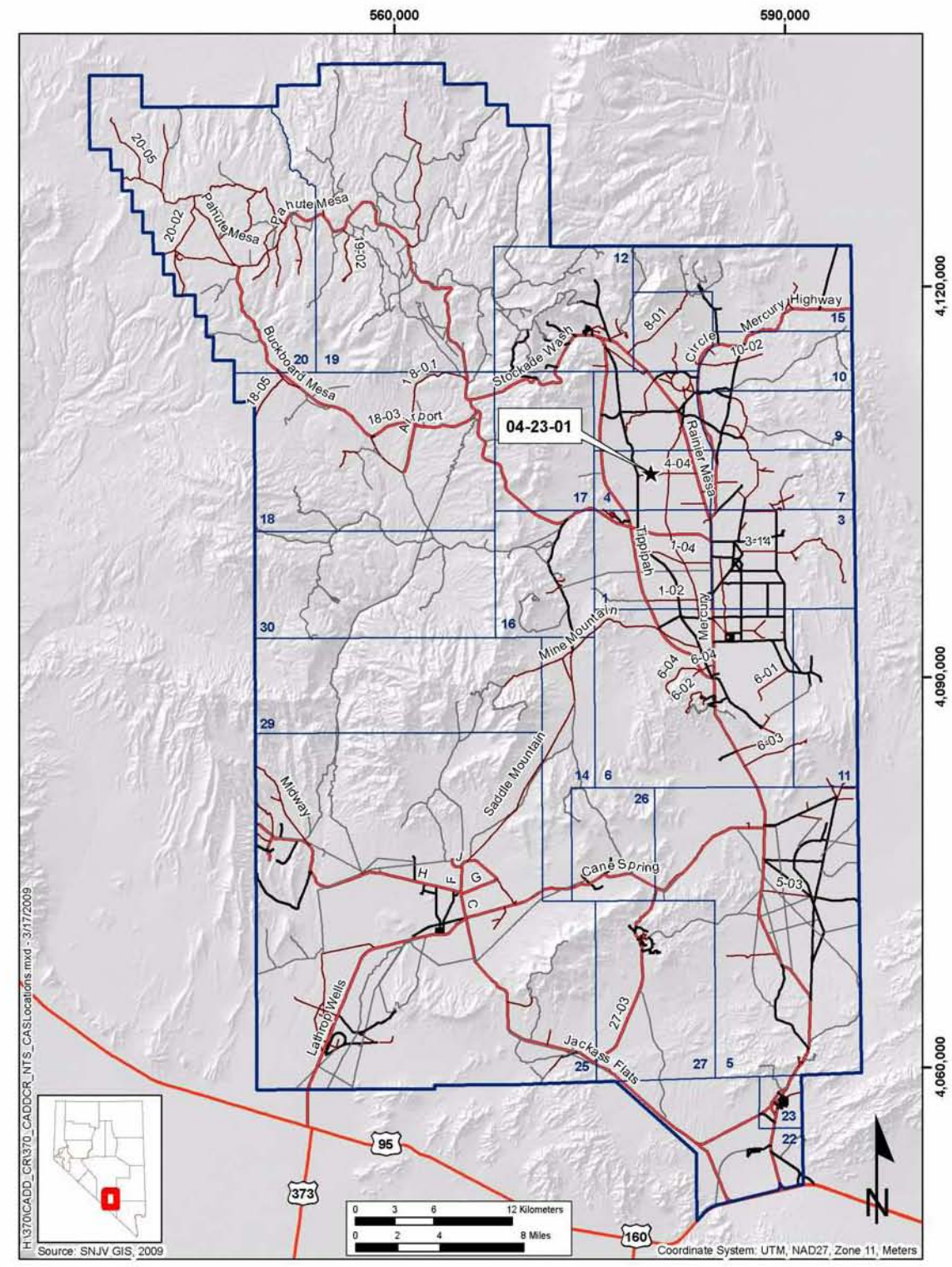


Figure A.1-1
Corrective Action Investigation Site Location Map for CAS 04-23-01, Atmospheric Test Site T-4

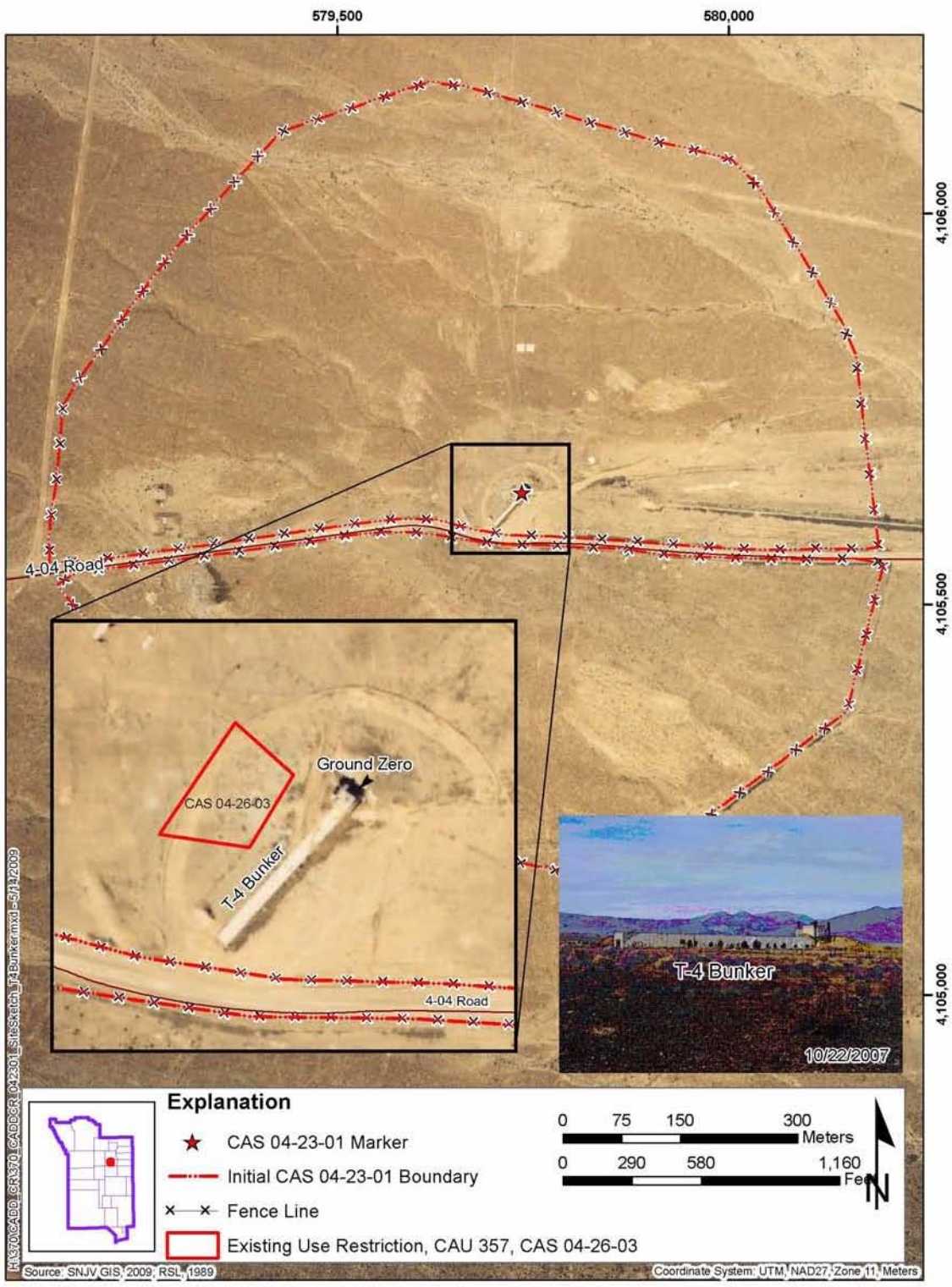


Figure A.1-2
Corrective Action Investigation Site Aerial View of CAS 04-23-01, Atmospheric Test Site T-4

A.1.2 Contents

This appendix describes the investigation and presents the results. The contents of this appendix are as follows:

- Section A.1.0 describes the investigation background, objectives, and contents.
- Section A.2.0 provides an overview of the investigation.
- Section A.3.0 provides investigation-specific information regarding the field activities, sampling methods, and laboratory analytical results from investigation sampling.
- Section A.4.0 summarizes waste management activities.
- Section A.5.0 discusses the QA and QC processes followed and results of the QA/QC activities.
- Section A.6.0 provides a summary of the investigation results.
- Section A.7.0 lists the cited references.

The complete field documentation and laboratory data, including Field Activity Daily Logs (FADLs), SCLs, analysis request/chain-of-custody forms, soil sample descriptions, laboratory certificates of analyses, and analytical results are retained in project files as hard copies or electronic media.

A.2.0 Investigation Overview

Field investigation and sampling activities for the CAU 370 CAI were conducted from June 25, 2008, through April 2, 2009. Figure A.2-1 is an aerial depiction of components of the site. The CAI activities that were conducted at CAS 04-23-01 include:

- Inspected and verified the CAS components identified in the CAIP.
- Verified sample plot locations, adjusting for obstructions/alterations where required.
- Conducted scanning gamma walkover surveys.
- Established sample plots and composite sample aliquot locations.
- Collected soil samples.
- Staged TLDs at vector plot locations to measure external dose.
- Field screened samples for alpha and beta/gamma radiation using a hand-held survey instrument.
- Conducted radiological grid survey.
- Submitted select samples for off-site laboratory analysis.
- Collected GPS coordinates for sample locations and points of interest.
- Removed nine lead objects.

The investigation and sampling program was managed in accordance with the requirements set forth in the CAU 370 CAIP (NNSA/NSO, 2008). Samples were collected, documented, and analyzed as prescribed in the CAIP. Quality control samples (e.g., trip blanks, and duplicate samples) were collected according to the Industrial Sites QAPP (NNSA/NV, 2002) and the CAU 370 CAIP.

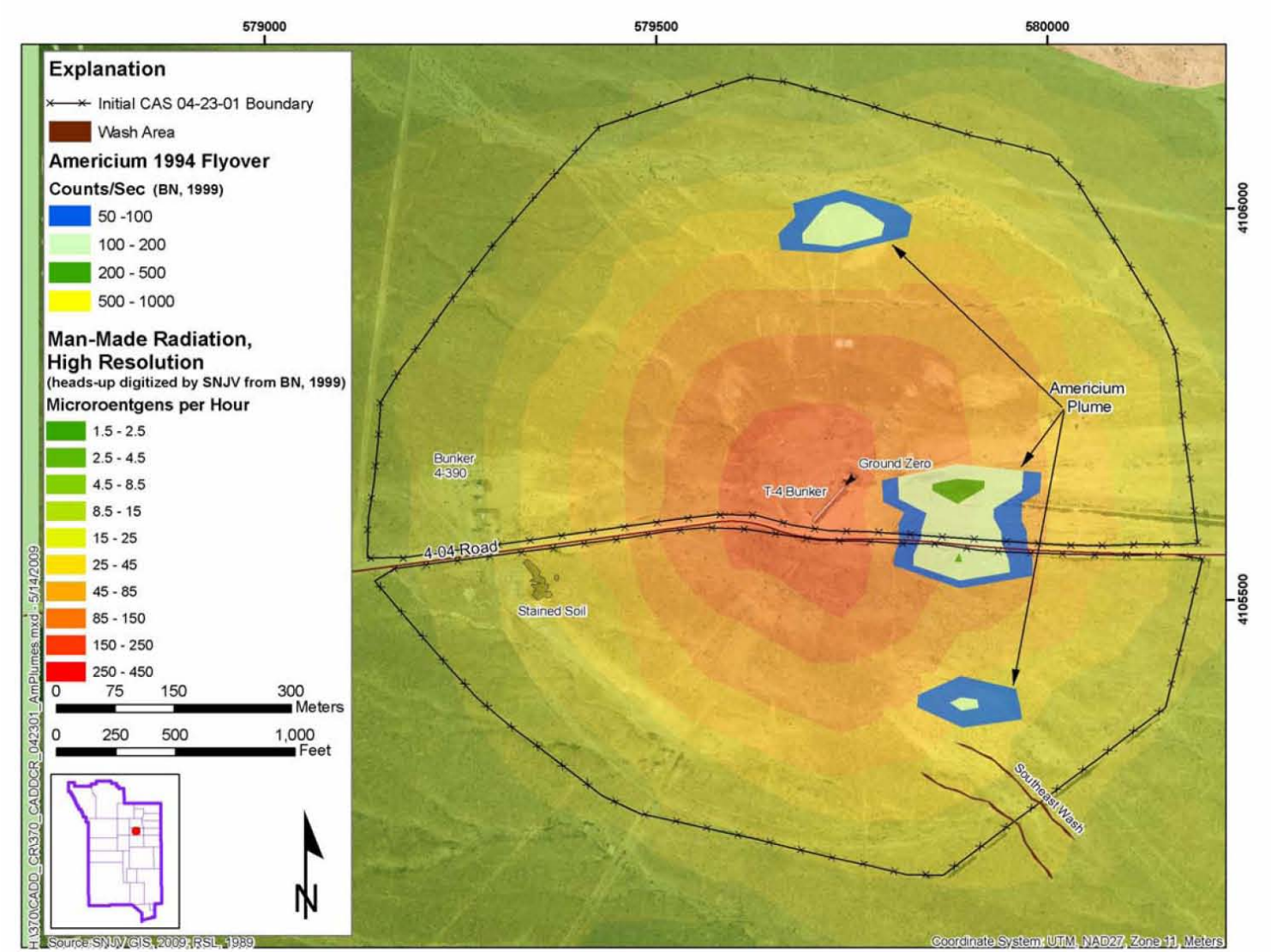


Figure A.2-1
Corrective Action Site 04-23-01 Major Site Components and 1994 Flyover Isopleths

The CAS was investigated by conducting radiological dose measurements, and sampling of surface soils. Surface soil samples were collected by hand coring (sample plots) and hand excavation (stained soil). The data collected at the site that contributes to the decisions made for site closure includes (1) laboratory analysis of the soil samples (i.e., internal dose component of the TEDE for sample plots, and all reported data for the sample from the stained soil), (2) analysis of the TLDs (i.e., external dose component of the TEDE for the sample plots, supplemented by Bicron meter readings for americium plume and wash plots), (3) radiological walkover surveys (i.e., surveys of the washes), and (4) radiological grid survey (i.e., Bicron meter readings for the 319 grid points across the site).

Except as noted in the following section, CAU 370 Decision I sampling locations were accessible and sampling activities at planned locations were not restricted.

A.2.1 Sample Locations

An investigation of contamination present in an annular distribution was implemented through a combination of judgmental and probabilistic sampling as stipulated in the CAU 370 CAIP (NNSA/NSO, 2008). Five sample plots, each along three sampling vectors (i.e., 15 sample plots total) originating near GZ, were established judgmentally to lie within decreasing radiological isopleths determined by a 1994 flyover survey and, if possible, coincide with previously investigated locations RIDP points (Figure A.2-2). Within each sample plot, the selection of sample (aliquot) locations were established using a probabilistic sampling approach (Figure A.2-3).

The CAU 370 CAIP (NNSA/NSO, 2008) designated the investigation of the three americium plumes and the washes as “other releases.” However, the three americium plumes and a wash trending to the southeast from the site were sampled using 100-m^2 plots with nine aliquots per sample in the same manner as the investigation of the annular distribution. Because the investigation approach was similar to that for the annular distribution, the results for the americium plumes are included in discussion of the results for the annual distribution.

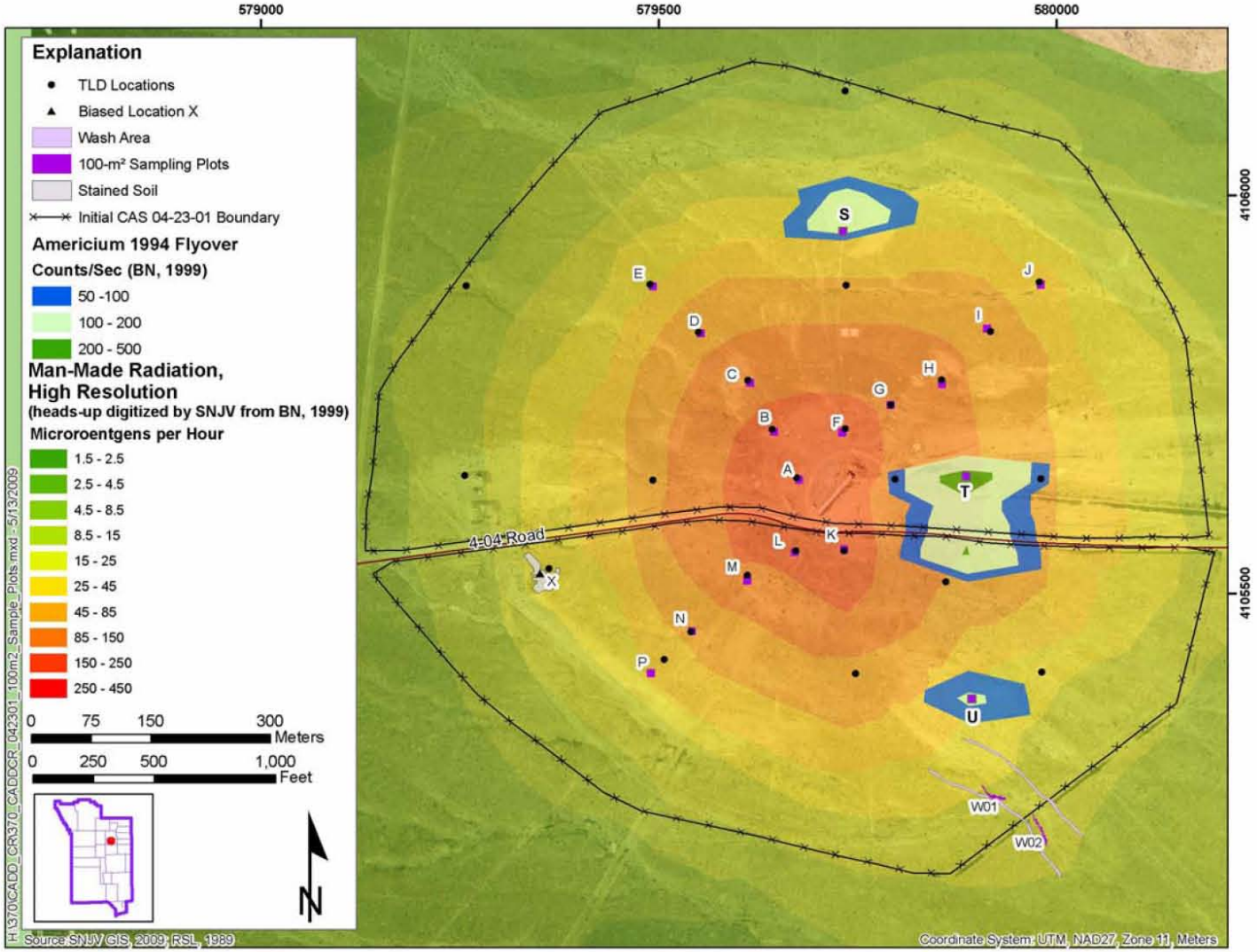


Figure A.2-2
Corrective Action Site 04-23-01 Sample Plot Locations

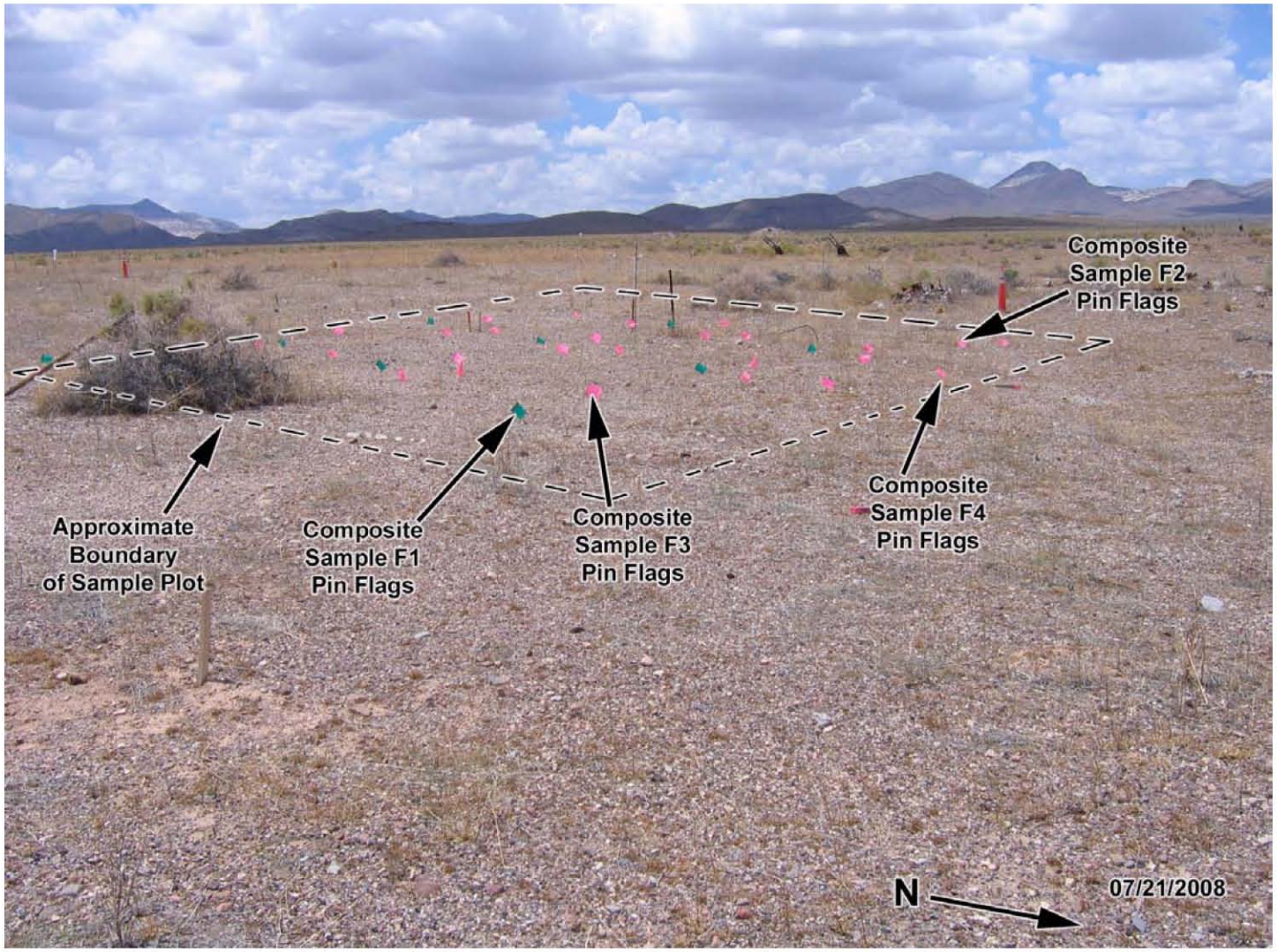


Figure A.2-3
Corrective Action Site 04-23-01, Pin Flags Marking Sample Aliquot Locations, Plot F

The investigation of contamination migrating in a wash draining the south-central portion of the CAS was conducted by establishing a 100-m^2 sample plot in an area of anomalous radiological readings within the RMA fence boundary, and another 100-m^2 sample plot in an area of anomalous radiological readings just outside the RMA fence boundary. The shape of each plot was adjusted to encompass a continuous area of the highest radiological readings and conform to the winding shape of the wash. One composite sample, with nine sample aliquots, and dose rate readings were collected at each of these two sample plots.

The orange and dark-grayish green stained soil was identified as a potentially contaminated area (Figure A.2-4). As a result, the soil was sampled to the depth of staining (4 in. bgs), and the sample was submitted for chemical and radiological analysis.

The soil in this area emits an odor similar to ferrous sulfate; the dark grayish-green staining exists primarily on pebbles and cobbles, and the orange staining exists primarily on sand, silt, and clay particles. All areas of staining are similar in appearance and are presumed to be composed of similar chemical materials.

Sampling plots for each site were selected based on the approach provided in the CAIP. The planned random sample locations (aliquots) are discussed in text and represented on figures in the CAIP. All random sample location coordinates were generated in Visual Sample Plan (PNNL, 2008). Final environmental sample locations (Table A.2-1) are shown in Figure A.2-2. Some locations were modified slightly from planned positions due to field conditions and observations (obstructions from subsurface rock and caliche, surface impediments, excavations and animal burrows). Sample locations were staked where appropriate and labeled. A GPS instrument was used to determine final sample location coordinates and CAS points of interest. Appendix G presents the coordinate data in a tabular format.

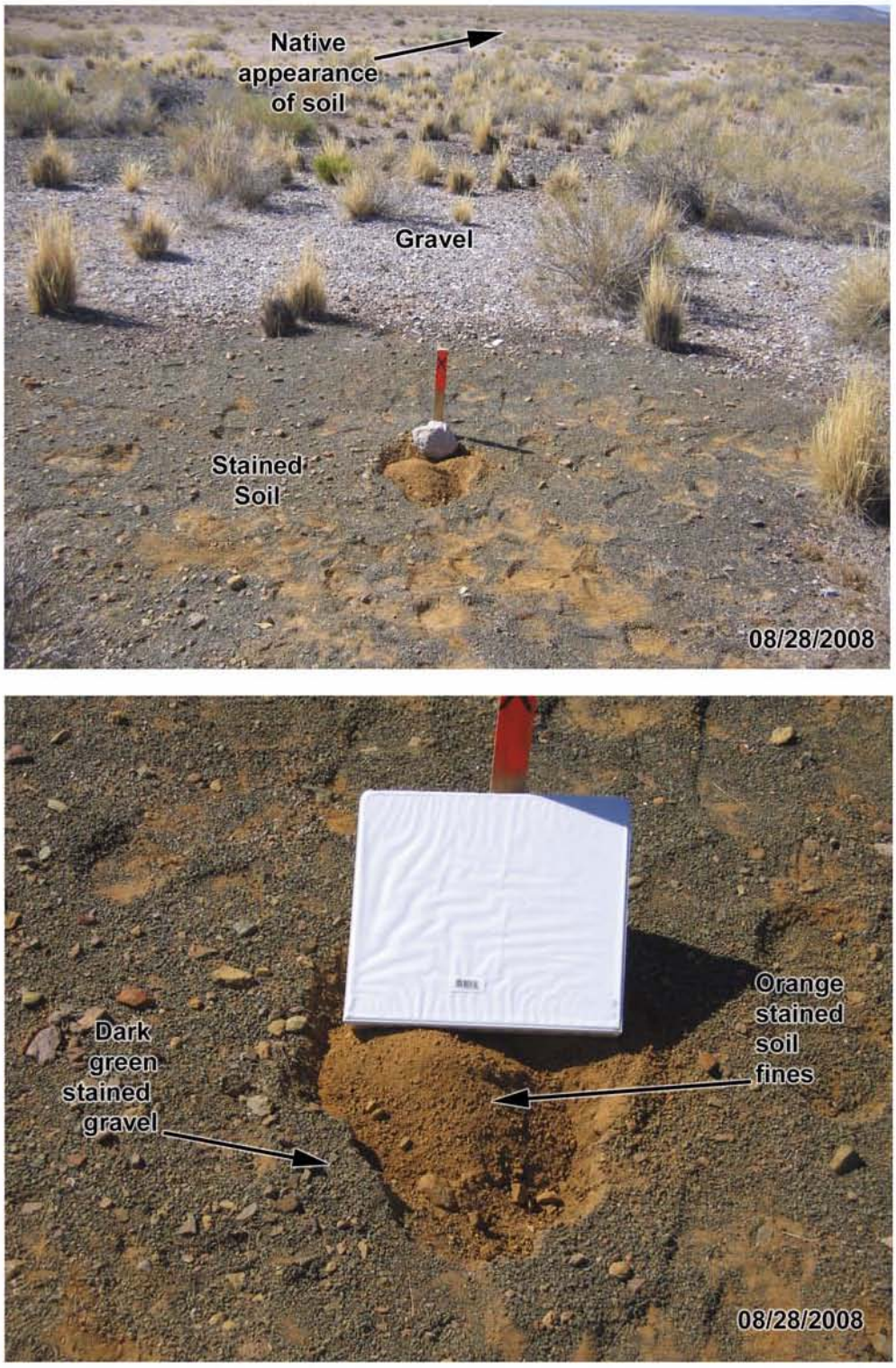


Figure A.2-4
Corrective Action Site 04-23-01, Stained Soil at Location X

Table A.2-1
Samples Collected at CAS 04-23-01, Atmospheric Test Site T-4
(Page 1 of 3)

Sample Plot or Location	Sample Number	Depth (cm bgs)	Matrix	Purpose	Analyses
A	370A001	0.0 - 5.0	Soil	Environmental	Set 1
	370A002	0.0 - 5.0	Soil	Environmental	Set 1
	370A003	0.0 - 5.0	Soil	Environmental	Set 1
	370A004	0.0 - 5.0	Soil	Environmental	Set 1
B	370B001	0.0 - 5.0	Soil	Environmental	Set 1
	370B002	0.0 - 5.0	Soil	Environmental	Set 1
	370B003	0.0 - 5.0	Soil	Environmental	Set 1
	370B004	0.0 - 5.0	Soil	Environmental	Set 1
C	370C001	0.0 - 5.0	Soil	Environmental	Set 1
	370C002	0.0 - 5.0	Soil	Environmental	Set 1
	370C003	0.0 - 5.0	Soil	Environmental	Set 1
	370C004	0.0 - 5.0	Soil	Environmental, Full Lab QC	Set 1
D	370D001	0.0 - 5.0	Soil	Environmental	Set 1
	370D002	0.0 - 5.0	Soil	Environmental	Set 1
	370D003	0.0 - 5.0	Soil	Field Duplicate of #370D002	Set 1
	370D004	0.0 - 5.0	Soil	Environmental	Set 1
	370D005	0.0 - 5.0	Soil	Environmental	Set 1
E	370E001	0.0 - 5.0	Soil	Environmental	Set 1
	370E002	0.0 - 5.0	Soil	Environmental	Set 1
	370E003	0.0 - 5.0	Soil	Environmental	Set 1
	370E004	0.0 - 5.0	Soil	Environmental	Set 1
F	370F001	0.0 - 5.0	Soil	Environmental	Set 1
	370F002	0.0 - 5.0	Soil	Environmental	Set 1
	370F003	0.0 - 5.0	Soil	Environmental	Set 1
	370F004	0.0 - 5.0	Soil	Environmental	Set 1
G	370G001	0.0 - 5.0	Soil	Environmental	Set 1
	370G002	0.0 - 5.0	Soil	Environmental	Set 1
	370G003	0.0 - 5.0	Soil	Environmental	Set 1
	370G004	0.0 - 5.0	Soil	Environmental	Set 1

Table A.2-1
Samples Collected at CAS 04-23-01, Atmospheric Test Site T-4
(Page 2 of 3)

Sample Plot or Location	Sample Number	Depth (cm bgs)	Matrix	Purpose	Analyses
H	370H001	0.0 - 5.0	Soil	Environmental	Set 1
	370H002	0.0 - 5.0	Soil	Environmental	Set 1
	370H003	0.0 - 5.0	Soil	Environmental	Set 1
	370H004	0.0 - 5.0	Soil	Environmental	Set 1
I	370I001	0.0 - 5.0	Soil	Environmental	Set 1
	370I002	0.0 - 5.0	Soil	Field Duplicate of #370I001	Set 1
	370I003	0.0 - 5.0	Soil	Environmental	Set 1
	370I004	0.0 - 5.0	Soil	Environmental, Full Lab QC	Set 1
	370I005	0.0 - 5.0	Soil	Environmental	Set 1
J	370J001	0.0 - 5.0	Soil	Environmental	Set 1
	370J002	0.0 - 5.0	Soil	Environmental	Set 1
	370J003	0.0 - 5.0	Soil	Environmental	Set 1
	370J004	0.0 - 5.0	Soil	Environmental	Set 1
K	370K001	0.0 - 5.0	Soil	Environmental	Set 1
	370K002	0.0 - 5.0	Soil	Environmental	Set 1
	370K003	0.0 - 5.0	Soil	Environmental	Set 1
	370K004	0.0 - 5.0	Soil	Environmental	Set 1
L	370L001	0.0 - 5.0	Soil	Environmental	Set 1
	370L002	0.0 - 5.0	Soil	Environmental	Set 1
	370L003	0.0 - 5.0	Soil	Environmental	Set 1
	370L004	0.0 - 5.0	Soil	Environmental	Set 1
M	370M001	0.0 - 5.0	Soil	Environmental	Set 1
	370M002	0.0 - 5.0	Soil	Field Duplicate of #370M001	Set 1
	370M003	0.0 - 5.0	Soil	Environmental	Set 1
	370M004	0.0 - 5.0	Soil	Environmental	Set 1
	370M005	0.0 - 5.0	Soil	Environmental	Set 1
N	370N001	0.0 - 5.0	Soil	Environmental	Set 1
	370N002	0.0 - 5.0	Soil	Environmental, Full Lab QC	Set 1
	370N003	0.0 - 5.0	Soil	Environmental	Set 1
	370N004	0.0 - 5.0	Soil	Environmental	Set 1

Table A.2-1
Samples Collected at CAS 04-23-01, Atmospheric Test Site T-4
(Page 3 of 3)

Sample Plot or Location	Sample Number	Depth (cm bgs)	Matrix	Purpose	Analyses
P	370P001	0.0 - 5.0	Soil	Environmental	Set 1
	370P002	0.0 - 5.0	Soil	Environmental	Set 1
	370P003	0.0 - 5.0	Soil	Environmental	Set 1
	370P004	0.0 - 5.0	Soil	Environmental	Set 1
S	370S001	0.0 - 5.0	Soil	Environmental	Set 1
	370S002	0.0 - 5.0	Soil	Environmental	Set 1
	370S003	0.0 - 5.0	Soil	Environmental	Set 1
	370S004	0.0 - 5.0	Soil	Environmental	Set 1
T	370T001	0.0 - 5.0	Soil	Environmental	Set 1
	370T002	0.0 - 5.0	Soil	Environmental	Set 1
	370T003	0.0 - 5.0	Soil	Environmental	Set 1
	370T004	0.0 - 5.0	Soil	Environmental	Set 1
U	370U001	0.0 - 5.0	Soil	Environmental	Set 1
	370U002	0.0 - 5.0	Soil	Environmental	Set 1
	370U003	0.0 - 5.0	Soil	Environmental	Set 1
	370U004	0.0 - 5.0	Soil	Environmental	Set 1
W01	370W001	0.0 - 5.0	Soil	Environmental, Full Lab QC	Set 1
W02	370W002	0.0 - 5.0	Soil	Environmental	Set 1
X01	370X001	0.0 - 10.2	Soil	Environmental	Set 2
	370X001A	0.0 - 10.2	Soil	Environmental	VOCs
	370X002	0.0 - 10.2	Soil	Field Duplicate of #370X001	Set 2
	370X002A	0.0 - 10.2	Soil	Field Duplicate of #370X001A	VOCs
N/A	370A001	N/A	Water	Trip Blank	VOCs

Set 1 = Gamma Spectroscopy, Isotopic Americium, Isotopic Uranium, Isotopic Plutonium, Strontium-90
Set 2 = SVOCs, RCRA Metals, TPH-DRO, PCBs, Gamma Spectroscopy, Isotopic Americium, Isotopic Uranium, Isotopic Plutonium, Strontium-90

DRO = Diesel-range organics
N/A = Not applicable
PCB = Polychlorinated biphenyl
RCRA = *Resource Conservation and Restoration Act*
SVOC = Semivolatile organic compound
VOC = Volatile organic compound

A.2.2 Surface Soil Sampling

Decision I and II environmental sampling activities included the collection of:

- Seventy-seven composite surface soil samples, each comprised of nine randomly located (random-start, triangular grid) aliquot surface soil samples within 20 sample plots as listed in Table A.3-2.
- One biased surface soil grab sample (0.0 to 0.33 ft bgs) (comprised of samples 370X001 and 370X001A) and one duplicate (comprised of samples 370X002 and 370X002A) at the stained soil in the western portion of the site.

Sample locations are shown on Figure A.2-2.

Composite soil samples were collected at each sample plot using a "vertical-slice cylinder and bottom-trowel" method. This method involved vertical insertion (by hand) of a metal cylinder (3.5-in. diameter) to a depth of 5 cm at the aliquot location, excavation of the outside soil along one side of the cylinder (to permit placement of the bottom trowel), and horizontal insertion of a trowel along the bottom of the cylinder wall. This method captured "slices" of a cylindrical shaped section of the soil.

Following collection, each aliquot was carefully placed atop a sieve (#4 mesh) fitted into a bottom pan (with a plastic bag lining the pan, which permitted minimal dust generation during transfer of the sample to a container). Each aliquot was slowly sieved, and oversize material left atop the sieve was returned to the aliquot location.

Following collection of the nine aliquots, comprising a composite sample, each sample was transferred to a "paint can" type container to minimize dust generation. The paint cans were then sealed with a lid and lock ring and shaken atop a "paint shaker" for three minutes to homogenize the soil.

At the stained soil in the western portion of the site, the soil grab sample and duplicate were collected to a depth of staining (0.0 to 4 in. bgs) at a central location using surface hand-grab sampling techniques (scoop and trowel). Sample containers for VOCs were filled with soil directly from the sample location. Additional soil was transferred into a contaminant-free pan and homogenized. Samples for the analysis of gamma radiation and TPH-DRO were then collected from the

homogenized soil and the remaining sample containers were filled. Excess soil was returned to its original location.

A.2.3 TLD Measurements

The National Security Technologies, LLC (NSTec) Environmental Technical Services group provided environmental monitoring TLDs for CAU 370. The TLDs were staged at each vector sample plot and at 11 additional locations to measure external doses. The 11 additional TLDs were placed as part of the CAI, but were not used for the purpose of evaluating external dose at the planned or biased sample plots. The 11 additional TLDs corresponded with historical RIDP *in situ* measurements and were emplaced to collect additional information about the site and the RIDP measurements.

Each TLD was attached to rebar, T-post, or other fixed objects (i.e., fencing and tower remnants) at a height of 1 m in a manner similar to the NTS routine environmental monitoring program. The TLDs were installed on May 29, 2008, and removed on September 12, 2008, yielding a total exposure time of 2,544 hours.

The TLDs were submitted to the Environmental Technical Services group for inclusion in the quarterly read of the NST environmental monitoring TLDs. The TLDs were analyzed using automated TLD readers that are calibrated and maintained by the NSTec Radiological Control Department. The data were reviewed and adjusted to an exposure time equivalent to the Industrial Area exposure scenario (NNSA/NSO, 2006). The TLD results are discussed in Section A.3.1.2.

Use of the TLDs and inclusion of the TLDs in the routine quarterly read-cycle allowed for the use of existing QC procedures for TLD processing. Details of the environmental monitoring TLD program and a summary of the routine environmental monitoring TLD quality control efforts and results are Section 5.2.1 of the Nevada Test Site Environmental Report (NNSA/NSO, 2007). In general, the average relative percent difference between pairs of environmental TLDs was 2.5 percent for 2006. Certification is maintained through the DOE Laboratory Accreditation Program for dosimetry.

Estimates of external dose, in mrem/yr, at the T-4 site are presented as net values (e.g., a natural background has been subtracted from the raw result). The value for the natural background at the T-4 site was obtained from an area that was determined to be unaffected by man-made activities at the

NTS. Ten areas are identified in Section 5.0 of the Nevada Test Site Environmental Report (NNSA/NSO, 2007) and are routinely monitored for external radiation exposure via environmental monitoring TLDs. The average annual dose for one of the ten areas, at Stake P-3 in Area 16 of the NTS, was 122 mrem per calendar year with a standard deviation of 2 mrem/yr. The average for all ten background TLD locations was 124.8 mrem per calendar year, and the median value was 127 mrem per calendar year.

Scaling the value of 122 mrem per calendar year (Stake P-3) from 8,760 hours in a calendar year to the 2,250 hours in an Industrial Area year (e.g., the exposure scenario for CAU 370) yielded a background value of 31.3 mrem/yr ± 1.1 mrem. Therefore, 31.3 mrem/yr was subtracted from all CAU 370 TLD results.

The determination of the external dose component of the TEDE at CAU 370 by TLDs was determined to be defensible and the most accurate method because:

1. The use of a TLD to determine an individual's external exposure is the standard in radiation safety and serves as the "legal dose of record" when other measurements are available. Specifically, 10 CFR Part 835.402 (CFR, 2009) indicates that personal dosimeters shall be provided to monitor individual exposures and that the monitoring program that utilizes the dosimeters shall be accredited in accordance with a DOE Laboratory Accreditation Program, as was the case for the TLDs utilized at CAU 370.

2. The TLDs would be exposed at the CAU 370 sample plots for an entire exposure duration exceeding the 2,250 hours of the Industrial Area exposure scenario. This precluded errors in dose-rate meter scale graduations and needle fluctuations that would be magnified when the as-read meter values were multiplied from units of "per hour" to 2, 250 hours.

A.2.4 Radiological Surveys

Radiological surveys (i.e., gamma walkover and micro-REM grid) were performed at CAS 04-23-01 during the CAI. Radiological surveys were performed to provide information on the distribution of radiological contamination at the site.

Gamma Walkover Surveys: Global Positioning System-assisted GWSs were conducted in the three most significant washes at CAS 04-23-01. These surveys were conducted to investigate the potential for the migration of radiological contamination. Surveys of the two washes closest to the 4-04 Road, one exiting the site north of the road and one exiting south of the road, identified no anomalous readings away from the GZ area. A survey of the third wash, exiting the far southeast side of the site, identified two areas of anomalous readings. This wash drains a significant portion of the south side of the site that is within the 25-mrem/yr area.

The GWSs were performed with the gamma radiation detector held at approximately 1 m above ground surface. Gross count-rate data were recorded (counts per second), along with GPS position information at 1-second intervals.

Transects across the wash and above the wash shoulders on each side were walked at 3-m intervals. Figure A.2-5 presents a color-coded graphic representation of the data displayed as the number of standard deviations above the mean.

The GWS readings for the two areas in the southeast wash were anomalous compared to readings at 10 m on either side of the wash. The areas of anomalous readings were established as 100-m^2 polygon-shaped sample plots adjusted to encompass the areas of highest elevated readings (Figure A.2-6). Composite samples and dose-rate readings were collected at the plots.

Micro-REM Grid Survey: The area within the initial CAS boundary (as shown in Figure A.2-7) was divided into 50-m grids for a micro-REM Grid Survey. Survey points were established at the grid intersections. At each point, a Bicron micro-REM/hour meter reading (10-second measurement) was collected with the meter held at 1 m above ground surface.

A.2.5 Visual Inspection

Visual inspection of the T-4 site was conducted over the course of several site walks, sampling efforts, and during the radiological grid survey. While walking the various areas of the site, observations were recorded of physical hazards, the presence of debris, and potentially hazardous materials. Aside from the widespread distribution of trinity glass and metallic debris, notable features of the site include

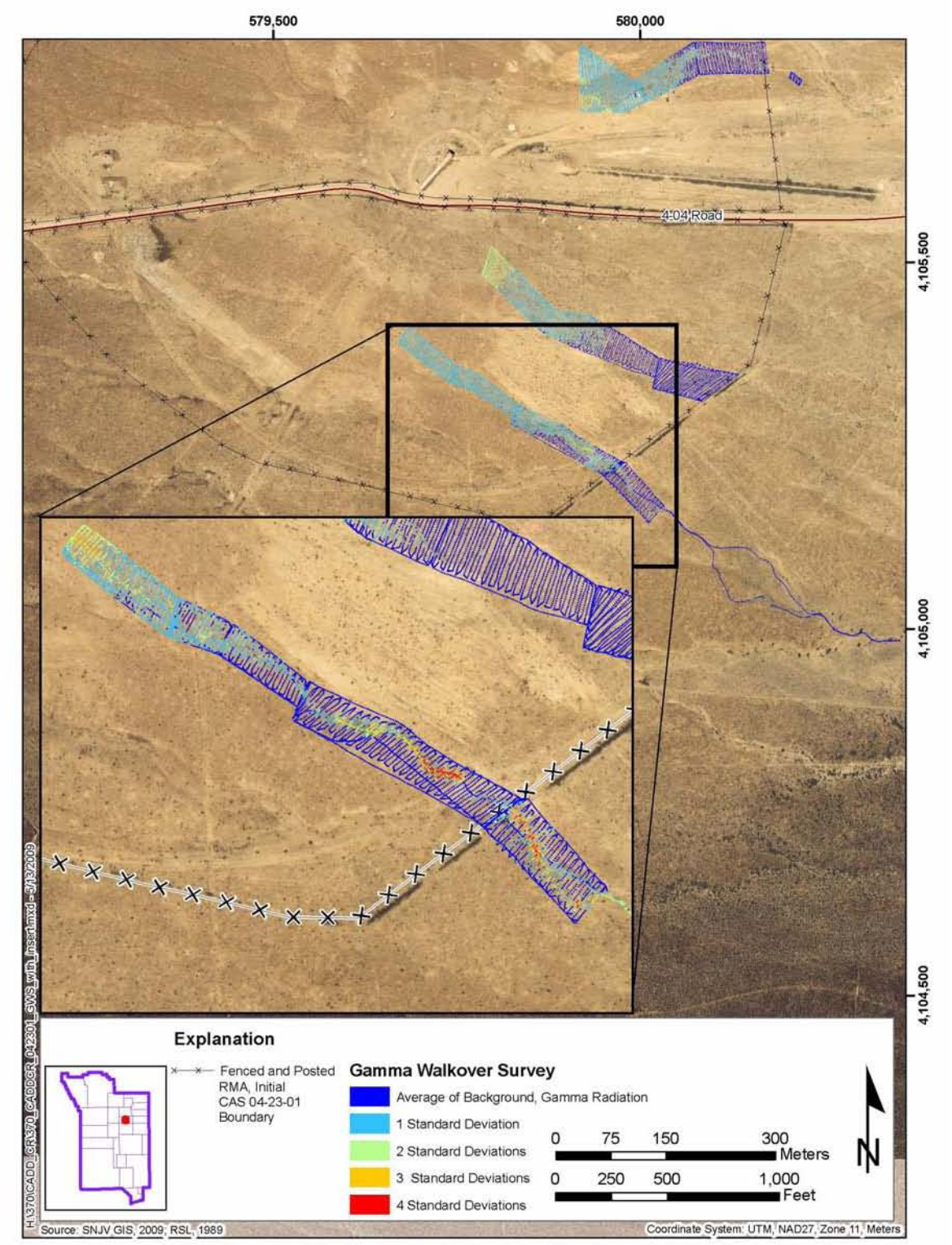


Figure A.2-5
Gamma Walkover Surveys of Selected Washes at CAS 04-23-01, Atmospheric Test Site T-4

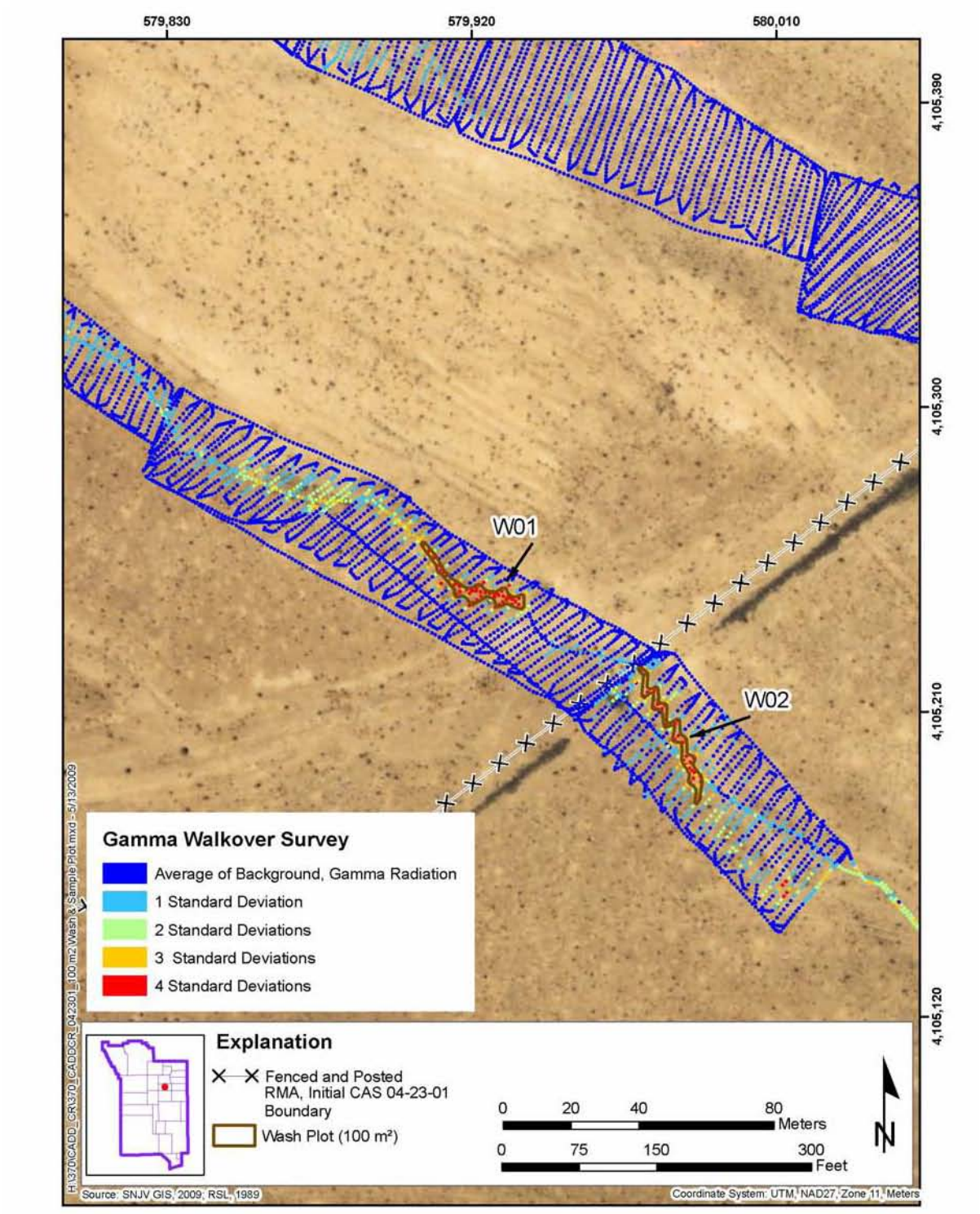


Figure A.2-6
Sample Plots Established in Southeast Wash, CAS 04-23-01

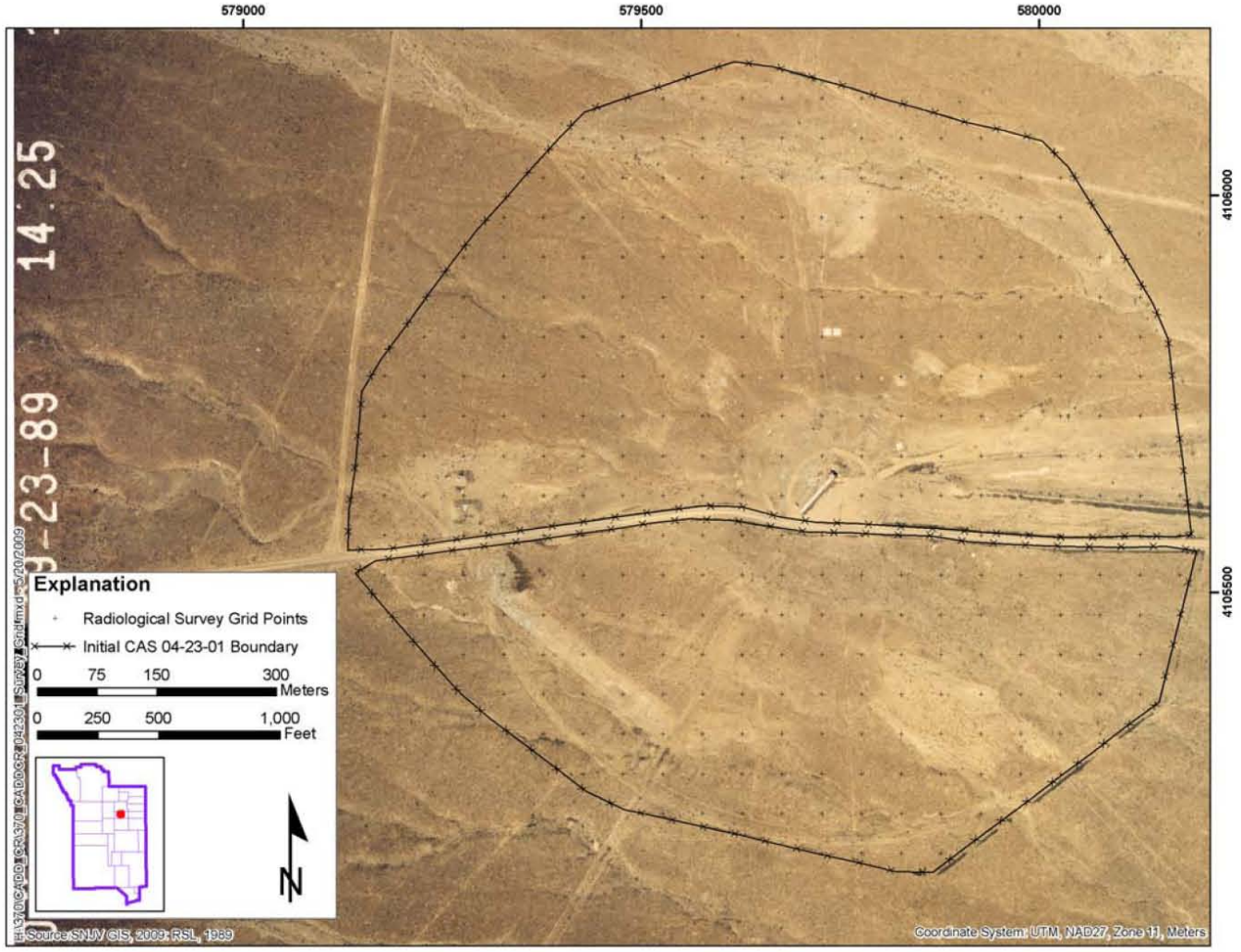


Figure A.2-7
Radiological Grid Survey Points, CAS 04-23-01

- The locations of two sets of underground bunker systems, each with several entrances.
- Three occurrences of lead bricks.
- One lead sheet.
- Two loose, and several attached, lead panels atop Bunker 4-390.
- Three lead-acid batteries.
- Several debris piles containing mostly metal and concrete.
- An area of soil stained orange and dark grayish-green.
- The presence of washes and gullies.

The two underground bunker systems were inspected for the presence of hazardous materials (i.e., PSM) and other indicators of potential contamination by lowering a video camera and lighting system into each entrance. Review of the recordings found nothing to indicate the presence of potential contamination. As a result, no further actions were taken.

The lead objects (i.e., three lead bricks, two loose lead panels, one lead sheet, and three lead-acid batteries [Figure A.2-8]) were collected, screened, and submitted for recycling. Section A.3.3 discusses the potential for other lead objects at the site.

The metal and concrete piles gave no indication of hazardous material (i.e., PSM) during inspection. The potential exists, however, that metallic material remaining at the site (i.e., metal inside the T-4 bunker, metal used for the towers, the tower anchors and anchor cables, and the metal rebar inside concrete) became activated during the detonations, and the metal and concrete near GZ was contaminated by fallout. These piles are located within the use restriction boundary applied to the site, thus no further actions were taken.

The orange and dark-grayish green stained soil was identified as a potentially contaminated area. As a result, the soil was sampled to the extent of staining (4 in.bgs) and the sample was submitted for chemical and radiological analysis. Section A.3.2 discusses the analytical results

The several washes and gullies departing the site to the southeast were identified as potential routes for migration of contaminated soil. As a result, radiological surveys were conducted at the three most significant washes. Section A.3.1 contains the results from the wash sampling.

The locations of these features are shown in Figure A.2-9.

Figure A.2-8
Lead Objects Identified at CAS 04-23-01, Atmospheric Test Site T-4

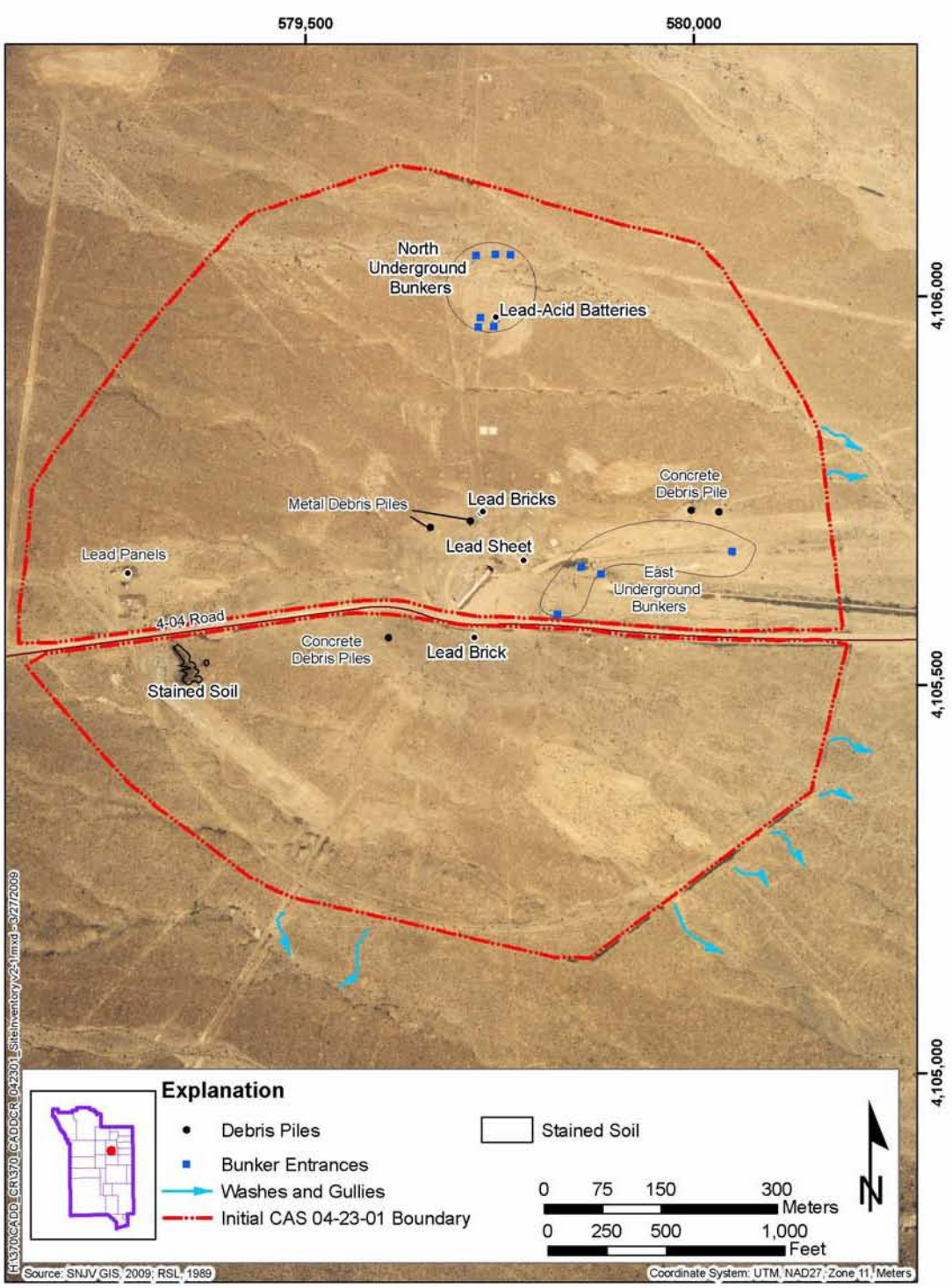


Figure A.2-9
Features Identified During Visual Inspection, CAS 04-23-01, Atmospheric Test Site T-4

A.2.6 Laboratory Analytical Information

Radiological and chemical analyses were performed by Paragon Analytics, Inc., of Fort Collins, Colorado. The analytical suites and laboratory analytical methods used to analyze investigation samples are listed in Table A.2-2. Analytical results are reported in this appendix if they were detected above the minimum detectable concentrations (MDCs). The complete laboratory data packages are available in the project files.

Table A.2-2
Laboratory Analyses and Methods, CAU 370 Investigation Samples[a]

Analysis	Analytical Method[b]
VOCs	Aqueous/Non-aqueous - EPA SW-846[c] 8260
SVOCs	Aqueous/Non-aqueous - EPA SW-846[c] 8270
PCBs	Aqueous/Non-aqueous - EPA SW-846[c] 8082
TPH-DRO	Aqueous/Non-aqueous - EPA SW-846[c] 8015 Modified
Metals	Aqueous - EPA SW-846[c] 6010/6020/7470 Non-aqueous - EPA SW-846[c] 6010/6020/7471
Isotopic U	Aqueous/Non-aqueous - DOE EML HASL-300[d] U-02-RC
Isotopic Pu	Aqueous - DOE EML HASL-300[d] Pu-10-RC Non-aqueous - DOE EML HASL-300[d] Pu-02-RC
Isotopic Am	Aqueous - DOE EML HASL-300[d] Am-03-RC Non-aqueous - DOE EML HASL-300[e] Am-01-RC
Gamma Spectroscopy	Aqueous - EPA 901.1[e] Non-aqueous - DOE EML HASL-300[d], Ga-01-R
Sr-90	Aqueous - EPA 905.0[e] Non-aqueous - DOE EML HASL-300[d] Sr-02-RC

[a]Investigation samples include both environmental and associated QC samples.
[b]The most current EPA, DOE, ASTM, NIOSH, or equivalent accepted analytical method may be used, including approved Laboratory Standard Operating Procedures (SNJV, 2006).
[c]*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA, 2008).
[d]*The Procedures Manual of the Environmental Measurements Laboratory* (DOE, 1997).
[e]*Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA, 1980).

Note: The term "modified" indicates modifications of approved methods. All modifications have been approved by SNJV's Analytical Services Department.

EML = Environmental Measurements Laboratory
EPA = U.S. Environmental Protection Agency
NIOSH = National Institute for Occupational Safety and Health
HASL = Health and Safety Laboratory
SNJV = Stoller-Navarro Joint Venture
Sr = Strontium

Validated analytical data for CAU 370 investigation samples have been compiled and evaluated to confirm the presence of contamination and define the extent of contamination. The validated results of the radiochemical analyses were evaluated for only those radionuclides that contribute to an internal dose (see Appendix C). The analytical results for the CAS are presented in Section A.3.0.

The analytical parameters were selected through the application of site process knowledge as described in the CAIP.

A.2.7 Comparison to Action Levels

A COC is defined as any contaminant present in environmental media exceeding a FAL. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006).

If COCs are present, corrective action must be considered for the CAS. The radiological FAL for the annular distribution was established in the CAIP as 25-mrem/yr TEDE. The FALs for the other releases are defined in Appendix C. Results that are equal to or greater than FALs are identified by bold text in the results tables (Section A.3.1).

The evaluation of the need for corrective action included the potential for wastes that are present at a site to cause the future contamination of site environmental media if the wastes were to be released. To evaluate the potential for wastes to result in the introduction of a COC to the surrounding environmental media, the following conservative assumptions were made:

- That any containment of waste would fail at some point and the waste would be released to the surrounding soil.
- That the resulting concentration of contaminants in the surrounding soil would be equal to the concentration of contaminants in the impacted debris.

A.3.0 Corrective Action Investigation Results

The following sections provide the analytical and computational results for samples and dose-measurements collected for the investigation of annular distribution (including the americium plumes and washes) and for the investigation of other releases. All investigation samples were analyzed by the CAIP-specified analytical methods, which included analysis for the gamma spectroscopy suite, Sr-90, isotopic americium, plutonium, and uranium. The soil samples collected from the stained soil were also analyzed by the same methods as well as by analysis for VOCs, SVOCs, TPH-DRO, RCRA metals, and PCBs. Polychlorinated biphenyls are added parameters because these contaminants are a common concern at the NTS. The analytical parameters and laboratory methods used to analyze the investigation samples are listed in Table A.2-2. Table A.2-1 lists the sample-specific analytical suite for CAS 04-23-01.

Establishment of the FALs are presented in Appendix C. The FAL for the annular distribution was established as the 25-mrem/yr TEDE.

A.3.1 Results for Investigation of Annular Distributions

The CAI for the annular distribution area estimated the internal dose based on soil sample results, and external dose based on direct measurements (i.e., TLDs or Bicron readings) at the sample plot. The results for the americium plumes and wash samples are also presented in this discussion because the dose at these locations was determined using sample plots and the same techniques used for the annular distribution.

Results of internal radiological dose estimations made from analyses of composite soil sample collected at the sample plots are summarized in Section A.3.1.1. Results from the TLDs staged at the sample plots to measure external doses are summarized in Section A.3.1.2. The Bicron measurements at the americium plume plots and wash plots are also summarized in Section A.3.1.2. The combined estimated radiological dose for each sample plot, expressed as the TEDE, is summarized in Section A.3.1.3.

A.3.1.1 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each sample plot were made through evaluation of the soil sample analytical results (from the less than 0.25-in. fraction) using the RESRAD computer code to establish the RRMG (Appendix C, Attachment 1) and are presented in Tables A.3-1 and A.3-2.

The CAU 370 RRMGs for each radiological potential COC (in pCi/g of soil) was derived using RESRAD and the modified Industrial Area exposure scenario (Appendix C). A soil sample with a radionuclide concentration that is equal to the RRMG for that radionuclide would yield a 25-mrem/yr internal dose.

For each soil sample, the radionuclide-specific analytical result was divided by the RRMG (Appendix C, Attachment 1, Table 5-2) for that radionuclide to yield a fraction. The fractions for all radionuclides detected in a soil sample were summed to yield a total fraction for that sample. The total fraction was then multiplied by 25 to yield an internal dose estimate (in mrem/yr) at that sample location. Samples in a sample plot were then averaged to generate an estimate for the plot (Appendix C, Attachment 1, Table 5-3).

Values for the internal dose estimates from the RRMG-based computations ranged from a low of approximately 0.05 mrem/yr for the fourth composite sample collected at plot J and the third composite sample collected at plot P to a high of 9.6 mrem/yr for the fourth composite sample collected at plot L (Table A.3-1).

Data tables listing the analytical results for individual radionuclides in each composite sample are presented in Appendix F.

Table A.3-1
Internal Dose Estimations at Vector Sample Plots

Vector 1 (mrem/yr)					
Plot	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Duplicate**
A	2.18	1.51	2.46	1.66	--
B	1.41	2.37	1.55	1.10	--
C	1.12	1.07	0.84	2.16	--
D	0.09	0.11	0.22	0.25	0.16
E	0.08	0.07	0.07	0.12	--
Vector 2 (mrem/yr)					
Plot	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Duplicate**
F	1.71	0.96	1.76	1.15	--
G	2.79	2.18	2.28	2.42	--
H	0.71	0.46	0.56	1.19	--
I	0.11	0.12	0.12	0.11	0.13
J	0.08	0.08	0.07	0.05	--
Vector 3 (mrem/yr)					
Plot	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Duplicate**
K	2.18	2.13	2.51	1.75	--
L	5.83	5.90	5.78	9.61	--
M	4.90	2.69	3.32	4.30	2.64
N	0.11	0.13	0.09	0.14	--
P	0.08	0.08	0.05	0.11	--

-- = Duplicate not taken for this plot.

Table A.3-2
Internal Dose Estimations at Americium Plume and Wash Sample Plots

Americium Plumes and Wash Samples (mrem/yr)				
Plot	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**
S	0.21	0.20	0.21	0.14
T	1.56	2.52	3.10	5.07
U	0.18	0.31	0.26	0.14
W01	1.2	--	--	--
W02	0.5	--	--	--

-- = Only one sample taken.

A.3.1.2 External Radiological Dose Measurements

Measurements for the external dose that a receptor would receive at each sample plot were derived from the results of TLDs staged at the sample plots. The TLD results were adjusted for the difference between placement time (2,544 hours), and industrial area exposure (2,250 hours), and adjusted for the background at a similar site. The TLD effective dose values are presented in Tables A.3-3 and A.3-4.

Table A.3-3
External Dose Measurements at Vector Sample Plots

Vector 1		Vector 2		Vector 3	
Plot	**TLD (mrem/yr)**	**Plot**	**TLD (mrem/yr)**	**Plot**	**TLD (mrem/yr)**
A	**173**	F	**141**	K	**218**
B	**118**	G	**99**	L	**174**
C	**132**	H	**166**	M	**153**
D	**45**	I	**30**	N	**28**
E	10	J	10	P	21

Table A.3-4
External Dose Measurements at Americium Plume and Wash Sample Plots

Americium Plumes and Wash Samples	
Plot	**Bicron Reading[a] (mrem/yr)**
S	3
T	**48**
U	3
W01	**107**
W02	3

[a]TLD adjusted

The Bicron measurements taken at the plume and wash sample plots (Bicron Dose Rate, Table A.3-5) were converted to estimated TLD equivalent values using the correlation established between the 26 TLDs staged at CAS 04-23-01 (15 TLDs staged at the vector sample plots plus 11 other TLDs staged at RIDP points) and the Bicron measurements at the 26 TLD locations (Bicron Effective Dose,

TLD Adjusted, Table A.3-5, Figure A.3-1). The Bicron readings (TLD adjusted) are listed in Table A.3-4.

Table A.3-5
Bicron Dose Rate, TLD and Bicron Effective Dose and Bicron Effective Dose/TLD Adjusted
(Page 1 of 2)

Plot or TLD Location	Bicron Dose Rate (mrem/hr)	TLD Effective Dose (mrem/yr)[a]	Bicron Effective Dose (mrem/yr)[b]	Bicron Effective Dose, TLD Adjusted (mrem/yr)[c]
A	0.080	173	149	196
B	0.070	118	126	166
C	0.050	132	81	107
D	0.020	45	14	18
E	0.020	10	14	18
F	0.060	141	104	137
G	0.050	99	81	107
H	0.060	166	104	137
I	0.025	30	25	33
J	0.015	10	2	3
K	0.080	218	149	196
L	0.075	174	137	180
M	0.060	153	104	137
N	0.020	28	14	18
P	0.020	21	14	18
S	0.015	--	2	3
T	0.03	--	36	48
U	0.015	--	2	3
W01	0.05	--	81	107
W02	0.015	--	2	3
ERB2	0.025	53	25	33
ERB5	0.030	47	36	47
ERB6	0.010	0	0	0
ERB8	0.020	24	14	18
ERB9	0.050	71	81	107
ERB12	0.030	61	36	47
ERB13	0.040	110	59	78
ERB14	0.020	14	14	18

Table A.3-5
Bicron Dose Rate, TLD and Bicron Effective Dose
and Bicron Effective Dose/TLD Adjusted
(Page 2 of 2)

Plot or TLD Location	Bicron Dose Rate (mrem/hr)	TLD Effective Dose (mrem/yr)[a]	Bicron Effective Dose (mrem/yr)[b]	Bicron Effective Dose, TLD Adjusted (mrem/yr)[c]
ERB15	0.010	0	0	0
ERB16	0.010	0	0	0
ERB19	0.015	10	2	3

[a]TLDs were not staged at sample plots S, T, U, W01, and W02.
[b]Bicron Effective Dose = Bicron Dose Rate *2,250 hours per year – background (31.3 mrem/yr).
[c]Bicron Effective Dose/TLD Adjusted = Bicron Effective Dose *1.3154.

mrem/hr = Millirem per hour
-- = No value

A.3.1.3 Total Effective Dose Equivalent

The TEDE for each sample plot was calculated as the sum of the internal dose estimates and the external dose measurements and are presented in Tables A.3-6 and A.3-7.

Based on the process established in the CAIP for establishing a minimum sample size (NNSA/NSO, 2008), the required minimum number of samples needed for valid statistical analysis were computed and compared to the number collected at each sample plot. The required minimum number of samples needed at each plot was three, which is less than the number of samples collected (Tables A.3-8 and A.3-9).

The probabilistic sampling design as described in the CAIP for CAU 370 (NNSA/NSO, 2008) stipulates comparing the radiological dose at each sample plot to the 25-mrem/yr-dose FAL to determine whether a COC is present. The average TEDE calculated from sample results is an estimate of the true (unknown) TEDE. It is uncertain how well the average TEDE represents the true TEDE. If an average TEDE was directly compared to the FAL, any significant difference between the true TEDE and the sample TEDE could lead to decision errors. To reduce the probability of a false negative decision error (thus increasing the probability of a false positive decision error), a conservative estimate of the true TEDE is used to compare to the FAL. This conservative estimate

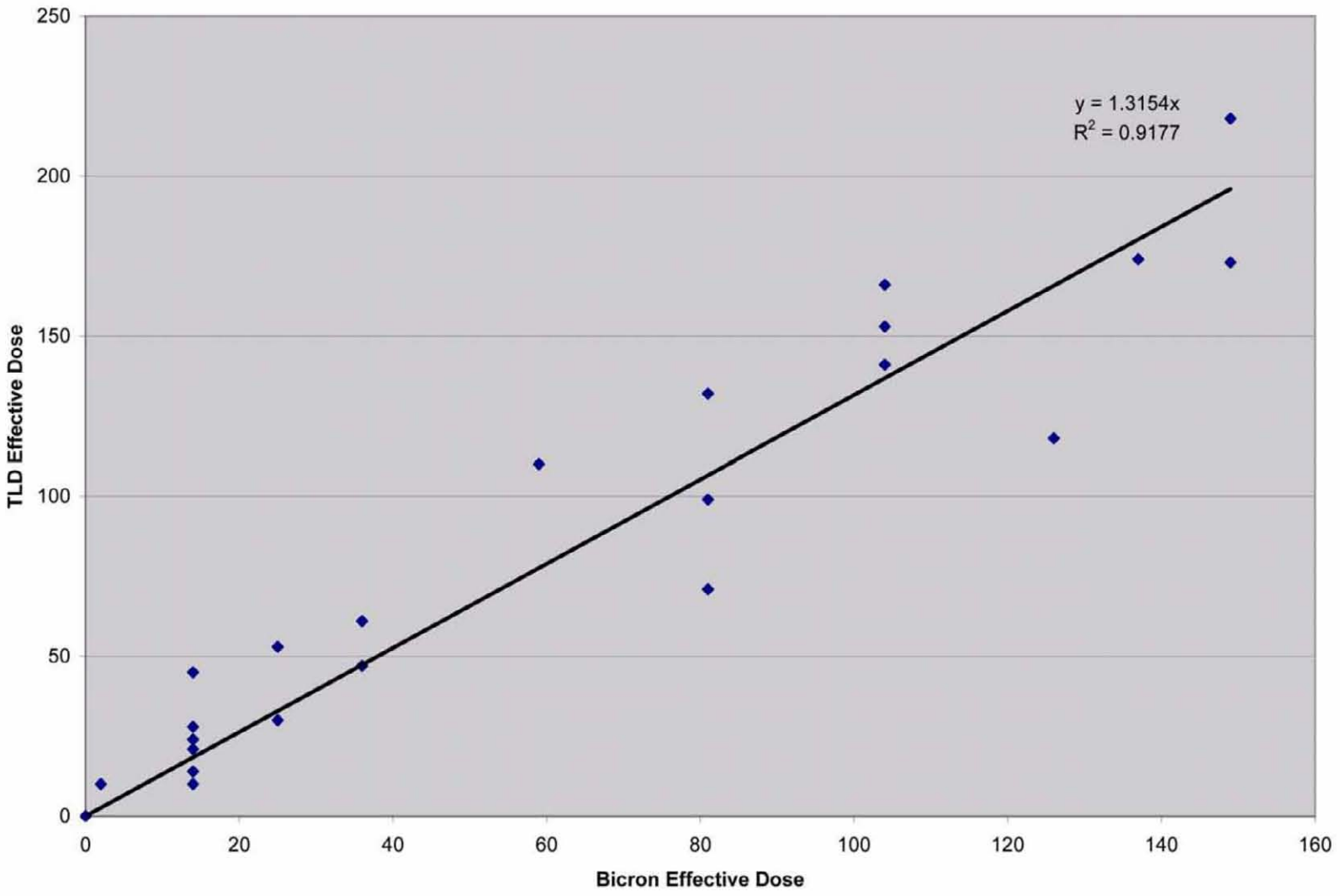


Figure A.3-1
Correlation Between Bicron Effective Dose and TLD Effective Dose

Table A.3-6
Total Effective Dose Equivalents at Vector Sample Plots (mrem/yr)

Vector 1					
Plot	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Duplicate**
A	**175.2**	**174.5**	**175.5**	**174.7**	--
B	**119.4**	**120.4**	**119.6**	**119.1**	--
C	**133.1**	**133.1**	**132.8**	**134.2**	--
D	**45.1**	**45.1**	**45.2**	**45.3**	**45.2**
E	10.1	10.1	10.1	10.1	--
Vector 2					
Plot	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Duplicate**
F	**142.7**	**142.0**	**142.8**	**142.2**	--
G	**101.8**	**101.2**	**101.3**	**101.4**	--
H	**166.7**	**166.5**	**166.6**	**167.2**	--
I	**30.1**	**30.1**	**30.1**	**30.1**	**30.1**
J	10.1	10.1	10.1	10.1	--
Vector 3					
Plot	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Duplicate**
K	**220.2**	**220.1**	**220.5**	**219.8**	--
L	**179.8**	**179.9**	**179.8**	**183.6**	--
M	**157.9**	**155.7**	**156.3**	**157.3**	**155.6**
N	**28.1**	**28.1**	**28.1**	**28.1**	--
P	21.1	21.1	21.1	21.1	--

-- = Duplicate not taken for this plot.

Table A.3-7
Total Effective Dose Equivalents, Americium Plume and Wash Sample Plots (mrem/yr)

Americium Plumes and Wash Samples				
Plot	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**
S	3.2	3.2	3.2	3.1
T	**49.6**	**50.5**	**51.1**	**53.1**
U	3.2	3.3	3.3	3.1
W01	**108.2**	--	--	--
W02	3.5	--	--	--

-- = Only one sample taken.

(over-estimation) of the true TEDE was calculated as the 95 percent UCLs of the average TEDE calculated from the respective individual TEDEs associated with each composite sample. By definition, there will be a 95 percent probability that the true TEDE is less than the 95 percent UCL of the calculated average TEDE.

Table A.3-8
Statistics for Vector Sample Plot Data

Vector 1						
Plot	**Count**	**SD**	**Average (mrem/yr)**	**UCL (mrem/yr)**	**t-Test Statistic**	**Distance (m)**
A	4	0.45	**175.0**	**175.5**	2.35	83.1
B	4	0.54	**119.6**	**120.3**	2.35	116.4
C	4	0.58	**133.3**	**134.0**	2.35	176.1
D	5	0.07	**45.2**	**45.2**	2.13	263.0
E	4	0.02	10.1	10.1	2.35	347.8
Vector 2						
Plot	**Count**	**SD**	**Average (mrem/yr)**	**UCL (mrem/yr)**	**t-Test Statistic**	**Distance (m)**
F	4	0.40	**142.4**	**142.9**	2.35	57.9
G	4	0.27	**101.4**	**101.7**	2.35	103.9
H	4	0.32	**166.7**	**167.1**	2.35	158.0
I	5	0.01	**30.1**	**30.1**	2.13	248.4
J	4	0.01	10.1	10.1	2.35	343.3
Vector 3						
Plot	**Count**	**SD**	**Average (mrem/yr)**	**UCL (mrem/yr)**	**t-Test Statistic**	**Distance (m)**
K	4	0.31	**220.1**	**220.5**	2.35	102.4
L	4	1.89	**180.8**	**183.0**	2.35	125.5
M	5	1.00	**156.6**	**157.5**	2.13	192.9
N	4	0.02	**28.1**	**28.1**	2.35	286.3
P	4	0.02	21.1	21.1	2.35	367.7

SD = Standard deviation

Table A.3-9
Statistics for Americium Plume and Wash Sample Plot Data

Americium Plumes and Wash Samples						
Plot	**Count**	**SD**	**Average (mrem/yr)**	**UCL (mrem/yr)**	**t-Test Statistic**	**Distance (m)**
S	4	0.03	3.2	3.2	2.35	303.6
T	4	1.48	**51.1**	**52.8**	2.35	139.7
U	4	0.07	3.2	3.3	2.35	319.2
W01	1	--	--	--	--	440.6
W02	1	--	--	--	--	504.2

-- = Only one sample taken.

The estimated standard deviations, averages, TEDEs (calculated as the 95 percent UCLs of the average), the t-Test statistic, and the distances of the plots from GZ, are presented in Tables A.3-8 and A.3-9. The values for the 95 percent UCL of the TEDE at the plots are shown on Figure A.3-2.

Sample plots A, B, C, D, F, G, H, I, K, L, M, and N verified that a COC (i.e., radiological dose above 25 mrem/yr) was present at the CAS (Decision I). The TEDE at sample plots E, J, and P were less than 25 mrem/yr, thus meeting the DQO criteria that at least one plot is less than 25 mrem/yr, and at least one plot is greater than 25 mrem/yr, on each vector.

For the americium plume plots, the TEDEs were comparable to the TEDEs at the vector sample plots within the same respective isopleths (i.e., there was no apparent additional contribution of dose to the TEDE by the fractionated americium plumes).

A.3.2 Results for Investigation of Other Releases

Analytical results from the soil samples taken from the stained soil (judgmental sampling) with concentrations exceeding MDCs are presented in the following sections.

A.3.2.1 Volatile Organic Compounds

Analytical results for VOC environmental samples collected at the stained area that were detected above MDCs are presented in Table A.3-10. No VOCs were detected at concentrations exceeding their respective PALs. The FALs were established at the PAL concentrations.

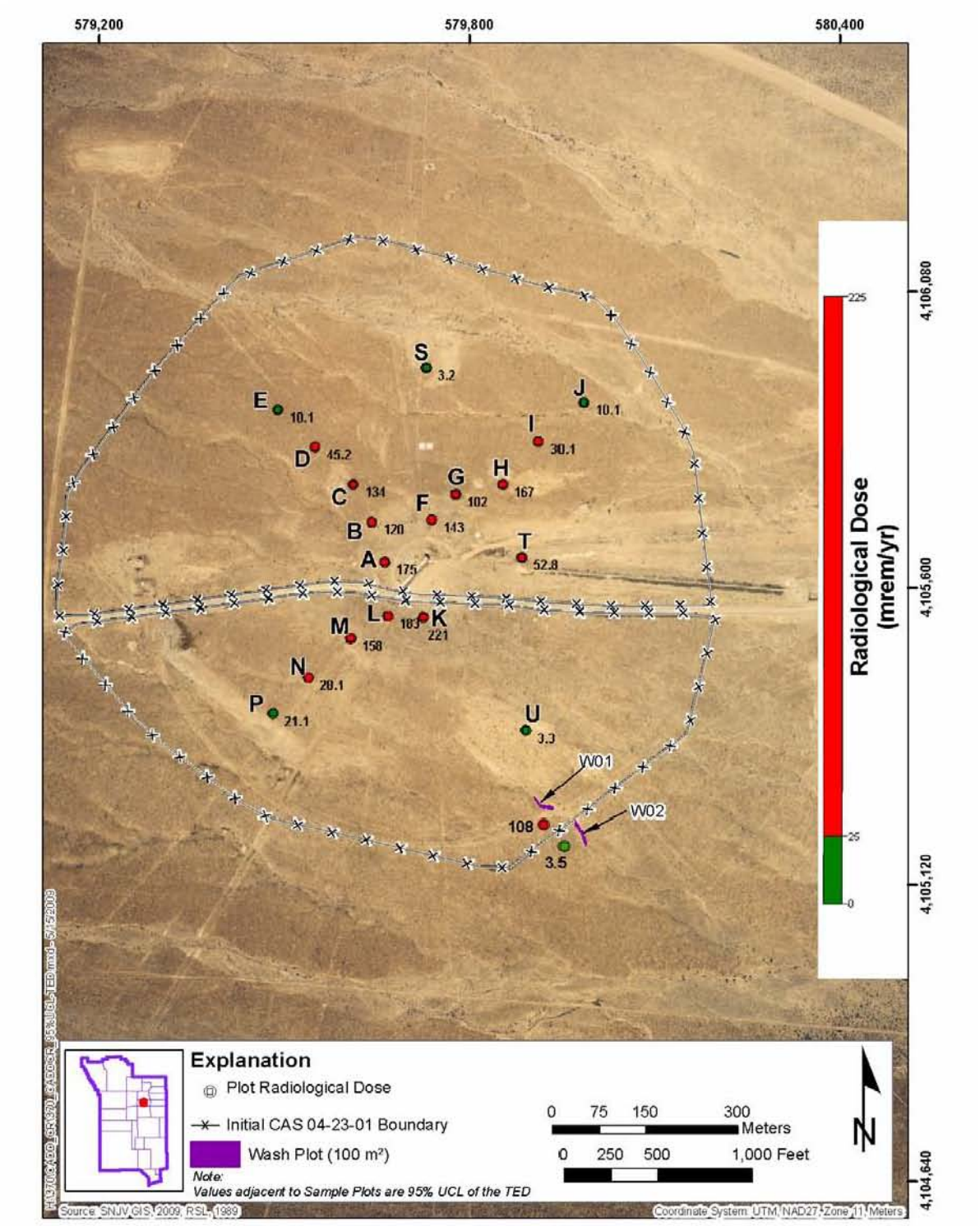


Figure A.3-2
Values for the 95 Percent UCL of the TEDE at CAS 04-23-01, Atmospheric Test Site T-4

Table A.3-10
Sample Results for Total VOCs Detected above
Minimum Detectable Concentrations at Stained Area, Location X

Sample Location	Sample Number	Depth (ft)	Contaminants of Potential Concern (mg/kg)	
			Acetone	Methylene Chloride
Final Action Levels[a]			54,000	21
X01	370X001A	0.0 - 0.33	0.016 (J)	--
	370X002A	0.0 - 0.33	0.017 (J)	0.0019 (J)

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004)

-- = Not detected above minimum detectable concentrations.
J = Estimated value

A.3.2.2 Semivolatile Organic Compounds

Analytical results for SVOC environmental samples collected at the stained area did not exceed the MDCs. The FALs were established at the PAL concentrations.

A.3.2.3 Total Petroleum Hydrocarbons

Analytical results for TPH-DRO environmental samples collected at the stained area did not exceed the MDCs. The FALs were established at the PAL concentrations.

A.3.2.4 RCRA Metals and Beryllium

The RCRA metals and beryllium analytical results for environmental samples collected at the stained area that were detected above MDCs are presented in Table A.3-11. No metals were detected at concentrations exceeding their PALs. The FALs were established at the PAL concentrations.

A.3.2.5 Polychlorinated Biphenyls

Analytical results for PCB environmental samples collected at the stained area did not exceed the MDCs. The FALs were established at the PAL concentrations.

Table A.3-11
Sample Results for RCRA Metals Detected above
Minimum Detectable Concentrations at Stained Area, Location X

Sample Location	Sample Number	Depth (ft)	Contaminants of Potential Concern (mg/kg)				
			Barium	Chromium	Lead	Mercury	Silver
Final Action Levels[a]			**67,000**	**450**	**800**	**310**	**5,100**
X01	370X001	0.0 -0.33	34	11	18	0.032	0.79
	370X002	0.0 - 0.33	37	12	18	0.04	1.5

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2004)

A.3.2.6 Gamma-Emitting Radionuclides

Analytical results for gamma-emitting radionuclide environmental samples collected at the stained area that were detected above MDCs are presented in Table A.3-12. No gamma-emitting radionuclides were detected at concentrations exceeding their respective PALs. The FALs were established at the PAL concentrations.

A.3.2.7 Isotopic Radionuclides

Isotopic Am, Pu, and isotopic U analytical results for environmental samples collected at the stained area that were detected above MDCs are presented in Tables A.3-13 and A.3-14. No isotopic Am, Pu, or U exceeded their respective PALs. The FALs were established at the PAL concentrations.

A.3.3 Potential Source Material

Lead objects, including three lead bricks, two lead panels, one lead sheet, and three lead-acid batteries, were also identified as PSM at the site and were removed for recycling. It is assumed that other lead objects may be present near GZ. Lead shielding may exist within the T-4 bunker and the potential presence of lead objects near the T-4 bunker is identified in an existing use restriction for CAU 357, CAS 04-26-03.

Soil beneath the lead objects removed during the CAI is also assumed to contain lead concentrations exceeding the FAL and are included within the use restriction boundary.

Table A.3-12
Sample Results for Gamma-Emitting Radionuclides Detected above Minimum Detectable Concentrations at Stained Area, Location X

Sample Location	Sample Number	Depth (ft)	Contaminants of Potential Concern (pCi/g)	
			Cesium-137	Lead-214
Final Action Levels			**12.2[a]**	**5[b]**
X01	370X001	0.0 - 0.33	2.01	3.19 (J)
	370X002	0.0 - 0.33	1.89	3.11 (J)

[a]Taken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were a 25-mrem/yr dose.
[b]Taken from the generic guidelines for residual concentrations of actinium-228, bismuth-214, lead-212, lead-214, thallium-208, and thorium-232, as found in Chapter IV of DOE Order 5400.5, Change 2, "Radiation Protection of the Public and Environment" (DOE, 1993).

NCRP = National Council on Radiation Protection and Measurements
J = Estimated value

Table A.3-13
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Stained Area, Location X

Sample Location	Sample Number	Depth (ft)	Contaminants of Potential Concern (pCi/g)
			Americium-241
Final Action Levels[a]			**12.7**
X01	370X001	0.0 - 0.33	0.36 (J)
	370X002	0.0 - 0.33	0.55 (J)

[a]Taken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were scaled to a 25-mrem/yr dose.

J = Estimated value

Table A.3-14
Sample Results for Isotopes Detected above
Minimum Detectable Concentrations at Stained Area, Location X

Sample Location	Sample Number	Depth (ft)	Contaminants of Potential Concern (pCi/g)			
			Pu-238	Pu-239/240	U-234	U-238
Final Action Levels[a]			13	12.7	143	105
X01	370X001	0.0 - 0.33	0.88	5.6	1.17	1.39
	370X002	0.0 - 0.33	1.33	7.1	1.45	1.32

[a]Taken from the construction, commercial, industrial land-use scenario in Table 2.1 of the NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source document were a 25-mrem/yr dose.

A.3.4 Nature and Extent of Contamination

The corrective action boundary for the annular distribution of radiological contamination was determined using:

- Information defining the pattern of distribution of radiological contamination based on the 1994 flyover survey.
- Correlation of distance from GZ along each vector to each TEDE at 15 sample plots.

The corrective action boundary was calculated based on the DQO criterion of the isopleth from the 1994 flyover survey that bounds all locations exceeding a 25-mrem/yr-dose rate. To protect against a false negative decision error, the TEDE estimates used to compare to the FAL were the 95 percent UCL of the TEDE results from the samples collected at each plot. Therefore, the corrective action boundary was defined as the flyover isopleth that encompassed all locations along each vector that exceed the 95 percent UCL of the TEDE.

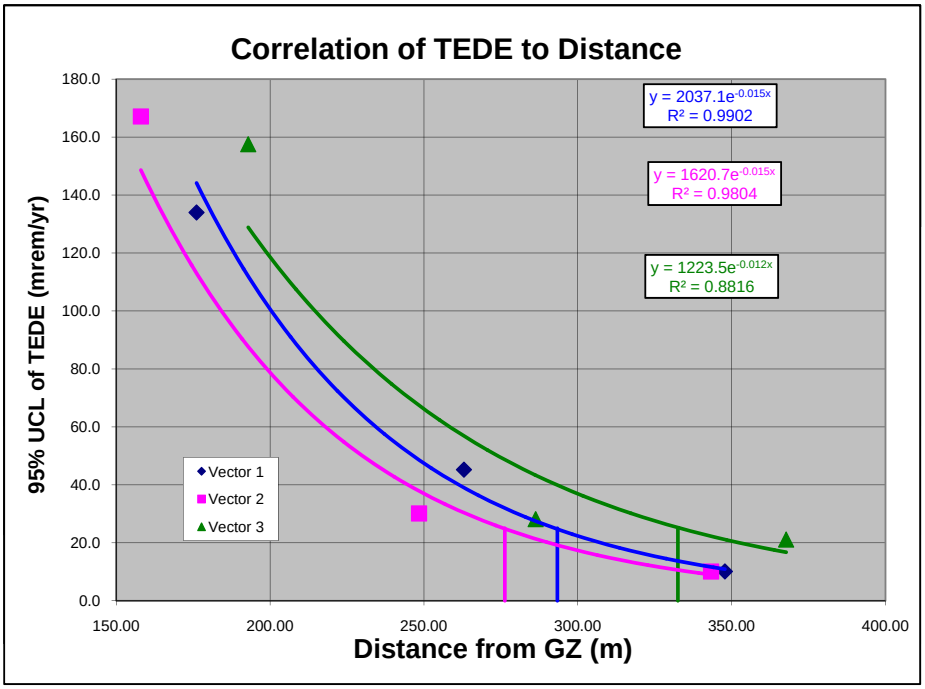
The locations along each vector that exceed the 95 percent UCL of the TEDE were determined based on a correlation of distance from GZ to the location along each vector where the 95 percent UCL of the average TEDE was estimated to be equivalent to the FAL. Although the measured distribution pattern associated with this release site showed generally decreasing dose rates with distance from GZ, due to surface disturbances near GZ and limited debris removals between tests, a decreasing pattern was not present within the central portion of the site. However, the outer three plots on each

vector demonstrated a consistent pattern of decreasing dose rates with distance. The correlations of TEDE to distance from GZ are presented in Figure A.3-3.

The calculated distances from GZ to a location where the 95 percent UCL of the TEDEs was equivalent to a 25-mrem/yr-dose rate for each of the three vectors were:

- Vector 1 – 293 m
- Vector 2 – 276 m
- Vector 3 – 333 m

The distances to a 95 percent UCL of the 25-mrem/yr-dose rate for the first and second vectors were encompassed by the third flyover survey isopleth and the distance to the 95 percent UCL of the 25 mrem/yr dose rate for the third vector was encompassed by the fourth flyover survey isopleth. Had only one vector been used, the corrective action boundary may have been set at either the third isopleth (an area of approximately 250,000 m^2) or the fourth isopleth (an area of approximately 370,000 m^2). To meet the DQO criterion of encompassing all locations exceeding the FAL of 25 mrem/yr, the corrective action boundary for the annular distribution was defined as the fourth flyover survey isopleth (Figure A.3-4).



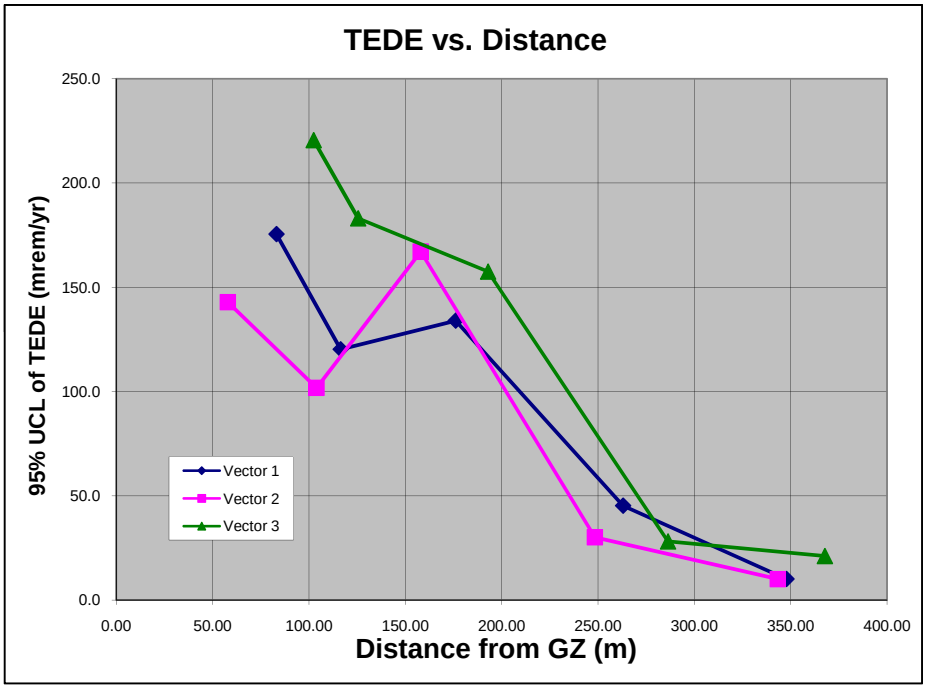


Figure A.3-3
Method 1. Correlation of the 95 Percent UCL of the Average TEDE to Distance from GZ

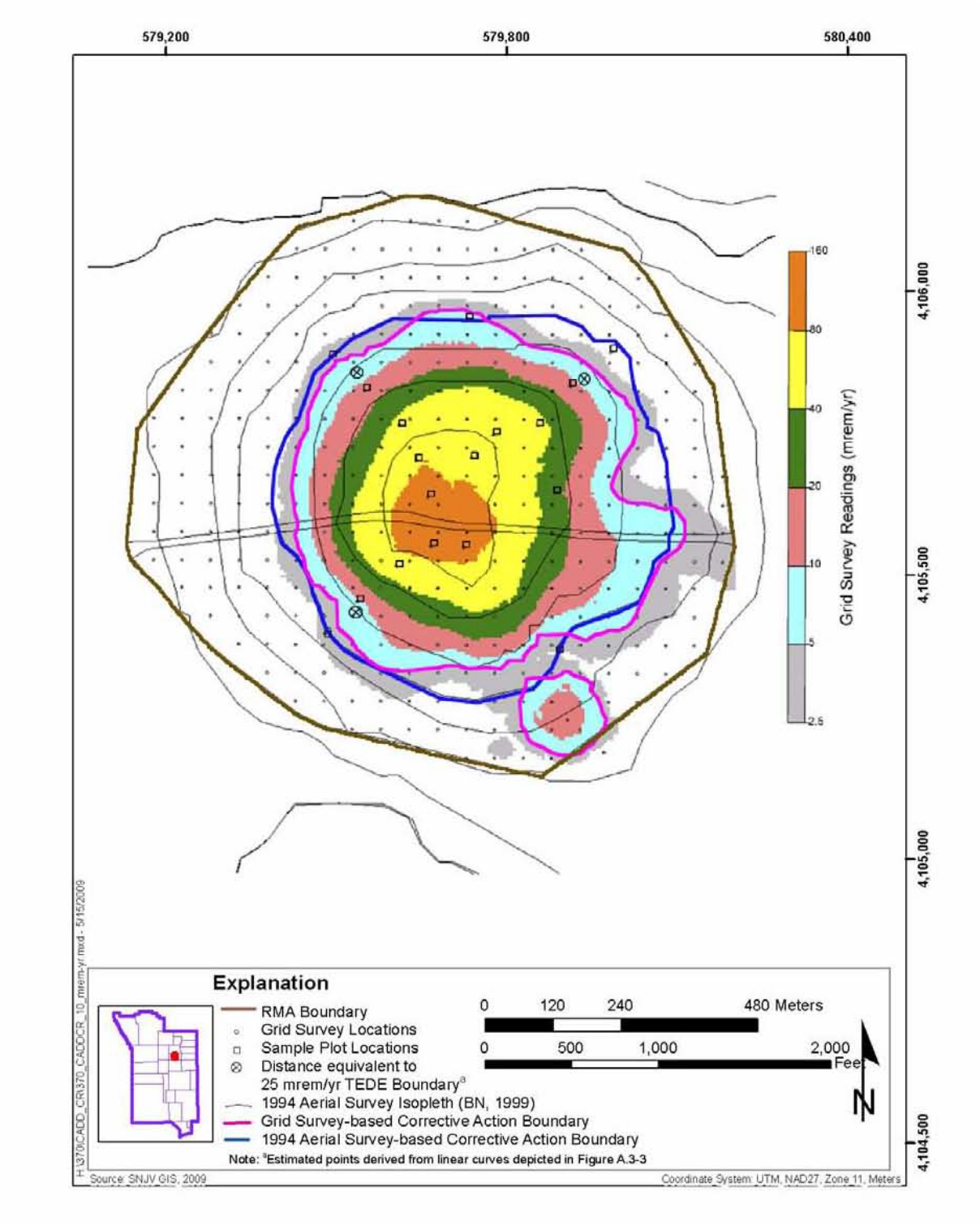


Figure A.3-4
Corrective Action Boundary for Annular Distribution

A radiological dose exceeding 25 mrem/yr was identified at the southeast wash plot inside the RMA fence (plot W01). An additional sample plot (W02) was established outside the RMA fence in an area of elevated radiological readings. Radiological results for plot W02 were below the 25-mrem/yr-dose criteria. The area exceeding 25 mrem/yr within the fence was added to the use restricted area by an extension of the boundary of the use restriction to the fence (Figure A.3-5).

The PSM identified in Section A.3.3 is contained within the bounds of the use restriction.

A.3.5 Deviations

Investigation samples and dose measurements were collected and processed as outlined in the CAU 370 CAIP (NNSA/NSO, 2008), and submitted for laboratory analysis, except for the following deviations:

- The CAIP states "... sample locations will be selected along nearby roads. These areas will be identified by walkover radiological surveys" (CAIP for CAU 370, Section 4.1.2). Locations along dirt roads near the site were not sampled. The 4-04 Road is the only road in the area investigated. During visual inspection of the site, no Trinity glass was identified on the road. Also, the base for the dirt road consists of clean fill spread on the road. There was no impact to the DQO decisions because the portion of the 4-04 Road that is within the fourth isopleth is contained within the use restriction, and Trinity glass was not identified on the road.

- The CAIP states "biased locations will be selected... at areas impacted by other releases identified during the investigation (e.g., lead bricks,...)" (CAIP for CAU 370, Section 4.1.2). Soil beneath lead objects was not sampled. It was assumed that the soil in contact with these lead objects was contaminated by lead. There was no impact to the DQO decisions because all locations at which lead objects were removed (for recycling) at CAS 04-23-01 are contained within the use restriction (Section A.3.3).

- The CAIP states "Several sample locations will be established in each wash... These areas will be identified by walkover radiological surveys" (CAIP for CAU 370, Section A.9.3). Each wash at the site was not sampled. There was no impact to the DQO decisions because the three most significant washes draining area within the use restriction were surveyed by a GWS (Section A.2.4) and, from these surveys, the only areas identified as anomalies within the southeast wash were sampled (Section A.3.4).

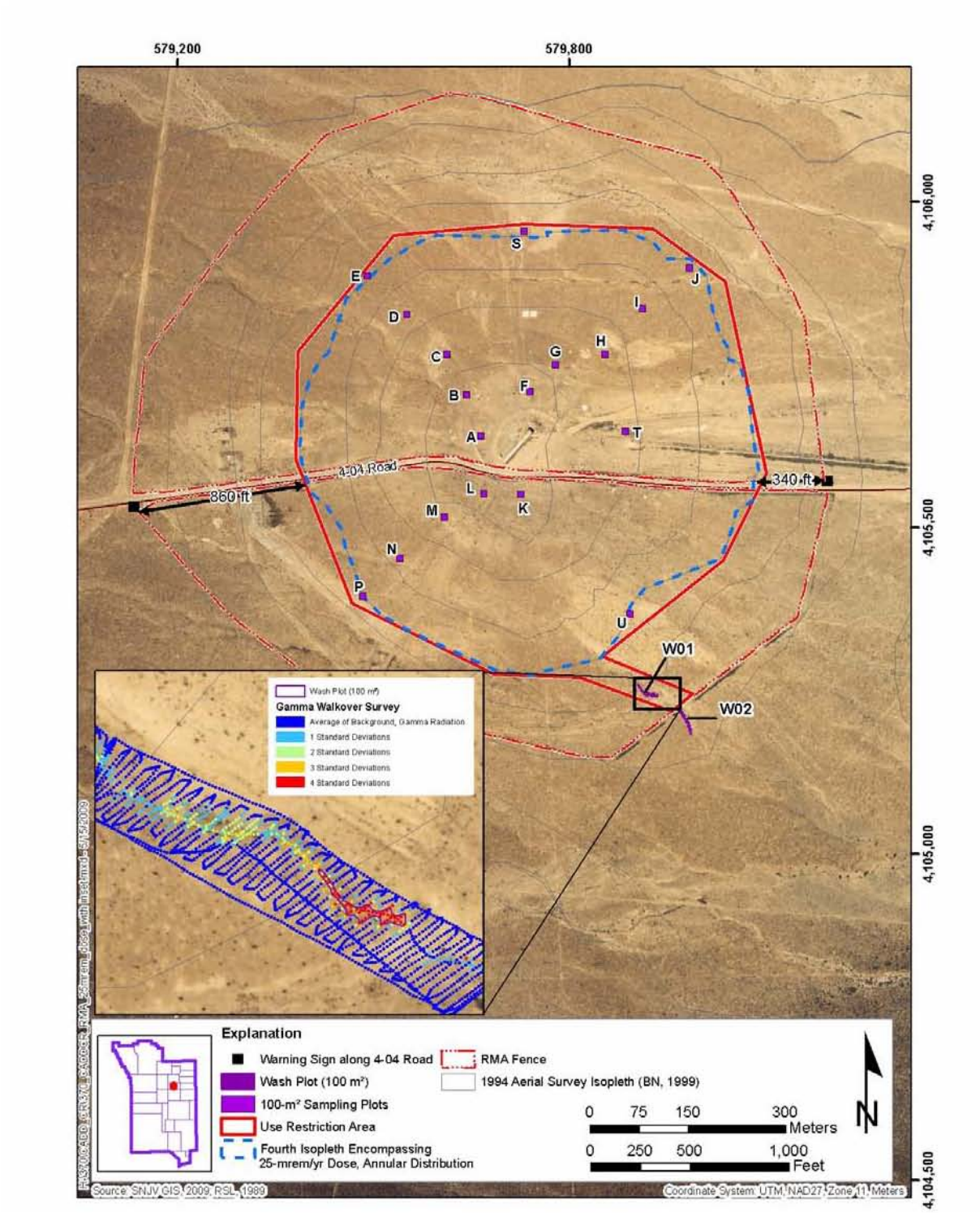


Figure A.3-5
Corrective Action Unit 370, T-4 Atmospheric Test Site, CAS 04-23-01
Land Use Restriction Boundary

- The CAIP states "At these deposition areas [americium plume plots], one sample location will be selected within the area identified by walkover surveys as having the highest radiological readings" (CAIP for CAU 370, Section A.9.3). Areas of highest radiological readings were not identified at two of the americium plume plots (plots T and U). The walkover survey at plot S identified an area along the southern portion of the plume having the highest radiological readings. However, the walkover radiological surveys could not distinguish specific locations at plots T and U. The decision was made to instead sample at the center of these two plumes. There was no impact to the DQO decisions because the areas within these two plumes appears to have fairly uniform radiological readings.

- Statistical analysis of the sample results was not conducted with the specified statistical software. The CAIP states that the "ProUCL statistical package will be used to: determine appropriate probability distribution, test for outliers, compute appropriate UCLs" (CAIP for CAU 370, Section C.2.1). Instead, the statistics were computed using the statistical for formulas presented in *Data Quality Assessment: Statistical Methods for Practitioners* (EPA, 2006).

- Two of the three innermost sample plots (A and K) that coincided with RIDP points were moved from their originally designated locations to nearby areas. Sample plot A was moved to the south and west due to the eastern half of the plot overlapping on buried asphalt, and the northern third of the site overlapping an area of disposed concrete. Plot A still resided within the same isopleth as the original location. Sample plot K was moved to the south due to its original presence across the 4-04 Road, and a second time to the southwest due to an error involving the use of erroneously larger sample plot areas in the GPS unit (plot K still resided within the same isopleth). Because both plots still reside within the original isopleth, there was no impact to the investigation or decisions.

A.3.6 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2008) were met at CAS 04-23-01. The information gathered during the CAI supports the CSM as presented in the CAIP for CAU 370. Therefore, no revisions were necessary to the CSM.

A.4.0 Waste Management

Investigation-derived waste was generated during the field investigation activities of CAU 370. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste. The waste streams generated were disposable personal protective equipment (PPE) and disposable sampling equipment. Radiological screening and swipes of PPE and sampling equipment during work at CAU 370 verified that removable contamination was not present at the site. The waste was bagged, marked, and placed in a roll-off for disposition at the U10c Industrial Landfill.

A.5.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 370 CAI. The following sections discuss the data validation process, QC samples, and nonconformances. A detailed evaluation of the DQIs is presented in Appendix B.

Laboratory analyses were conducted for samples used in the decision-making process to provide a quantitative measurement of contaminant of potential concern (COPCs) present. Rigorous QA/QC was implemented for all laboratory samples including documentation, verification and validation of analytical results, and affirmation of DQI requirements related to laboratory analysis. Detailed information regarding the QA program is contained in the Industrial Sites QAPP (NNSA/NV, 2002).

A.5.1 Data Validation

Data validation was performed in accordance with the Industrial Sites QAPP and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 370 were evaluated for data quality in a tiered process and are presented in Sections A.5.1.1 through A.5.1.3. Data were reviewed to ensure that samples were appropriately processed and analyzed, and the results were evaluated using validation criteria. Documentation of the data qualifications resulting from these reviews is retained in project files as a hard copy and electronic media.

All data analyzed as part of this investigation were subjected to Tier I and Tier II evaluations. A Tier III evaluation was performed on approximately 5 percent of the data analyzed.

A.5.1.1 Tier I Evaluation

Tier I evaluation for chemical and radiochemical analysis examines, but is not limited to:

- Sample count/type consistent with chain of custody.
- Analysis count/type consistent with chain of custody.
- Correct sample matrix.
- Significant problems and/or non-conformances stated in cover letter or case narrative.
- Completeness of certificates of analysis.
- Completeness of Contract Laboratory Program (CLP) or CLP-like packages.

- Completeness of signatures, dates, and times on chain of custody.
- Condition-upon-receipt variance form included.
- Requested analyses performed on all samples.
- Date received/analyzed given for each sample.
- Correct concentration units indicated.
- Electronic data transfer supplied.
- Results reported for field and laboratory QC samples.
- Whether or not the deliverable met the overall objectives of the project.

A.5.1.2 Tier II Evaluation

Tier II evaluation for chemical analysis examines, but is not limited to:

- Correct detection limits achieved.
- Sample date, preparation date, and analysis date for each sample.
- Holding time criteria met.
- Quality control batch association for each sample.
- Cooler temperature upon receipt.
- Sample pH for aqueous samples, as required.
- Detection limits properly adjusted for dilution, as required.
- Blank contamination evaluated and applied to sample results/qualifiers.
- Matrix spike (MS)/matrix spike duplicate (MSD) percent recoveries (%R) and relative percent differences (RPDs) evaluated and qualifiers applied to laboratory results, as necessary.
- Field duplicate (FD) RPDs evaluated using professional judgment and qualifiers applied to laboratory results, as necessary.
- Laboratory duplicate RPDs evaluated and qualifiers applied to laboratory results, as necessary.
- Surrogate %R evaluated and qualifiers applied to laboratory results, as necessary.
- Laboratory control sample (LCS) %R evaluated and qualifiers applied to laboratory results, as necessary.
- Initial and continuing calibration evaluated and qualifiers applied to laboratory results, as necessary.
- Internal standard evaluation.
- Mass spectrometer tuning criteria.
- Organic compound quantitation.

- Inductively coupled plasma interference check sample evaluation.
- Graphite furnace atomic absorption QC.
- Inductively coupled plasma serial dilution effects.
- Recalculation of 10 percent of laboratory results from raw data.

Tier II evaluation for radiochemical analysis examines, but is not limited to:

- Correct detection limits achieved.
- Blank contamination evaluated and, if significant, qualifiers are applied to sample results.
- Certificate of Analysis consistent with data package documentation.
- Quality control sample results (duplicates, LCSs, laboratory blanks) evaluated and used to determine laboratory result qualifiers.
- Sample results, uncertainty, and MDC evaluated.
- Detector system calibrated with National Institute for Standards and Technology (NIST)-traceable sources.
- Calibration sources preparation was documented, demonstrating proper preparation and appropriateness for sample matrix, emission energies, and concentrations.
- Detector system response to daily or weekly background and calibration checks for peak energy, peak centroid, peak full-width half-maximum, and peak efficiency, depending on the detection system.
- Tracers NIST-traceable, appropriate for the analysis performed, and recoveries that met QC requirements.
- Documentation of all QC sample preparation complete and properly performed.
- Spectra lines, photon emissions, particle energies, peak areas, and background peak areas support the identified radionuclide and its concentration.

A.5.1.3 Tier III Evaluation

The Tier III review is an independent examination of the Tier II evaluation. A Tier III review of 5 percent of the sample radiological analytical data were performed by Analytical Quality Associates, Inc. in Albuquerque, New Mexico, and of the sample chemical analytical data were performed by TLI Solutions, Inc. in Golden, Colorado. Tier II and Tier III results were compared and where

differences are noted, data were reviewed and changes were made accordingly. This review included the following additional evaluations:

- Review:
  - Case narrative, chain of custody, and sample receipt forms
  - Lab qualifiers (applied appropriately)
  - Method of analyses performed as dictated by the chain of custody
  - Raw data, including chromatograms, instrument printouts, preparation logs, and analytical logs
  - Manual integrations to determine whether the response is appropriate
  - Data package for completeness
- Determine sample results qualifiers through the evaluation of (but not limited to):
  - Tracers and QC sample results (e.g., duplicates, LCSs, blanks, MSs) evaluated and used to determine sample results qualifiers
  - Sample preservation, sample preparation/extraction and run logs, sample storage, and holding time
  - Instrument and detector tuning
  - Initial and continuing calibrations
  - Calibration verification (initial, continuing, second source)
  - Retention times
  - Second column and/or second detector confirmation
  - Mass spectra interpretation
  - Interference check samples and serial dilutions
  - Post digestion spikes and method of standard additions
  - Breakdown evaluations

- Perform calculation checks of:
  - At least one analyte per QC sample and its recovery
  - At least one analyte per initial calibration curve, continuing calibration verification, and second source recovery
  - At least one analyte per sample that contains positive results (hits); radiochemical results only require calculation checks on activity concentrations (not error)
- Verify that target compound detects identified in the raw data are reported on the results form.

Document any anomalies for the laboratory to clarify or rectify. The contractor should be notified of any anomalies.

A.5.2 Field Quality Control Samples

Field QC samples consisted of 1 trip blank, 5 full laboratory QCs, and 5 FDs collected and submitted for analysis by the laboratory analytical methods shown in Table A.2-2. The QC samples were assigned individual sample numbers and sent to the laboratory "blind." Additional samples were selected by the laboratory to be analyzed as laboratory duplicates. Trip blanks were analyzed for VOCs only.

During the CAI, 13 FDs were sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in Table A.2-2. For these samples, the duplicate results precision (i.e., RPDs between the environmental sample results and their corresponding FD sample results) were evaluated.

A.5.2.1 Laboratory Quality Control Samples

Analysis of preparation QC blanks (PBs) were performed on each sample delivery group (SDG) for inorganics. Analysis for surrogate spikes and method blanks (MBs) were performed on each SDG for organics only. Initial and continuing calibration and LCSs were performed for each SDG. The results of these analyses were used to qualify associated environmental sample results. Documentation of data qualifications resulting from the application of these guidelines is retained in project files as both hard copy and electronic media.

The laboratory included a PB, LCS, and a laboratory duplicate sample with each batch of field samples analyzed for radionuclides.

A.5.3 Field Nonconformances

There was one field nonconformance identified for the CAI, which involved not designating Sr-90 analysis on one chain-of-custody. However, the analysis for Sr-90 was conducted.

A.5.4 Laboratory Nonconformances

Laboratory nonconformances are generally due to inconsistencies in the analytical instrumentation operation, sample preparations, extractions, missed holding times, and fluctuations in internal standard and calibration results. Sixteen nonconformances were issued by the laboratories that may or may not have resulted in qualifying data. These laboratory nonconformances have been accounted for and resolved during the data validation process.

A.6.0 Summary

Organic, inorganics, and radionuclide contaminants detected in environmental samples during the CAI were evaluated against FALs to determine the nature and extent of COCs for CAU 370. Assessment of the data generated from investigation activities indicates that radiological contamination at the site exceeds the FAL for the radiological dose (25 mrem/yr) and requires corrective action. Additionally, several lead objects were identified, including lead objects and material within an existing use restriction for CAU 357, CAS 04-26-03 as well as the indication of lead objects within the T-4 Bunker. The presence of this lead as PSM also requires corrective action.

The extent of contamination exceeding FALs is defined by the fourth isopleth from GZ (Figure A.3-5), with a slight extension to include an area of sediment containing elevated radiological readings in the southeast wash.

Some of the lead objects, including three lead bricks, two lead panels, one lead sheet, and three lead acid batteries were removed as a corrective action. It is assumed that other lead objects may be present near the GZ (Section A.3.3). Soil beneath the lead objects removed during the CAI is also assumed to contain lead concentrations exceeding the FAL and is contained within the use restriction boundary.

A.7.0 References

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Appendix B

Data Assessment

B.1.0 Data Assessment

The DQA process is the scientific evaluation of the actual investigation results to determine whether the DQO criteria established in the CAU 370 CAIP (NNSA/NSO, 2008) were met and whether DQO decisions can be resolved at the desired level of confidence. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes help to ensure that DQO decisions are sound and defensible.

The DQA involves five steps that begin with a review of the DQOs and end with an answer to the DQO decisions. The five steps are briefly summarized as follows:

- Step 1: Review DQOs and Sampling Design – Review the DQO Process to provide context for analyzing the data. State the primary statistical hypotheses; confirm the limits on decision errors for committing false negative (Type I) or false positive (Type II) decision errors; and review any special features, potential problems, or deviations to the sampling design.
- Step 2: Conduct a Preliminary Data Review – Perform a preliminary data review by reviewing QA reports and inspecting the data both numerically and graphically, validating and verifying the data to ensure that the measurement systems performed in accordance with the criteria specified, and using the validated dataset to determine whether the quality of the data is satisfactory.
- Step 3: Select the Test – Select the test based on the population of interest, population parameter, and hypotheses. Identify the key underlying assumptions that could cause a change in one of the DQO decisions.
- Step 4: Verify the Assumptions – Perform tests of assumptions. If data are missing or are censored, determine the impact on DQO decision error.
- Step 5: Draw Conclusions from the Data – Perform the calculations required for the test.

B.1.1 Review DQOs and Sampling Design

This section contains a review of the DQO process presented in Appendix A of the CAU 370 CAIP (NNSA/NSO, 2008). The DQO decisions are presented with the DQO provisions to limit false negative or false positive decision errors. Special features, potential problems, or any deviations to the sampling design are also presented.

B.1.1.1 Decision I

The Decision I statement as presented in the CAU 370 CAIP: "Is any COPC associated with the CAS present in environmental media at a concentration exceeding its corresponding FAL?" (NNSA/NSO, 2008).

Decision I Rules:

- If the population parameter of any COPC in the Decision I population of interest (defined in Step 4 of the DQO) exceeds the corresponding FAL, then that COPC is identified as a COC, and Decision II samples will be collected, else no further investigation is needed for that release in that population.
- If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in Section A.6.2 of the CAU 370 CAIP, then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling to define the extent.
- If a waste is present that, if released, has the potential to cause a future release of COCs to environmental media, then a corrective action will be determined, else no further action will be necessary.

B.1.1.1.1 DQO Provisions To Limit False Negative Decision Error

A false negative decision error (where consequences are more severe) was controlled by meeting the following criteria:

1a. Having a high degree of confidence that sample locations selected will identify COCs if present anywhere within the CAS (judgmental sampling).

1b. Maintenance of a false negative decision error rate of 0.05 (probabilistic sampling).

2. Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.

3. Having a high degree of confidence that the dataset is of sufficient quality and completeness.

Criterion 1a:

The locations for sampling the stained soil in the western portion of the CAS, and the area of elevated radiological readings in the southeast wash, were selected based upon the criterion of visual field

observations (approximate center of a large swath of stained soil and elevated radiological readings from the gamma walkover survey modified to fit the winding nature of the wash) (Section A.2.1).

The locations of the non-vector sample plots "T" and "U" in the americium plumes were at the approximate center of the americium isopleths (1994 flyover survey) within the highest radiological readings. The location of sample plot "S" in the north americium plume was at the approximate location of the highest gamma readings within the highest radiological readings of the isopleth (Section A.2.1).

The locations of the Decision I sample plots for the annular distribution (as stipulated in the DQOs) were determined based on one innermost sample plot on each sample vector being placed at the RIDP point closest to GZ. Two of the three innermost sample plots (A and K) that coincided with RIDP points were moved from their originally designated locations to nearby areas (Section A.3.5). Sample plot A overlapped on asphalt and disposed concrete. Sample plot K was originally located on the 4-04 Road. Both plots were relocated to nearby areas that resided within the original isopleth.

Criterion 1b:

For probabilistic sampling designs, four requirements must be met to ensure that the average TEDE for each sample plot represents the true average contaminant concentrations:

- The population distributions fit the applied UCL determination method.
- A sufficient sample size was collected.
- The actual standard deviation is known.
- Analyses conducted were sufficient to detect any COCs present in samples.

The standard deviations for the TEDEs from each sample plot are very low (Table B.1-1). Most are less than 1 percent of the average with a maximum of 2.5 percent of the average. Therefore, a normal distribution was used to calculate the UCLs.

Table B.1-1
Input Values and VSP Determined Minimum Number of Samples for CAU 370, CAS 04-23-01

Plot	Average TEDE (mrem/yr)	Actual Standard Deviation	Gray Region	Initial Estimate of Minimum Number of Samples	Minimum Number of Samples[a]
A	**175.0**	0.45	12.5	4	3
B	**119.6**	0.54			3
C	**133.3**	0.58			3
D	**45.2**	0.07			3
E	10.1	0.02			3
F	**142.4**	0.40			3
G	**101.4**	0.27			3
H	**166.7**	0.32			3
I	**30.1**	0.01			3
J	10.1	0.01			3
K	**220.1**	0.31			3
L	**180.8**	1.89			3
M	**156.6**	1.0			3
N	**28.1**	0.02			3
P	21.1	0.02			3
S	3.2	0.03			3
T	**51.1**	1.48			3
U	3.2	0.07			3

[a]The actual required minimum number of samples calculated by the one-sample t-Test (EPA, 2006 and PNNL, 2008 [VSP Version 5.1]) was less than 3. The minimum number of samples required to calculate statistics is 3.

VSP = Visual Sample Plan

The minimum number of samples required from each plot was calculated using VSP from the statistics generated from the TEDE for each of the sample collected in the plot (Table B.1-1). The VSP software (PNNL, 2008) was used to confirm that the initial number of samples collected per plot was adequate to meet criteria stipulated in the CAU 370 CAIP (NNSA/NSO, 2008):

- A false rejection rate of 5 percent.
- A false acceptance rate of 20 percent.
- The maximum acceptable gray region set to one half the FAL (12.5 mrem/yr).
- The calculated standard deviation of each plot.

Selection of the sample aliquot locations within a sample plot (Section 4.1.1, Section A.8.2.1, and Section A.9.1 of the CAU 370 CAIP) was accomplished through the use of the VSP software (PNNL,

2008). Each set of sample aliquot locations were derived using the random start, systematic triangular grid pattern for sample placement. Use of the VSP software permitted an unbiased, equal-weighted chance that any given location within the boundaries of the sample plot would be chosen.

The input values and VSP determined minimum number of samples to be taken at each plot are listed in Table B.1-1.

For all sample plots, the variability of the results was less than the initial estimates, thus the 95 percent UCL for these TEDEs were used to make DQO decisions.

Criterion 2:

All samples were analyzed using the analytical methods listed in Table 6-2 of the CAU 370 CAIP and for the chemical and radiological analytes listed in Section A.1.6.3 of the CAIP (NNSA/NSO, 2008). Table B.1-2 provides a reconciliation of samples analyzed to the planned analytical program.

Samples were submitted for all of the analytical methods specified in the analytical program described in Section A.3.2.2 of the CAU 370 CAIP (NNSA/NSO, 2008).

Sample results were assessed against the acceptance criterion for the DQI of sensitivity as defined in the Industrial Sites QAPP (NNSA/NV, 2002). The sensitivity acceptance criterion defined in the CAU 370 CAIP is that analytical detection limits will be less than the corresponding FAL (NNSA/NSO, 2008). All detection limits were less than FALs; therefore, the DQI for sensitivity has been met.

Criterion 3:

To satisfy the third criterion, the entire dataset, as well as individual sample results, were assessed against the acceptance criteria for the DQIs of precision, accuracy, comparability, completeness, and representativeness, as defined in the Industrial Sites QAPP (NNSA/NV, 2002). The DQI acceptance criteria are presented in Table 6-1 of the CAU 370 CAIP (NNSA/NSO, 2008). As presented in the following subsections, these criteria were met for each the DQIs.

Table B.1-2
CAU 370 Analyses Performed

CAS Component	Total VOCs	Total SVOCs	PCBs	Metals	TPH-DRO	Gamma Spectroscopy	Isotopic Americium	Isotopic Uranium	Isotopic Plutonium	Strontium- 90
Vector Plots	NR	NR	NR	NR	NR	RS	RS	RS	RS	RS
Americium Plume Plots	NR	NR	NR	NR	NR	RS	RS	RS	RS	RS
Wash Plots	NR	NR	NR	NR	NR	RS	RS	RS	RS	RS
Stained Soil	RS	RS	RS	RS	RS	RS	RS	RS	RS	RS

NR = Not required and not submitted
RS = Required and submitted

Precision

Precision was evaluated as described in Section 6.2 of the CAU 370 CAIP (NNSA/NSO, 2008). Table B.1-3 provides the radiological precision analysis results for all constituents that were qualified for precision. No chemical measurements were qualified for precision. Radionuclides qualified for precision were Am-241, Pu-238, Pu-239/240, and Sr-90.

Table B.1-3
Precision Measurements[a]

Analyte	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Am-241	Americium	43	79	45.6
Am-241	Gamma	43	79	45.6
Pu-238	Plutonium	43	79	45.6
Pu-239/240	Plutonium	45	79	43
Sr-90	Strontium	12	79	84.8

[a]SW-846 Methods (EPA, 1999 and 2002)

As shown in Table B.1-3, the precision rate for all radionuclides except Am-241, Pu-238, and Pu-239/240 were above the CAU 370 CAIP acceptance criterion of 80 percent. The samples qualified for Am-241 (both gamma and isotopic), Pu-238, and Pu-239/240 precision were based on differences in laboratory duplicate sample results. High variability in the sampled matrix may

indicate the potential that discrete particles of contamination are present within the sample. This is especially true for the samples collected at CAS 04-23-01, given the presence of Trinity glass at all sample plot locations. Therefore, mixing will not produce homogeneity. This does not mean the precision of the measurement is poor but that activities are variable within the sample. This is commonly observed in isotopic Pu results, as a single particle of plutonium within a sample can result in detectable activities attributed to the entire sample. Therefore, when a duplicate sample is analyzed for isotopic Pu, the results can be significantly different depending on how many discrete particles are contained in each sample. However, there is negligible potential for a false negative DQO decision error because the higher result of the sample or its duplicate was used for calculations. Therefore, the Am-241, Pu-238, and Pu-239/240 results that were qualified for reasons of precision can be confidently used to support DQO decisions, and the dataset is determined to be acceptable for the DQI of precision.

Accuracy

Accuracy was evaluated as described in Section 6.2 of the CAU 370 CAIP (NNSA/NSO, 2008). The only contaminant qualified for accuracy was Am-241. Of 79 measurements, two Am-241 results were reported as qualified for accuracy. This results in a 97.5 percent accuracy, which is above the CAIP criterion of 80 percent. As the accuracy rates for all contaminants exceed the acceptance criterion for accuracy, the dataset is determined to be acceptable for the DQI of accuracy.

Representativeness

The DQO process as identified in Appendix A of the CAU 370 CAIP (NNSA/NSO, 2008) was used to address sampling and analytical requirements for CAU 370. During this process, appropriate locations were selected that enabled the samples collected to be representative of the population parameters identified in the DQO (the most likely locations to contain contamination [judgmental sampling] or that represent contamination of the sample plot [probabilistic sampling] and locations that bound COCs) (Section A.2.1). The sampling locations identified in the Criterion 1 discussion meet this criterion. Therefore, the analytical data acquired during the CAU 370 CAI are considered representative of the population parameters.

Comparability

Field sampling, as described in the CAU 370 CAIP (NNSA/NSO, 2008), was performed and documented in accordance with approved procedures that are comparable to standard industry practices. Approved analytical methods and procedures per DOE were used to analyze, report, and validate the data. These are comparable to other methods used not only in industry and government practices, but most importantly are comparable to other investigations conducted for the NTS. Therefore, project datasets are considered comparable to other datasets generated using these same standardized DOE procedures, thereby meeting DQO requirements.

Also, standard, approved field and analytical methods ensured that data were appropriate for comparison to the investigation action levels specified in the CAU 370 CAIP.

Completeness

The CAU 370 CAIP (NNSA/NSO, 2008) defines acceptable criteria for completeness to be that the dataset is sufficiently complete to be able to make the DQO decisions. This is initially evaluated as 80 percent of CAS-specific analytes identified in the CAU 370 CAIP having valid results. As data was provided for all samples and measurements, the dataset, including the TLD measurements of external dose, are considered to meet the DQI criterion for completeness.

Rejected data (either qualified as rejected or data that failed the criterion of sensitivity) are not used in the resolution of DQO decisions and are not counted toward meeting the completeness acceptance criterion. There were no rejected data for the site.

B.1.1.1.2 DQO Provisions To Limit False Positive Decision Error

The false positive decision error was controlled by assessing the potential for false positive analytical results. Quality assurance/QC samples such as one trip blank, LCSs, and method blanks were used to determine whether a false positive analytical result may have occurred. Of nine QA/QC samples submitted, no false positive analytical results were detected.

Proper decontamination of sampling equipment and the use of certified clean sampling equipment and containers also minimized the potential for cross contamination that could lead to a false positive analytical result.

B.1.1.2 Decision II

The Decision II statement for the investigation of other releases as presented in the CAU 370 CAIP: "Is sufficient information available to evaluate potential corrective action alternatives?" (NNSA/NSO, 2008).

The Decision II statement for the investigation of annular distribution as presented in the CAU 370 CAIP: "Is the extent of the area that provides a dose exceeding 25 mrem/yr defined?" (NNSA/NSO, 2008). Sufficient information to resolve this portion of Decision II includes identifying the volume of media containing a radiological dose above the threshold as well as ensuring the statistical criteria stipulated in Section A.8.2.2 of the CAU 370 CAIP was met.

Decision Rules for other releases:

The decision rules for Decision II regarding other releases (Section A.7.3 of the CAU 370 CAIP) is:

- If the population parameter (the observed concentration of any COC) in the Decision II population of interest (defined in Step 4) exceeds the corresponding FAL in any bounding direction, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.
- If COC contamination is inconsistent with the CSM, or extends beyond the spatial boundaries identified in Section A.6.2, then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling to define the extent.

Decision Rules for annular distribution:

The decision rules for Decision II regarding annular contamination distribution (Section A.7.3 of the CAU 370 CAIP) are:

- If a flyover isopleth exists that bounds all locations exceeding the 25-mrem/yr TEDE, then the isopleth will be established as the boundary for the 25-mrem/yr dose; otherwise, additional sample plots will be established until that boundary is determined.
- If COC contamination is inconsistent with the CSM, or extends beyond the spatial boundaries identified in Section A.6.2, then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling to define the extent.

B.1.1.2.1 DQO Provisions To Limit False Negative Decision Error

A false negative decision error (where consequences are more severe) was controlled by meeting the following criteria:

1a. Having a high degree of confidence that sample locations selected will identify the extent of COCs (judgmental sampling).

1b. Maintenance of a false negative error rate of 0.05 (probabilistic sampling)

2. Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.

3. Having a high degree of confidence that the dataset is of sufficient quality and completeness.

Criterion 1a:

Because no COCs were found in the sample and duplicate collected from the stained area in the western portion of the site, there was no need to determine extent for these samples.

A radiological dose exceeding 25 mrem/yr was identified at the southeast wash plot inside the RMA fence (plot W01). An additional sample plot (W02) was established outside the RMA fence in an area of elevated radiological readings. Both wash plots were adjusted into 100-m^2 polygons to conform to the winding nature of the wash. Radiological results for plot W02 were below the 25-mrem/yr-dose criteria, thereby determining the extent of radiological contamination of the wash.

The locations of the vector sample plots were stipulated in the DQOs (NNSA/NSO, 2008). Additional factors affecting the location of sample plots included the following:

- Three sample vectors were established.
- Each sample vector included at least two RIDP points.
- Five plots were established along each vector.
- The outermost sample plot on each sample vector was placed beyond the 25-mrem/yr-dose boundary.

Criterion 1b:

For criterion 1b, the high degree of confidence that the true average contaminant concentrations are represented by the average sample contaminant concentrations was by selection of the sample aliquot locations. These were established in an unbiased (random) manner, with the chance of each lateral location being selected to have equal weight and to be distributed on a triangular grid.

B.1.1.2.2 DQO Provisions To Limit False Positive Decision Error

The false positive decision error was controlled by assessing the potential for false positive analytical results. Quality assurance/QC samples such as field blanks, one trip blank, LCSs, and method blanks were used to determine whether a false positive analytical result may have occurred. Of nine QA/QC samples submitted, no false positive analytical results were detected.

Proper decontamination of sampling equipment and the use of certified clean sampling equipment and containers also minimized the potential for cross contamination that could lead to a false positive analytical result.

B.1.1.3 Sampling Design

The CAU 370 CAIP (NNSA/NSO, 2008) made the following commitments for sampling:

1. Judgmental sampling will be conducted at other releases, at the americium plumes, along the downstream direction of washes transecting the site, along dirt roads near the site, and at locations of potential contamination identified during the CAI.

   Result: Judgmental sampling was conducted at the americium plumes and in the wash at locations of elevated radioactivity. Samples were collected at these locations in the same manner as the sampling conducted at the vector plots. Sampling along dirt roads near the site was not conducted, as the radiological grid survey of the site did not detect elevated readings along the ends of the 4-04 Road (see Section A.3.5 for discussion of this deviation). Sampling at the stained area in the western portion of the site was conducted by placing the sample location in the approximate center of the largest stained area. Sampling of the soil beneath lead objects removed from the site was not conducted, as the site was closed with a use restriction for lead (see Section A.3.5 for discussion of this deviation).

2. Sampling of annular distributions will be conducted by a combination of judgmental and probabilistic sampling approaches.

   Result: The location of the plots along the three sample vectors were selected judgmentally and samples were collected within each plot probabilistically as described in Section A.2.2.

B.1.2 Conduct a Preliminary Data Review

A preliminary data review was conducted by reviewing QA reports and inspecting the data. The contract analytical laboratories generate a QA nonconformance report when data quality does not meet contractual requirements. All data received from the analytical laboratories met contractual requirements, and a QA nonconformance report was not generated. Data were validated and verified to ensure that the measurement systems performed in accordance with the criteria specified. The validated dataset quality was found to be satisfactory.

B.1.3 Select the Test and Identify Key Assumptions

For other releases, the test for making DQO decisions is the comparison of the maximum analyte result to the corresponding FAL. For annular distribution sampling, the test for making DQO decisions is the comparison of the TEDE to the FAL of 25 mrem/yr.

The key assumptions that could impact a DQO decision are listed in Table B.1-4.

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 370 DQOs and Table B.1-4 except as listed below:

- Exception: The measured distribution pattern associated with this release site showed generally decreasing dose rates with distance from GZ. Due to surface disturbances near GZ, this pattern is not consistent within the central portion of the site for Vectors 1 and 2 (Figure A.3-3). The outer three plots on each vector demonstrated a consistent pattern of decreasing dose rates with distance and encompassed the locations where the 95 percent UCL of the TEDE was equivalent to the FAL of 25 mrem/yr. Therefore, the 95 percent UCL of the TEDE from the outer three plots of each vector were used for the correlation of dose to distance from GZ.
- Impact: There was no impact to the DQO decisions. The outer plot on each of the three vectors bracketed the 25-mrem/yr dose (Section A.3.4).

Table B.1-4
Key Assumptions

Exposure Scenario	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to contaminants of potential concerns through oral ingestion, inhalation, dermal contact (absorption) of soil and/or debris due to inadvertent disturbance of these materials or radiation by radioactive materials.
Affected Media	Surface soil and shallow subsurface soil; debris such as concrete and metal.
Location of Contamination/Release Points	Interface between contaminated soil/debris and native soil.
Transport Mechanisms	Surface water runoff may provide for the transportation of some contaminants within or outside of the footprint of the CAS. Percolation of precipitation through subsurface media serves as a minor driving force for migration of contaminants.
Preferential Pathways	Drainages.
Lateral and Vertical Extent of Contamination	Contamination, if present, is expected to be contiguous to the release points. Concentrations are expected to decrease with distance and depth from the source. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is expected to be within the spatial boundaries.
Groundwater Impacts	None.
Future Land Use	Nuclear and high explosives.
Other Data Quality Objective Assumptions	Refractory plutonium is present as discrete particles. Collection of a representative sample can be impacted by the distribution of the plutonium particles in the sampled soil.

B.1.4.1 Other DQO Commitments

The CAU 370 CAIP (NNSA/NSO, 2008) made the following commitments for sampling:

1. The five sample plots along each vector would be placed so that one would be located at a RIDP point closest to GZ, based upon the likelihood of the soil containing a COC within the 25-mrem/yr dose boundary, and that the outermost sample plot would be located beyond the 25-mrem/yr-dose boundary (Section 4.1.1 of the CAU 370 CAIP).

   Result: The locations of the sample plots met these requirements.

2. If a predetermined location cannot be feasibly sampled, the SS will determine an alternate location (Section A.9.1 of the CAU 370 CAIP).

   Result: The modification of aliquot locations from planned positions was due to field conditions and observations (obstruction from rock and caliche, surface impediments, excavations and animal burrows). The distances of the new aliquot locations from the planned locations ranged from approximately 2 in. to approximately 7.5 ft (from an excavation). These changes in the planned locations did not impact the DQO decisions because bias was not used for the selection of the new aliquot locations (i.e., the closest unobstructed location).

B.1.5 Draw Conclusions from the Data

This section resolves the two DQO decisions.

B.1.5.1 Decision Rules for Decision I

Decision Rule: If the concentration of any COPC in a target population exceeds the FAL for that COPC during the initial investigation, then that COPC is identified as a COC and Decision II sampling will be conducted.

Result: The following COCs were identified at CAS 04-23-01.

- A TEDE (i.e., radiological dose) exceeding 25 mrem/yr to an industrial worker
- Metallic lead in bricks and sheets (PSM)

Decision Rule: If all COPC concentrations are less than the corresponding FALs, then the decision will be no further action.

Result: Contaminants of concern were identified for the CAS. Corrective action is required.

B.1.5.2 Decision Rules for Decision II

Decision Rule: If the observed concentration of any COC in a Decision II sample exceeds the FALs, then additional samples will be collected to complete the determination of the extent.

Result: Samples to define extent were collected from each of the three vectors. The TEDE of the outermost plot in each vector was below the FAL. Therefore, additional samples to define extent were not required.

Decision Rule: If all observed COC population parameters are less than the FALs, then the decision will be that the extent of contamination has been defined in the lateral and/or vertical direction.

Result: The lateral extent of contamination at CAS 04-23-01 was defined. The extent of COC contamination is displayed in Figure B.1-1.

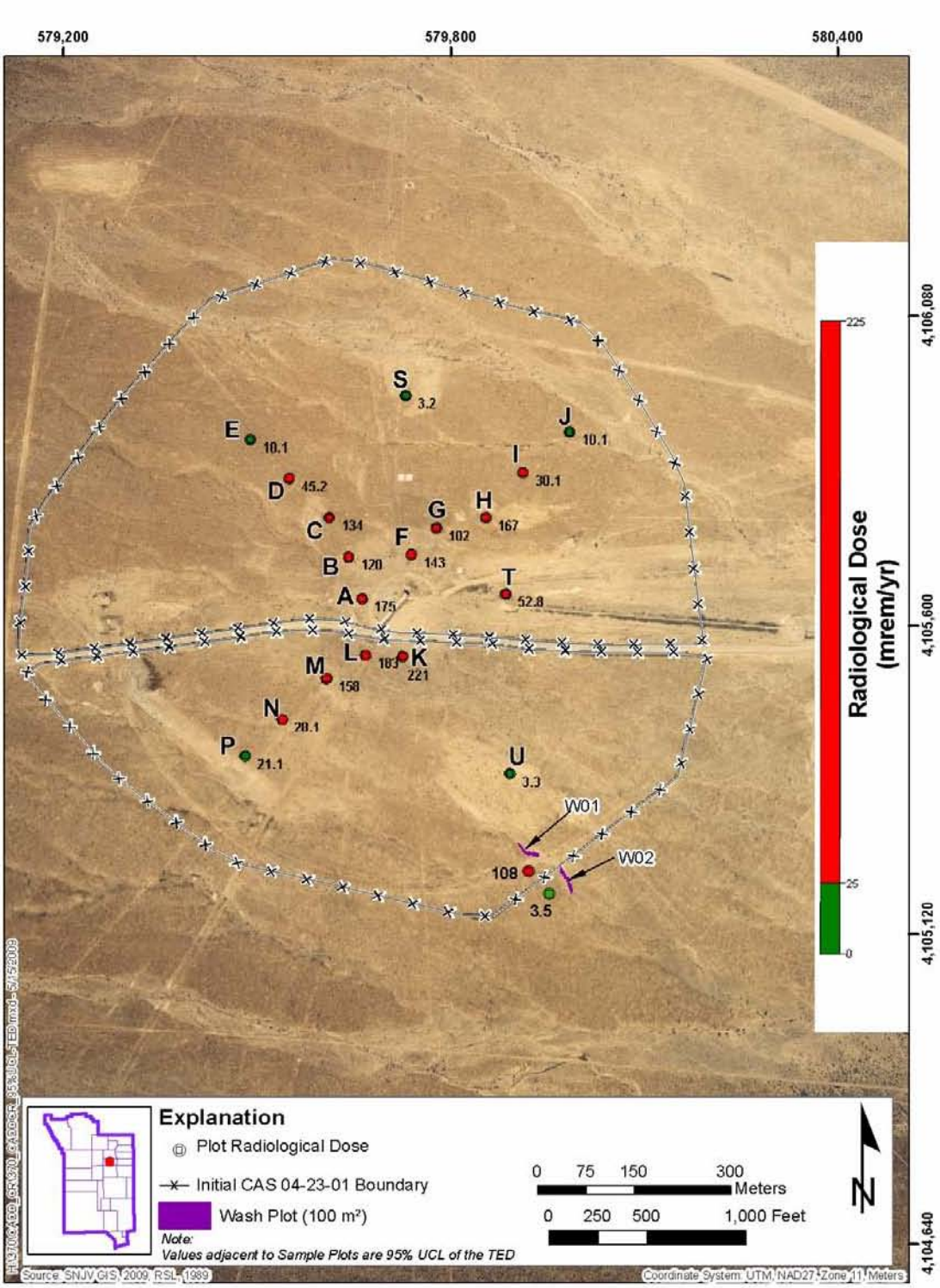

Figure B.1-1
Values for the 95 percent UCL of the TEDE at CAS 04-23-01, Atmospheric Test Site T-4

B.2.0 References

EPA, see U.S. Environmental Protection Agency.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

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Appendix C

Risk Assessment

C.1.0 Risk Assessment

The RBCA process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2006a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2006b) requires the use of ASTM Method E 1739-95 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary."

The evaluation of the need for corrective action will include the potential for wastes that are present at a site to cause the future contamination of site environmental media if the wastes were to be released.

This section contains documentation of the RBCA process used to establish FALs described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). This process defines three tiers (or levels) to establish FALs used to evaluate DQO decisions:

- Tier 1 – Sample results from source areas (highest concentrations) compared to risk-based screening levels (RBSLs) (i.e., PALs) based on generic (non-site-specific) conditions.
- Tier 2 – Sample results from exposure points compared to SSTLs calculated using site-specific inputs and Tier 1 formulas.
- Tier 3 – Sample results from exposure points compared to SSTLs and points of compliance calculated using chemical fate/transport and probabilistic modeling.

The process of establishing FALs in this appendix will address only contaminants associated with the other releases because the FAL for the annular distribution releases was established in the CAU 370 CAIP as 25 mrem/yr.

The RBCA decision process stipulated in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) is summarized in Figure C.1-1.

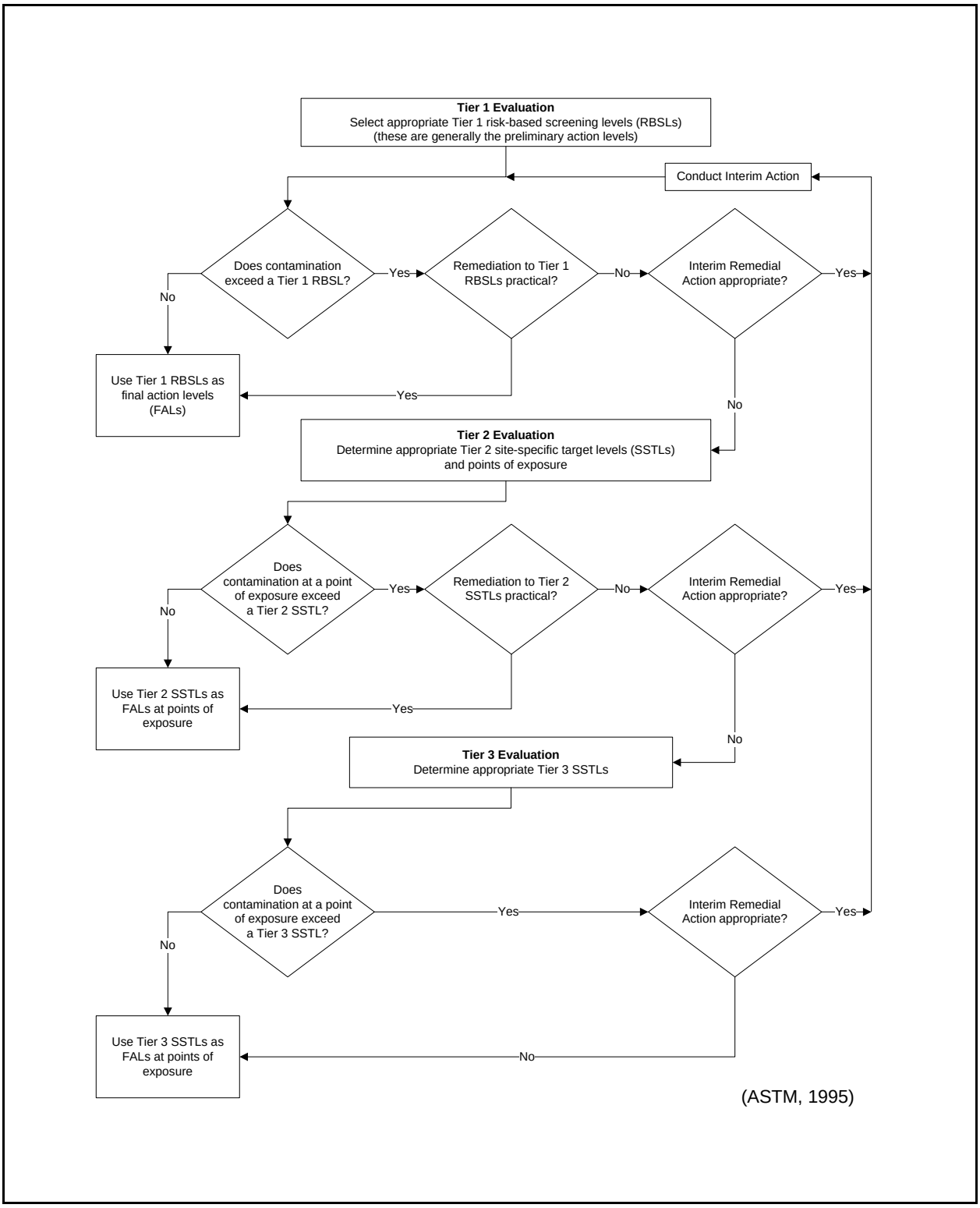

Figure C.1-1
Risk-Based Corrective Action Decision Process

C.1.1 A. Scenario

Corrective Action Unit 370, T-4 Atmospheric Test Site, consists of CAS 04-23-01, Atmospheric Test Site T-4, within Area 4 of the NTS.

Corrective Action Site 04-23-01 is located in the area around the T-4 bunker, and consists of contamination of the soil in and around the T-4 GZ, which was impacted by releases from atmospheric tower tests of four nuclear devices at the T-4 site conducted in the 1950s. The site includes remnants from the testing tower, the associated bunker and soil berm, pieces of metal and concrete debris, and the posted RMA from GZ that extends to the fences. However, this excludes the 4-04 Road, which divides the site. Several washes enter the area from the west/northwest, and continue through the site, while other smaller washes form on the site.

C.1.2 B. Site Assessment

The CAI at CAS 04-23-01 entailed visual inspections, radiological dose and walkover surveys, and soil sampling activities at the CAS. Surface soil samples were collected from randomly selected locations (probabilistic sampling approach) within judgmentally located plots for the annular distribution area. Additionally, a surface soil sample (and duplicate) was collected from one biased location identified as a potential release point (i.e., stained soil). The inner four sample plots on each of the three vectors and the sample plot at the east americium plume were determined to exceed the 25-mrem/yr-dose criteria.

No other contaminants were identified at the CAS. However, several lead objects (bricks, sheet, panels, and lead-acid batteries) were identified.

The maximum dose (i.e., 95 percent UCL of the TEDE) was determined as 220.5 mrem/yr for the sample plots for an industrial worker exposure scenario.

C.1.3 C. Site Classification and Initial Response Action

The four major site classifications listed in Table 3 of the ASTM Standard are (1) immediate threat to human health, safety, and the environment; (2) short-term (0 to 2 years) threat to human health, safety,

and the environment; (3) long-term (greater than 2 years) threat to human health, safety, or the environment; and (4) no demonstrated long-term threats.

Based on the CAI, CAS 04-23-01 does not present an immediate threat to human health, safety, and the environment; therefore, no interim response actions are necessary at this site. However, corrective actions are required at this site due to the presence of a radiological dose exceeding 25 mrem/yr, and PSM (i.e., lead). At CAS 04-23-01, the radiological dose within the identified area, and the presence of lead, was determined to pose a short-term threat to human health, safety, or the environment. Thus, the CAS has been determined to be Classification 2 site as defined by ASTM Method E 1739-95.

C.1.4 D. Development of Tier 1 Lookup Table of Risk-Based Screening Levels

Tier 1 action levels have been defined as the PALs established during the DQO process. The chemical PALs are a tabulation of chemical-specific (but not site-specific) screening levels based on the type of media (soil) and potential exposure scenarios (industrial). These are very conservative estimates of risk, are preliminary in nature, and are used as action levels for site screening purposes. Although the PALs are not intended to be used as FALs, a FAL may be defined as the Tier 1 action level (i.e., PAL) value if individual contaminant analytical results are below the corresponding Tier 1 action level value. The FAL may also be established as the Tier 1 action level value if individual contaminant analytical results exceed the corresponding Tier 1 action level value and implementing a corrective action based on the Tier 1 action level is practical. The PALs are defined as:

- The EPA Region 9 Risk-Based PRGs for Industrial Soils (EPA, 2004).
- Background concentrations for RCRA metals will be evaluated when natural background exceeds the PAL, as is often the case with arsenic. Background is considered the mean plus two times the standard deviation of the mean based on data published in Mineral and Energy Resource Assessment of the Nellis Air Force Range (NBMG, 1998; Moore, 1999).
- The TPH concentrations above the action level of 100 mg/kg per NAC 445A.2272 (NAC, 2006c).
- For COPCs without established PRGs, a protocol similar to EPA Region 9 will be used to establish an action level; otherwise, an established PRG from another EPA region may be chosen.

The PALs were developed based on an industrial scenario. Because CAS 04-23-01 in Area 4 is not an assigned work station, and is considered to be in remote or occasional use areas, use of the industrial scenario based PALs is conservative. The Tier 1 lookup table is defined as the PAL concentrations or activities defined in the CAU 370 CAIP (NNSA/NSO, 2008).

C.1.5 E. Exposure Pathway Evaluation

The DQOs stated that site workers would be exposed to COCs through oral ingestion, inhalation, dermal contact (absorption) of soil or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials at the CAS. Lead objects are present in several areas of the site. The potential exposure pathways would be through worker contact with the contaminated soil and debris and exposure to radiation from radioactive materials at the CAS. The depth to groundwater and chemical limitations on vertical migration (i.e., very low solubility and/or high sorption) of the lead supports the selection and evaluation of only surface contact as the complete exposure pathways. Groundwater is not considered to be a significant exposure pathway.

C.1.6 F. Comparison of Site Conditions with Tier 1 Risk-Based Screening Levels

For each sample plot, the radiological dose, calculated as the TEDE, was used to compare to the FAL (25-mrem/yr dose). The TEDE was calculated as the sum of separate internal and external dose estimates. Each internal dose was estimated from the laboratory analytical results of the soil fraction using the RESRAD computer code (Attachment 1). The external gamma pathway in RESRAD was turned off so that only the internal dose pathways (i.e., inhalation and ingestion) were considered.

All analytical results from CAU 370 samples were less than corresponding Tier 1 action levels (i.e., PALs) except for the presence of lead objects.

C.1.7 G. Evaluation of Tier 1 Results

For all contaminants, the FALs were established as the Tier 1 RBSLs. It was determined that no further action is required at this CAS for contaminants other than lead.

It was determined that corrective actions for lead based on Tier 1 RBSLs is appropriate and feasible. Therefore, a Tier 2 SSTL will not be calculated for this contaminant at CAS 04-23-01.

C.1.8 H. Tier 1 Remedial Action Evaluation

Lead Evaluation

Corrective action alternatives were evaluated (see Appendix E) for the lead contamination at CAS 04-23-01 based on Tier 1 action levels. It was determined that a corrective action of closure in place with a use restriction should be implemented.

C.2.0 Recommendations

Lead, in the form of lead bricks, a lead sheet, lead-acid batteries, and lead panels were removed from the site. The soil in contact with the lead objects is considered to be contaminated with lead. Lead shielding is indicated inside the T-4 bunker, and lead objects are indicated in subsurface soil for a use restricted area for CAU 357; both were identified as PSM. The presence of lead contaminated soil and possible lead shielding inside the T-4 bunker warrants corrective action.

C.3.0 References

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NBMG, see Nevada Bureau of Mines and Geology.

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Attachment 1

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at Corrective Action Unit (CAU) 370, CAS 04-23-01, Atmospheric Test Site T-4, Nevada Test Site, Nevada

(14 Pages)

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at Corrective Action Unit (CAU) 370, Corrective Action Site (CAS) 04-23-01, Atmospheric Test Site T-4, Nevada Test Site, Nevada

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Environmental Restoration Division,
Las Vegas, Nevada**

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at Corrective Action Unit (CAU) 370, Corrective Action Site (CAS) 04-23-01, Atmospheric Test Site T-4, Nevada Test Site, Nevada

1.0 Introduction

The U.S. Department of Energy (DOE), the U.S. and the National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Environmental Restoration Division have numerous sites impacted from the development, testing, and production of nuclear weapons. These impacts can take the form of chemical and/or radiological contaminants. Similar to its approach for chemical contamination, the NNSA/NSO is committed to properly evaluating, radiologically characterizing, and where appropriate, managing these sites to ensure the doses to radiation workers and members of the public are maintained as-low-as-reasonably achievable; at a minimum, below the basic dose limits as stated in DOE Order 5400.5 (DOE, 1993).

To accomplish this, the potential for residual radioactive contamination in soils must be evaluated to determine the status of compliance with the requirements of DOE Order 5400.5 (DOE, 1993). The DOE Order 5400.5 requires that: "The Authorized Limits shall be established to (1) provide that, at a minimum, the basic dose limits … will not be exceeded, or (2) be consistent with applicable generic guidelines." The basic dose limit is 100 millirem per year (mrem/yr), with a dose constraint at CAU 370 (established with stakeholders) of 25 mrem to a receptor under a modified "Industrial Access" exposure scenario. In the modified site evaluation approach that was used at CAU 370, the dose constraint is also the final action level (FAL).

Because generic guidelines have not been established for volumetric residual radioactivity for the radionuclides of concern at CAU 370 CAS 04-23-01, Residual Radioactive Material Guidelines (RRMG) were derived using the Residual Radioactive (RESRAD) model and computer code, version 6.4 (Yu et al., 2001). The goal of this effort was to produce guidelines for soil sample results, in units of picocuries per gram (pCi/g) that would result in a committed effective dose (CED [or internal dose]) that is less than the dose constraint.

The effective dose (i.e., "external dose") was evaluated separately and added to the internal dose to formulate the total effective dose (TED). Decisions at CAU 370 are based upon the TED and its comparison to the dose constraint.

To develop the RRMGs, a "realistic" yet conservative analysis was conducted using an approved exposure scenario and site-specific assumptions to establish a translation between surface soil concentrations and the resultant internal radiation doses. For this analysis, site-specific data included soil sampling results obtained during site investigation activities at CAU 370 CAS 04-23-01, and meteorological data obtained from the Air Resources Laboratory/Special Operations and Research Division. This report provides the modeling and analysis that supports the derivation of the RRMGs for CAU 370 CAS 04-23-01, Atmospheric test Site T-4. This report also presents the radionuclides considered, the approved exposure scenarios for the NTS, identifies the applicable exposure pathways and key input data or assumptions, and presents the radiation doses for unit concentrations of radionuclides in soil (ARL/SORD, 2007).

2.0 Site Closure Activities and Sample Results

Radionuclides from anthropogenic activities were found in the soil samples. The internal dose calculations are based on validated analytical sample results obtained during site investigation activities and other applicable information specified in the CAU 370 CAIP (NNSA/NSO, 2008).

The sampling plan for CAU 370 consisted of a mixture of randomized, random-start systematic, and biased sampling. A total of 77 composite surface-soil samples were collected from within CAS 04-23-01, at 20 locations. Three of these samples were biased samples used in the investigation of three known americium (Am)-241 plumes. Two samples were biased samples used in the investigation of two small areas of elevated activity in a wash. One additional sample (not a composite) and a duplicate sample were biased and used to investigate a small area for possible chemical contamination. Because CAU 370 utilized a modified site evaluation approach, only internal doses were calculated for each of the 78 surface soil samples.

Appendix A of the CAU 370 Corrective Action Decision Document/Closure Report contains a detailed description of the sample results, analytical parameters, and laboratory methods used to analyze the soil samples. The maximum concentrations (including background) found at CAS 04-23-01 are listed in Table 2-1.

Table 2-1
Maximum Radionuclide Results Found in CAU 370, CAS 04-23-01, Soil Samples

Radionuclide	Sample Number	Concentration (pCi/g)
Americium-241	370L004	376
Cesium-137	370L004	254
Cobalt-60	370L003	1.39
Europium-152	370A004	96
Europium-154	370A004	3.76
Plutonium-238	370L004	394
Plutonium-239/240	370L004	1450
Strontium-90	370L001	27.9
Thorium-232[a]	370I003	2.17
Uranium-234	370L002	2.15
Uranium-235	370P002	0.11
Uranium-238	370L002	1.52

[a]Thorium-232 is considered to be in equilibrium with its daughter-product, actinium-228.

pCi/g = Picocuries per gram

3.0 Initial Concentrations for Principal Radionuclides

Principal radionuclides are defined as radionuclides with a half-life greater than six months. The decay products of any principal radionuclide down to, but not including, the next principal radionuclide in its decay chain are defined as associated radionuclides. The RESRAD code assumes that a principal radionuclide is in secular equilibrium with its associated radionuclides at the point of exposure. Therefore, associated radionuclides and radionuclides with half-lives less than six months are not input into the RESRAD calculations.

3.1 Authorized Values for Initial Concentrations of Principal Radionuclides

Corrective Action Unit 370 utilized a modified site evaluation approach, where the CED or "internal dose" was calculated for each of the 78 surface soil samples. The initial concentration of the principal radionuclides was set at the reported value for each radionuclide, and internal dose was determined 78 times through the application of RRMGs which were determined through use of the RESRAD code. Only data that represented analytical "detects" were used.

3.2 Authorized Values Initial Concentrations of Principal Radionuclides for Area Averaging/Location Specific Scenarios

The DOE Order 5400.5 (DOE, 1993) states: "Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m^2" (5400.5, IV, 4.a.). DOE Order 5400.5 also states: "If the average concentration of any surface or below-surface area less than or equal to 25 square meters (m^2), exceeds the limit or guideline by a factor of $(100/A)^{0.5}$, [where A is the area (in square meters) of the region in which concentrations are elevated], limits for "hot-spots" shall also be developed and applied" (5400.5, IV, 4.a.(1)).

Evaluation of internal dose at CAU 370 was performed under a modified "Industrial Access" exposure scenario. One of the modifications to the scenario was to set the "area of the contaminated zone" to 100m^2. One of the reasons for this was to ensure that dose was evaluated over and area that was consistent with DOE Order 5400.5. This area was also reasonable in regards to the field of view of the RIDP *in situ* gamma spectroscopy measurements. Because each sample plot was evaluated over a 100-m^2 area, consideration of "hot spots" and the need for averaging was eliminated.

3.3 Inhomogeneous Contamination and Initial Radionuclide Concentrations

The modified site evaluation approach at CAU 370 estimated the internal dose for four separate samples taken at each of the sample plot locations. Each of the four separate samples was a composite sample. A composite sample was comprised of nine sample aliquots that were collected over a random-start systematic pattern within the 100-m^2 sample plot. The use of composite samples served to "mechanically average" the soil and ensured that the sample results more closely represented the typical conditions within each plot. Because the size of the plot to be evaluated was relatively small (i.e., 100 m^2 vs. thousands of m^2 in a typical RESRAD dose evaluation), and because each composite sample was evaluated separately, inhomogeneous contamination was not a significant consideration.

3.4 Initial Concentrations of Principal Radionuclide for CAU 370, CAS 04-23-01

The radionuclide concentrations used for the RESRAD calculations are listed in Appendix F.

4.0 Authorized RESRAD Exposure Pathways and Scenarios

This section describes the input parameters, exposures scenarios, and guidance for calculating the RRMGs for CAU370 using the RESRAD computer code, as agreed to by NNSA/NSO and Nevada Division of Environmental Protection (NDEP).

4.1 Guidance for RESRAD Calculations

The guidance in this section was developed by NNSA/NSO and NDEP and is only applicable to soils containing residual radioactive material. This guidance does not apply to structures, facilities, equipment, and building materials containing contaminated surfaces or volume contamination. The primary dose limit for any member of the public is 100-millirem (mrem) total effective dose (TED) in a year. This limit applies to the sum of internal and external doses resulting from all modes of exposure to all radiation sources other than background radiation and doses received as a patient from medical sources as required by DOE 5400.5, II.1.a.(3)(a) (DOE, 1993). The dose constraint is defined as one quarter of the dose limit (i.e., 25 mrem/yr) and will be applied to ensure that, in a 1,000-year period, the maximally exposed individual does not exceed the dose constraint in any single year.

Background radiation refers to the local area and includes:

Concentration of naturally occurring radionuclides.

Cosmic radiation.

Radionuclides of anthropogenic origin that have been globally dispersed and are present at low concentrations such as fallout from nuclear weapons. (Note: This is not the case at the NTS because the historical aspects of the NTS [e.g., above and underground testing, and other operations resulted in dispersion of radionuclides locally].)

Due to the impracticality of determining and validating a "true" background data set at the NTS, RRMGs with no background subtraction will be used (i.e., the sample plot analytical results will not be reduced by the subtraction of background values). The use of RRMGs with no background subtraction is a conservative approach because it will slightly over estimate the internal dose radioactive contamination present as a result of NTS activities.

4.2 Description of Approved Scenarios

Detailed description for each scenario can be found in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). These scenarios were modified by selecting specific values for some RESRAD input parameters, as described in Table 5-1.

4.3 Residual Radioactive Material Guideline

The residual radioactive material guidelines at CAU 370 represent the concentrations of residual radioactive material that would result in an internal dose of 25 mrem/yr to a receptor under the Industrial Access exposure scenario. Using site-specific parameters and sample analysis results,

the RRMG can be calculated for a given dose limit of H_{EL} for an individual as follows;

$$RRMG = \frac{H_{EL}}{DSR}$$

where DSR is the total dose/source concentration ratio. The dose constraint (H_{EL}), used to derive the residual radioactive material guideline, is 25 mrem/yr.

Single radionuclide guidelines are calculated for individual radionuclides such that the annual dose to a receptor at the site should not exceed an annual dose constraint of 25 mrem/yr. Sites contaminated with two or more radionuclides (i.e., a mixture of radionuclides) require further evaluation to ensure that collective exposures from individual radionuclides do not exceed the 25-mrem/yr-dose constraint. This evaluation is performed using a "sum of the fractions" method. The initial soil concentration of each radionuclide is divided by the single radionuclide guideline for that radionuclide to produce a ratio. These ratios are then summed, with the summed value referred to as the sum of the fractions or SoF.

If the SoF for a soil sample is less than or equal to unity (1), then the collective annual internal dose from all radionuclides at the site should not exceed the 25 mrem/yr annual dose constraint. To determine the numerical value of the internal dose for a sample, the SoF is multiplied by 25 to yield a product in terms of mrem/yr. The calculations are presented in Section 5.4.

5.0 RESRAD Calculations for CAU 370 CAS 04-23-01, Atmospheric Test Site T-4

This section discuses the RESRAD calculations and results for CAU 370 CAS 04-23-01. The modified Industrial Access scenario was selected as the exposure scenario because of the past operational history of the CAS, potential future use of the area surrounding the CAS, and because it is the limiting (conservative) of the three exposure scenarios.

5.1 User Input Parameters

The key RESRAD parameters used in the calculations for CAU 370, CAS 04-23-01 in this report are presented in Table 5-1, "RESRAD Parameter Input Values for CAU 370 CAS 04-23-01". The initial radionuclide concentrations used for analyses are those listed in Appendix A.

5.2 Radionuclide Concentrations and Dose Estimates

The maximum internal dose results calculated from the RRMGs derived by RESRAD (Section 5.4) for the 78 surface soil samples at CAU 370, CAS 04-23-01 is 9.6 mrem/yr, occurring at year zero (current year).

Uncertainty in the derivation of dose estimates and dose/source contribution ratios comes from the distribution of possible input parameter values, as well as uncertainty in the conceptual model used to represent the site. The pathway contributing to the total annual dose at the time of maximum dose occurs are inhalation (84 percent) and soil ingestion (16 percent). Therefore, uncertainties in the following parameters: soil disturbance (e.g., erosion rates), thickness of contaminated zone, and occupancy factors have the greatest significance on the model predictions.

5.3 Residual Radioactive Material Guidelines for CAU 370 CAS 04-23-01

Table 5-2 presents the RRMGs for radionuclides at CAU 370.

5.4 Derivation of the CED from the RRMG

The CED values for each sample, and the average for each plot, are listed in Table 5-3. For each soil sample, the radionuclide-specific analytical result (Appendix F) was divided by the RRMG (Table 5-2) for that radionuclide to yield a fraction (i.e., Am-241 fraction column, Cs-137 fraction column," Co-60 fraction column,). The fractions for all radionuclides detected in a soil sample were summed to yield a total fraction for that sample ("Sum of Fractions" column). The total fraction was then multiplied by 25 to yield an internal dose estimate, in mrem/year, at that sample location ("Multiplied by 25 mrem/yr" column). All samples in a sample plot were then averaged to generate an estimate for the plot ("Plot Ave" column).

The detailed RESRAD results for this CAS are provided in Exhibit 1, RESRAD Summary Report: CAU 370 CAS 04-23-01. The internal dose results for the 78 soil samples are presented in Section A.3.1.1.

Table 5-1
RESRAD Parameters Input Values for CAU 370 CAS 04-23-01

Parameter	Units	CAU 370 CAS 04-23-01	Defaults	Reference/Rationale
Area of CZ	m^2	1.000E+02	1.000E+04	Matches DOE Order 5400.5 and is a reasonable match for RIDP measurements.
Thickness of CZ	m	5.000E-02	2.000E+00	At NTS, bulk of contamination is bound-up in the top 5 cm of soil
Principal radionuclides	pCi/g	See Table 2-2	0.0	
Average Annual Wind Speed	m/sec	4.07	2.000E+00	NNSA/NSO, 2007
Precipitation	m/yr	1.626E-01	1.000E+00	Data from Air Resources Laboratory
Runoff Coefficient	-	4.000E-01	2.000E-01	Open Sandy Loam 30% impervious Table 10.1 (Yu, 1993)
Mass Loading for Inhalation	g/m^3	6.00E-04	1E-04	The estimated mass loading for construction activities. (Yu, 1993)
Exposure Duration	yr	25	30	Standard for Industrial/Commercial Scenario
Shielding Factor Inhalation	-	1.0	0.4	Assumes no indoor time fraction
Shielding Factor External Gamma	-	not used	0.7	Pathway disabled, external dose determined separately
Fraction of Time Spent Indoors	-	0.0	0.5	Assumes no indoor time fraction
Fraction of Time Spent Outdoors	-	8.55E-02	0.25	NNSA/NSO, 2006
Soil Ingestion Rate	g/yr	108	36.5	NNSA/NSO, 2006

CZ = Contaminated Zone
g/m^3 = Grams per cubic meter
g/yr = Grams per year
m = Meter
m^2 = Square meter
m/sec = Meters per second
m/yr = Meters per year pCi/g = Picocuries per gram
RESRAD = Residual Radioactive
yr = Year
- = Unitless

Table 5-2
Residual Radioactive Material Guidelines for CAU 370

Radionuclide	RRMG (pCi/g)
Americium-241	5.627E+03
Cobalt-60	2.701E+06
Cesium-137	1.634E+06
Europium-152	6.990E+06
Europium-154	5.093E+06
Europium-155	3.417E+07
Plutonium-238	6.299E+03
Plutonium-239/240	5.718E+03
Strontium-90	4.517E+05
Thorium-232	1.856E+03
Uranium-234	2.288E+04
Uranium-235	2.452E+04
Uranium-238	2.546E+04

pCi/g = picocuries per gram

Table 5-3
Radionuclide Fractions, and Sample and Plot-Average CEDs, CAU 370, T-4 Atmospheric Test Site

Sample Number	Am-241 Fraction	Cs-137 Fraction	Co-60 Fraction	Eu-152 Fraction	Eu-154 Fraction	Pu-238 Fraction	Pu-239/240 Fraction	Sr-90 Fraction	Th-232 Fraction	U-234 Fraction	U-235 Fraction	U-238 Fraction	Sum of Fractions	Multiplied by 25 mrem/yr	Plot Average
370A001	0.011587	5.81E-05	4.15E-07	1.29E-05	6.32E-07	0.015082	0.059636	2.9E-05	0.00062	3.63E-05	0	3.77E-05	0.0871	2.17749112	--
370A002	0.007784	5.51E-05	3.96E-07	1.29E-05	6.87E-07	0.010525	0.040574	3.23E-05	0.001169	4.9E-05	0	3.1E-05	0.060234	1.50583821	--
370A003	0.014395	5.51E-05	3.74E-07	1.2E-05	5.42E-07	0.017304	0.066107	2.46E-05	0.000598	5.42E-05	0	3.65E-05	0.098588	2.4646897	--
370A004	0.010254	5.25E-05	3.7E-07	1.37E-05	7.38E-07	0.011113	0.044246	2.26E-05	0.00069	5.24E-05	0	3.89E-05	0.066484	1.66210418	1.953
370B001	0.007215	4.51E-05	2.03E-07	4.62E-06	2.45E-07	0.00916	0.039175	1.22E-05	0.000894	4.59E-05	0	2.79E-05	0.05658	1.41451145	--
370B002	0.01196	5.18E-05	2.2E-07	4.84E-06	2.47E-07	0.015241	0.066632	1.17E-05	0.000787	5.46E-05	0	3.89E-05	0.094781	2.36953406	--
370B003	0.007091	4.86E-05	2.19E-07	5.41E-06	2.93E-07	0.010097	0.043896	1.97E-05	0.0007	4.94E-05	0	3.81E-05	0.061946	1.54865633	--
370B004	0.00439	4.08E-05	2.01E-07	5.36E-06	3.4E-07	0.007112	0.03148	1.48E-05	0.000706	5.11E-05	0	3.77E-05	0.043838	1.09593872	1.607
370C001	0.003696	3.67E-05	2.34E-07	8.34E-06	4.73E-07	0.006747	0.033578	5.98E-06	0.000819	6.82E-05	0	3.69E-05	0.044998	1.12493884	--
370C002	0.003377	3.49E-05	2.15E-07	8.64E-06	4.14E-07	0.006858	0.03148	7.31E-06	0.000981	5.46E-05	0	4.63E-05	0.042847	1.07118477	--
370C003	0.003146	3.08E-05	2.37E-07	8.73E-06	3.97E-07	0.00516	0.024309	5.56E-06	0.000889	6.21E-05	0	4.48E-05	0.033656	0.84139764	--
370C004	0.00981	4.9E-05	2.63E-07	8.21E-06	3.75E-07	0.014605	0.061035	7.04E-06	0.000609	6.12E-05	0	3.5E-05	0.08622	2.15551241	1.298
370D001	0.000117	5.26E-06	5.66E-08	2.73E-06	1.83E-07	0.000273	0.002169	2.63E-06	0.000954	4.68E-05	0	3.81E-05	0.003608	0.09020848	--
370D002	0.000121	6.24E-06	6.7E-08	2.82E-06	0	0.000356	0.002851	0	0.000954	4.28E-05	0	3.97E-05	0.004372	0.10930997	--
370D003	0.000316	6.3E-06	7.15E-08	2.89E-06	1.88E-07	0.000803	0.006418	3.34E-06	0.001153	5.16E-05	0	3.93E-05	0.008795	0.21986566	--
370D004	0.000359	7.47E-06	6.29E-08	2.66E-06	2.65E-07	0.001032	0.00787	3.08E-06	0.000754	5.59E-05	0	3.57E-05	0.01012	0.25300768	--
370D005	0.000162	6.06E-06	5.66E-08	2.73E-06	1.85E-07	0.000584	0.004687	0	0.00104	3.8E-05	0	3.42E-05	0.006554	0.16384981	0.167
370E001	0.000121	3.1E-06	0	8.67E-07	0	0.000267	0.001976	0	0.000894	4.2E-05	0	3.34E-05	0.003337	0.08343701	--
370E002	8E-05	3.41E-06	0	8.14E-07	0	0.000221	0.001714	0	0.000873	4.15E-05	0	3.46E-05	0.002968	0.07419216	--
370E003	9.42E-05	3.44E-06	0	8.3E-07	0	0.0002	0.001591	0	0.000889	4.55E-05	0	4.2E-05	0.002866	0.07166113	--
370E004	0.000117	3.63E-06	0	8.54E-07	0	0.000389	0.00313	0	0.000959	4.2E-05	0	3.65E-05	0.004679	0.11696821	0.087
370F001	0.009739	4.58E-05	3.37E-07	1.05E-05	5.54E-07	0.011907	0.04547	9.3E-06	0.000932	4.85E-05	0	3.89E-05	0.068202	1.70504807	--
370F002	0.004549	3.27E-05	2.89E-07	1.14E-05	6.81E-07	0.006572	0.026233	6.64E-06	0.000819	4.94E-05	0	3.3E-05	0.038308	0.95769958	--
370F003	0.011463	4.61E-05	3.15E-07	1.03E-05	4.69E-07	0.012065	0.04582	9.52E-06	0.000824	4.37E-05	0	4.05E-05	0.070323	1.7580859	--
370F004	0.005367	4.32E-05	3.07E-07	1.01E-05	3.83E-07	0.008144	0.03148	7.53E-06	0.000706	4.76E-05	0	3.34E-05	0.045839	1.14597701	1.392
370G001	0.007357	7.28E-05	4.18E-07	1.12E-05	6.52E-07	0.01397	0.089542	2.08E-05	0.000603	9.31E-05	0	4.44E-05	0.111717	2.79291258	--

Table 5-3
Radionuclide Fractions, and Sample and Plot-Average CEDs, CAU 370, T-4 Atmospheric Test Site (Continued)

Sample Number	Am-241 Fraction	Cs-137 Fraction	Co-60 Fraction	Eu-152 Fraction	Eu-154 Fraction	Pu-238 Fraction	Pu-239/240 Fraction	Sr-90 Fraction	Th-232 Fraction	U-234 Fraction	U-235 Fraction	U-238 Fraction	Sum of Fractions	Multiplied by 25 mrem/yr	Plot Average
370G002	0.010627	7.28E-05	3.63E-07	8.34E-06	4.44E-07	0.014605	0.061035	1.31E-05	0.000749	4.9E-05	0	3.34E-05	0.087194	2.1798612	--
370G003	0.012618	6.43E-05	3.63E-07	1.17E-05	7.25E-07	0.014605	0.062959	1.08E-05	0.000776	6.99E-05	0	4.12E-05	0.091157	2.27893054	--
370G004	0.012085	6E-05	3.11E-07	8.54E-06	5.52E-07	0.016034	0.067856	1.15E-05	0.000787	6.12E-05	0	4.16E-05	0.096945	2.42362822	2.419
370H001	0.001351	3.06E-05	1.94E-07	7.24E-06	3.63E-07	0.002651	0.023085	5.73E-06	0.000986	7.26E-05	0	3.34E-05	0.028223	0.7055725	--
370H002	0.000738	2.56E-05	1.75E-07	8E-06	4.46E-07	0.001349	0.014865	0	0.001158	5.51E-05	0	4.28E-05	0.018243	0.45607055	--
370H003	0.00105	2.34E-05	1.72E-07	7.67E-06	4.34E-07	0.002127	0.018188	7.75E-06	0.000884	5.29E-05	0	3.53E-05	0.022377	0.55942774	--
370H004	0.002399	3.43E-05	2.33E-07	7.22E-06	4.38E-07	0.004302	0.039874	5.89E-06	0.000711	9.09E-05	0	4.75E-05	0.047473	1.18682992	0.727
370I001	0.000171	3.54E-06	0	2.26E-06	0	0.000445	0.002798	0	0.001045	5.03E-05	0	3.69E-05	0.004552	0.11378869	--
370I002	0.000108	3.05E-06	4.37E-08	2.25E-06	0	0.000464	0.00327	0	0.001072	4.24E-05	0	3.65E-05	0.004999	0.12497027	--
370I003	0.000142	4.08E-06	3.89E-08	2.43E-06	1.85E-07	0.000373	0.003026	0	0.001169	5.11E-05	0	4.4E-05	0.004812	0.12029549	--
370I004	0.000121	3.29E-06	0	2.33E-06	1.47E-07	0.000295	0.002623	0	0.001105	4.68E-05	0	4.12E-05	0.004238	0.1059431	--
370I005	0.000165	3.84E-06	0	2.33E-06	0	0.000491	0.003323	0	0.001094	5.2E-05	0	4.44E-05	0.005175	0.12937454	0.119
370J001	0.00013	2.05E-06	0	5.01E-07	0	0.000246	0.001889	0	0.000722	3.41E-05	0	2.83E-05	0.003051	0.07628697	--
370J002	0.00011	3.98E-06	0	5.74E-07	0	0.000256	0.002029	0	0.000781	3.32E-05	3.47E-06	2.63E-05	0.003243	0.08108169	--
370J003	7.46E-05	2.39E-06	0	5.54E-07	0	0.000159	0.001749	0	0.000808	3.8E-05	2.45E-06	3.3E-05	0.002867	0.07167133	--
370J004	4.28E-05	2.04E-06	0	5.18E-07	0	0.000148	0.001002	0	0.000846	3.67E-05	0	3.1E-05	0.002109	0.05271934	0.070
370K001	0.01013	5.51E-05	2.48E-07	8.44E-06	4.46E-07	0.013177	0.062784	2.28E-05	0.000862	8E-05	0	3.73E-05	0.087157	2.17892496	--
370K002	0.010485	6.98E-05	2.92E-07	7.95E-06	4.3E-07	0.013494	0.060511	3.5E-05	0.000603	6.77E-05	0	3.5E-05	0.08531	2.13274018	--
370K003	0.012262	7.22E-05	3E-07	8.21E-06	4.54E-07	0.015399	0.072053	5.22E-05	0.00056	5.77E-05	0	4.08E-05	0.100507	2.51267638	--
370K004	0.009454	5.75E-05	2.67E-07	8.28E-06	3.46E-07	0.010319	0.049318	2.06E-05	0.000722	7.12E-05	0	4.4E-05	0.070016	1.75039211	2.144
370L001	0.034832	0.000133	4.48E-07	4.58E-06	2.63E-07	0.036196	0.160895	6.18E-05	0.000776	6.12E-05	0	4.56E-05	0.233007	5.82516956	--
370L002	0.032877	0.000151	4.81E-07	4.51E-06	4.36E-07	0.039371	0.162644	4.85E-05	0.0007	9.4E-05	0	5.97E-05	0.235951	5.89878421	--
370L003	0.030922	0.000152	5.15E-07	4.89E-06	0	0.040006	0.159147	5.76E-05	0.000814	6.21E-05	0	4.01E-05	0.231206	5.78014224	--
370L004	0.066821	0.000155	4.89E-07	4.15E-06	3.36E-07	0.06255	0.253585	5.53E-05	0.000916	8.96E-05	0	5.73E-05	0.384234	9.6058531	6.777
370M001	0.032699	6.49E-05	3.3E-07	5.77E-06	2.36E-07	0.030799	0.131165	9.74E-06	0.000975	7.91E-05	0	2.47E-05	0.195823	4.89556946	--
370M002	0.014573	6.67E-05	3.26E-07	5.77E-06	2.91E-07	0.015399	0.0766	8.41E-06	0.000803	6.21E-05	0	3.69E-05	0.107555	2.68888408	--

Table 5-3
Radionuclide Fractions, and Sample and Plot-Average CEDs, CAU 370, T-4 Atmospheric Test Site (Continued)

Sample Number	Am-241 Fraction	Cs-137 Fraction	Co-60 Fraction	Eu-152 Fraction	Eu-154 Fraction	Pu-238 Fraction	Pu-239/240 Fraction	Sr-90 Fraction	Th-232 Fraction	U-234 Fraction	U-235 Fraction	U-238 Fraction	Sum of Fractions	Multiplied by 25 mrem/yr	Plot Average
370M003	0.018838	6.73E-05	3.15E-07	5.32E-06	5.99E-07	0.020479	0.09269	1.53E-05	0.000695	7.65E-05	0	3.93E-05	0.132907	3.32266441	--
370M004	0.024169	6.85E-05	3.18E-07	5.26E-06	3.34E-07	0.026195	0.120672	1.28E-05	0.000873	7.52E-05	0	3.3E-05	0.172104	4.30259238	--
370M005	0.013684	8.02E-05	3.89E-07	5.39E-06	3.34E-07	0.017146	0.073802	1.68E-05	0.000792	6.95E-05	0	3.06E-05	0.105627	2.64067247	3.570
370N001	0.000179	3.94E-06	5.37E-08	2.03E-06	1.51E-07	0.000397	0.002571	0	0.001029	3.28E-05	0	2.79E-05	0.004243	0.1060787	--
370N002	0.000208	4.99E-06	4.81E-08	1.97E-06	0	0.00041	0.003428	0	0.000964	3.58E-05	0	3.18E-05	0.005084	0.12710976	--
370N003	0.000146	4.11E-06	0	2.13E-06	0	0.000257	0.002256	0	0.000938	3.32E-05	0	2.71E-05	0.003663	0.09157514	--
370N004	0.000304	3.17E-06	4.89E-08	2.07E-06	1.55E-07	0.00053	0.003585	0	0.001002	4.06E-05	2.57E-06	3.3E-05	0.005503	0.13757793	0.116
370P001	9.06E-05	3.19E-06	0	7.11E-07	0	0.000246	0.001819	0	0.00104	4.24E-05	0	2.91E-05	0.003271	0.08176899	--
370P002	0.000123	1.98E-06	0	7.02E-07	0	0.000243	0.001714	0	0.001083	3.41E-05	4.49E-06	3.89E-05	0.003243	0.08106299	--
370P003	4.57E-05	1.08E-06	0	6.9E-07	0	0.000113	0.000817	0	0.001094	3.63E-05	0	3.26E-05	0.00214	0.05348768	--
370P004	0.000322	2.74E-06	0	6.91E-07	0	0.000443	0.002431	0	0.000932	4.06E-05	0	3.14E-05	0.004203	0.10507795	0.080
370S001	0.000197	8.69E-06	4E-08	9.81E-07	0	0.000845	0.006243	0	0.000851	4.55E-05	0	2.95E-05	0.008221	0.20553002	--
370S002	0.000195	9.18E-06	5E-08	9.79E-07	0	0.000773	0.006191	0	0.000932	3.98E-05	0	3.46E-05	0.008176	0.20440644	--
370S003	0.000293	7.1E-06	4.92E-08	1.08E-06	0	0.000984	0.006034	0	0.00097	4.68E-05	0	2.87E-05	0.008365	0.20911473	--
370S004	9.6E-05	7.28E-06	4.41E-08	1.09E-06	0	0.000483	0.003882	0	0.001013	4.68E-05	0	3.46E-05	0.005564	0.1390933	0.190
370T001	0.004709	5.81E-05	2.34E-07	1.07E-06	0	0.011272	0.045296	1.84E-05	0.000905	5.73E-05	0	3.93E-05	0.062356	1.55890364	--
370T002	0.012618	7.47E-05	2.52E-07	1.24E-06	0	0.017939	0.069255	2.24E-05	0.000916	6.6E-05	0	4.12E-05	0.100934	2.52334454	--
370T003	0.016883	8.14E-05	2.74E-07	1.06E-06	0	0.021908	0.08412	4.18E-05	0.000981	6.86E-05	0	4.83E-05	0.124134	3.10333887	--
370T004	0.034654	9.49E-05	3.44E-07	1.29E-06	0	0.034132	0.132914	2.1E-05	0.000981	8.48E-05	0	4.79E-05	0.202931	5.0732797	3.065
370U001	0.000387	8.51E-06	0	3.15E-07	0	0.000984	0.004949	3.1E-06	0.000916	4.11E-05	0	3.26E-05	0.007323	0.18306343	--
370U002	0.000754	1.22E-05	4.15E-08	4.32E-07	0	0.001778	0.008709	4.52E-06	0.000927	4.59E-05	0	3.38E-05	0.012265	0.30661332	--
370U003	0.000652	9.24E-06	0	3.56E-07	0	0.001492	0.007398	2.99E-06	0.000927	4.11E-05	0	3.81E-05	0.010561	0.26401744	--
370U004	0.000275	6.36E-06	0	2.98E-07	0	0.000665	0.00383	0	0.000894	3.85E-05	0	3.3E-05	0.005743	0.14357916	0.224
370W001	0.001759	4.72E-05	1.71E-07	1.3E-06	0	0.003445	0.043547	6.07E-06	0.000824	6.82E-05	0	4.28E-05	0.049741	1.24352828	--
370W002	0.000732	2.71E-05	8.66E-08	7.94E-07	0	0.00173	0.018188	4.49E-06	0.000803	5.11E-05	0	2.87E-05	0.021566	0.53914577	--
370X001	6.4E-05	1.23E-06	0	0	0	0.00014	0.000979	0	0	5.11E-05	0	5.46E-05	0.00129	0.03225018	--

6.0 References

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Exhibit 1

RESRAD Summary Report:
CAU 370 CAS 04-23-01

(33 Pages)

Summary : Soil Project 25 mrem Industrial Shallow Layer no External
File : C:\RESRAD_FAMILY\RESRAD\USERFILES\CAU 370 NO EXTERNAL.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	Ac-225 (Source: FGR 12)	6.371E-02	6.371E-02	DCF1(1)
A-1	Ac-227 (Source: FGR 12)	4.951E-04	4.951E-04	DCF1(2)
A-1	Ac-228 (Source: FGR 12)	5.978E+00	5.978E+00	DCF1(3)
A-1	Am-241 (Source: FGR 12)	4.372E-02	4.372E-02	DCF1(4)
A-1	At-217 (Source: FGR 12)	1.773E-03	1.773E-03	DCF1(5)
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(6)
A-1	Ba-137m (Source: FGR 12)	3.606E+00	3.606E+00	DCF1(7)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(8)
A-1	Bi-211 (Source: FGR 12)	2.559E-01	2.559E-01	DCF1(9)
A-1	Bi-212 (Source: FGR 12)	1.171E+00	1.171E+00	DCF1(10)
A-1	Bi-213 (Source: FGR 12)	7.660E-01	7.660E-01	DCF1(11)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(12)
A-1	Co-60 (Source: FGR 12)	1.622E+01	1.622E+01	DCF1(13)
A-1	Cs-137 (Source: FGR 12)	7.510E-04	7.510E-04	DCF1(14)
A-1	Eu-152 (Source: FGR 12)	7.006E+00	7.006E+00	DCF1(15)
A-1	Eu-154 (Source: FGR 12)	7.678E+00	7.678E+00	DCF1(16)
A-1	Eu-155 (Source: FGR 12)	1.822E-01	1.822E-01	DCF1(17)
A-1	Fr-221 (Source: FGR 12)	1.536E-01	1.536E-01	DCF1(18)
A-1	Fr-223 (Source: FGR 12)	1.980E-01	1.980E-01	DCF1(19)
A-1	Gd-152 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(20)
A-1	Np-237 (Source: FGR 12)	7.790E-02	7.790E-02	DCF1(21)
A-1	Pa-231 (Source: FGR 12)	1.906E-01	1.906E-01	DCF1(22)
A-1	Pa-233 (Source: FGR 12)	1.020E+00	1.020E+00	DCF1(23)
A-1	Pa-234 (Source: FGR 12)	1.155E+01	1.155E+01	DCF1(24)
A-1	Pa-234m (Source: FGR 12)	8.967E-02	8.967E-02	DCF1(25)
A-1	Pb-209 (Source: FGR 12)	7.734E-04	7.734E-04	DCF1(26)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(27)
A-1	Pb-211 (Source: FGR 12)	3.064E-01	3.064E-01	DCF1(28)
A-1	Pb-212 (Source: FGR 12)	7.043E-01	7.043E-01	DCF1(29)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(30)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(31)
A-1	Po-211 (Source: FGR 12)	4.764E-02	4.764E-02	DCF1(32)
A-1	Po-212 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(33)
A-1	Po-213 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(34)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(35)
A-1	Po-215 (Source: FGR 12)	1.016E-03	1.016E-03	DCF1(36)
A-1	Po-216 (Source: FGR 12)	1.042E-04	1.042E 04	DCF1(37)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(38)
A-1	Pu-238 (Source: FGR 12)	1.513E-04	1.513E-04	DCF1(39)
A-1	Pu-239 (Source: FGR 12)	2.952E-04	2.952E-04	DCF1(40)
A-1	Pu-240 (Source: FGR 12)	1.467E-04	1.467E-04	DCF1(41)
A-1	Ra-223 (Source: FGR 12)	6.034E-01	6.034E-01	DCF1(42)
A-1	Ra-224 (Source: FGR 12)	5.119E-02	5.119E-02	DCF1(43)
A-1	Ra-225 (Source: FGR 12)	1.102E-02	1.102E-02	DCF1(44)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(45)
A-1	Ra-228 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(46)
A-1	Rn-219 (Source: FGR 12)	3.083E-01	3.083E-01	DCF1(47)
A-1	Rn-220 (Source: FGR 12)	2.298E-03	2.298E-03	DCF1(48)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(49)

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	Sr-90 (Source: FGR 12)	7.043E-04	7.043E-04	DCF1(50)
A-1	Th-227 (Source: FGR 12)	5.212E-01	5.212E-01	DCF1(51)
A-1	Th-228 (Source: FGR 12)	7.940E-03	7.940E-03	DCF1(52)
A-1	Th-229 (Source: FGR 12)	3.213E-01	3.213E-01	DCF1(53)
A-1	Th-230 (Source: FGR 12)	1.209E-03	1.209E-03	DCF1(54)
A-1	Th-231 (Source: FGR 12)	3.643E-02	3.643E-02	DCF1(55)
A-1	Th-232 (Source: FGR 12)	5.212E-04	5.212E-04	DCF1(56)
A-1	Th-234 (Source: FGR 12)	2.410E-02	2.410E-02	DCF1(57)
A-1	Tl-207 (Source: FGR 12)	1.980E-02	1.980E-02	DCF1(58)
A-1	Tl-208 (Source: FGR 12)	2.298E+01	2.298E+01	DCF1(59)
A-1	Tl-209 (Source: FGR 12)	1.293E+01	1.293E+01	DCF1(60)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(61)
A-1	U-233 (Source: FGR 12)	1.397E-03	1.397E-03	DCF1(62)
A-1	U-234 (Source: FGR 12)	4.017E-04	4.017E-04	DCF1(63)
A-1	U-235 (Source: FGR 12)	7.211E-01	7.211E-01	DCF1(64)
A-1	U-236 (Source: FGR 12)	2.148E-04	2.148E-04	DCF1(65)
A 1	U-238 (Source: FGR 12)	1.031E-04	1.031E 04	DCF1(66)
A-1	Y-90 (Source: FGR 12)	2.391E-02	2.391E-02	DCF1(67)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.724E+00	6.700E+00	DCF2(1)
B-1	Am-241	4.440E-01	4.440E-01	DCF2(2)
B-1	Co-60	2.190E-04	2.190E-04	DCF2(3)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(4)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(5)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(7)
B-1	Eu-155	4.140E-05	4.140E-05	DCF2(8)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(9)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(10)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(11)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(12)
B-1	Pu 238	3.920E-01	3.920E 01	DCF2(13)

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-1	Am-241	3.640E-03	3.640E-03	DCF3(2)
D-1	Co-60	2.690E-05	2.690E-05	DCF3(3)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(4)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(5)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(7)
D-1	Eu-155	1.530E-06	1.530E-06	DCF3(8)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(9)
D-1	Np-237+D	4.444E-03	4.440E-03	DCF3(10)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(11)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(12)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(13)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(15)
D-1	Pu-240	3.540E-03	3.540E-03	DCF3(16)
D-1	Ra 226+D	1.321E-03	1.320E-03	DCF3(18)
D-1	Ra-228+D	1.442E-03	1.440E-03	DCF3(19)
D-1	Sr-90+D	1.528E-04	1.420E-04	DCF3(20)
D-1	Th-228+D	8.086E-04	3.960E-04	DCF3(21)
D-1	Th-229+D	4.027E-03	3.530E-03	DCF3(22)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(23)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(24)
D-1	U-233	2.890E-04	2.890E-04	DCF3(25)
D-1	U-234	2.830E-04	2.830E-04	DCF3(26)
D-1	U-235+D	2.673E-04	2.660E-04	DCF3(27)
D-1	U-236	2.690E-04	2.690E-04	DCF3(28)
D-1	U-238	2.550E-04	2.550E-04	DCF3(29)
D-1	U-238+D	2.687E-04	2.550E-04	DCF3(30)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(2,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(2,3)
D-34				
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(3,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(3,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(3,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(4,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(4,3)
D-34				
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(5,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(5,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-05	5.000E-05	RTF(5,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(7,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-05	5.000E-05	RTF(7,3)
D-34				
D-34	Eu-155 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	Eu-155 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(8,2)
D-34	Eu-155 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-05	5.000E-05	RTF(8,3)
D-34				
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(9,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(9,3)
D-34				
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(10,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(10,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(10,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(11,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(11,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(11,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(12,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(12,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(12,3)
D-34				
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(13,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(13,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(13,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(15,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(15,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(15,3)
D-34				
D-34	Pu-240 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(16,1)
D-34	Pu-240 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(16,2)
D-34	Pu-240 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(16,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(18,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(18,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(18,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(19,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(19,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(19,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(20,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(20,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(20,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu		Parameter	Current Value#	Base Case*	Parameter Name
D-34	Th-228+D	, plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(21,1)
D-34	Th-228+D	, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(21,2)
D-34	Th-228+D	, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(21,3)
D-34					
D-34	Th-229+D	, plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(22,1)
D-34	Th-229+D	, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(22,2)
D-34	Th-229+D	, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(22,3)
D-34					
D-34	Th-230	, plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(23,1)
D-34	Th-230	, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(23,2)
D-34	Th-230	, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(23,3)
D-34					
D-34	Th-232	, plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(24,1)
D-34	Th-232	, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(24,2)
D-34	Th-232	, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(24,3)
D-34					
D-34	U-233	, plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(25,1)
D-34	U-233	, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(25,2)
D-34	U-233	, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(25,3)
D-34					
D-34	U-234	, plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(26,1)
D-34	U-234	, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(26,2)
D-34	U-234	, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(26,3)
D-34					
D-34	U-235+D	, plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(27,1)
D-34	U-235+D	, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(27,2)
D-34	U-235+D	, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(27,3)
D-34					
D-34	U-236	, plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(28,1)
D-34	U-236	, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(28,2)
D-34	U-236	, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(28,3)
D-34					
D-34	U-238	, plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(29,1)
D-34	U-238	, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(29,2)
D-34	U-238	, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(29,3)
D-34					
D-34	U-238+D	, plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(30,1)
D-34	U-238+D	, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(30,2)
D-34	U-238+D	, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(30,3)
D-5	Bioaccumulation factors, fresh water, L/kg:				
D-5	Ac-227+D	, fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D	, crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5					
D-5	Am-241	, fish	3.000E+01	3.000E+01	BIOFAC(2,1)
D-5	Am-241	, crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5					
D-5	Co-60	, fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Co-60	, crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(3,2)
D-5					

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(4,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(4,2)
D-5				
D-5	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(5,2)
D-5				
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(7,1)
D-5	Eu 154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(7,2)
D-5				
D-5	Eu-155 , fish	5.000E+01	5.000E+01	BIOFAC(8,1)
D-5	Eu-155 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(8,2)
D-5				
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(9,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(9,2)
D-5				
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(10,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(10,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(11,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(12,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(12,2)
D-5				
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(13,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(13,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(15,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(15,2)
D-5				
D-5	Pu-240 , fish	3.000E+01	3.000E+01	BIOFAC(16,1)
D-5	Pu-240 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(16,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(18,1)
D-5	Ra 226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(18,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(19,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(19,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(20,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(20,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(21,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(21,2)
D-5				
D-5	Th 229+D , fish	1.000E+02	1.000E+02	BIOFAC(22,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(22,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(23,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(23,2)

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(24,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(24,2)
D-5				
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(25,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(25,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(26,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(26,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(27,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(27,2)
D-5				
D-5	U-236 , fish	1.000E+01	1.000E+01	BIOFAC(28,1)
D-5	U-236 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(28,2)
D-5				
D-5	U-238 , fish	1.000E+01	1.000E+01	BIOFAC(29,1)
D-5	U-238 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(29,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(30,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(30,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

Menu	Parameter		User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)		1.000E+02	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)		5.000E-02	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)		not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)		2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)		0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)		1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)		3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)		1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)		3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)		1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)		3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)		1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)		not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)		not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g):	Am-241	1.000E+00	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g):	Co-60	1.000E+00	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g):	Cs-137	1.000E+00	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g):	Eu-152	1.000E+00	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g):	Eu-154	1.000E+00	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g):	Eu-155	1.000E+00	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g):	Pu-238	1.000E+00	0.000E+00	---	S1(13)
R012	Initial principal radionuclide (pCi/g):	Pu-239	1.000E+00	0.000E+00	---	S1(15)
R012	Initial principal radionuclide (pCi/g):	Pu-240	1.000E+00	0.000E+00	---	S1(16)
R012	Initial principal radionuclide (pCi/g):	Sr-90	1.000E+00	0.000E+00	---	S1(20)
R012	Initial principal radionuclide (pCi/g):	Th-232	1.000E+00	0.000E+00	---	S1(24)
R012	Initial principal radionuclide (pCi/g):	U-234	1.000E+00	0.000E+00	---	S1(26)
R012	Initial principal radionuclide (pCi/g):	U-235	1.000E+00	0.000E+00	---	S1(27)
R012	Initial principal radionuclide (pCi/g):	U-238	1.000E+00	0.000E+00	---	S1(29)
R012	Concentration in groundwater (pCi/L):	Am-241	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L):	Co-60	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L):	Cs-137	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L):	Eu-152	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L):	Eu-154	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L):	Eu-155	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L):	Pu-238	not used	0.000E+00	---	W1(13)
R012	Concentration in groundwater (pCi/L):	Pu-239	not used	0.000E+00	---	W1(15)
R012	Concentration in groundwater (pCi/L):	Pu-240	not used	0.000E+00	---	W1(16)
R012	Concentration in groundwater (pCi/L):	Sr-90	not used	0.000E+00	---	W1(20)
R012	Concentration in groundwater (pCi/L):	Th-232	not used	0.000E+00	---	W1(24)
R012	Concentration in groundwater (pCi/L):	U-234	not used	0.000E+00	---	W1(26)
R012	Concentration in groundwater (pCi/L):	U-235	not used	0.000E+00	---	W1(27)
R012	Concentration in groundwater (pCi/L):	U-238	not used	0.000E+00	---	W1(29)
R013	Cover depth (m)		0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)		not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)		not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)		1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)		1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity		4.000E-01	4.000E-01	---	TPCZ

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	4.070E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.626E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	4.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Am-241				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.223E-02	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.503E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	4.600E+03	4.600E+03	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	4.600E+03	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	4.600E+03	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.414E-04	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.883E-04	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.883E-04	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for Eu-155				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.883E-04	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(13)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(13,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.252E-04	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(15)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(15,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(15)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.252E-04	ALEACH(15)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(15)
R016	Distribution coefficients for Pu-240				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(16)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(16,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(16)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.252E-04	ALEACH(16)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(16)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCC(20)
R016	Unsaturated zone 1 (cm**3/g)	not used	3.000E+01	---	DCNUCU(20,1)
R016	Saturated zone (cm**3/g)	not used	3.000E+01	---	DCNUCS(20)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.155E-02	ALEACH(20)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(20)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(24)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(24,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(24)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.084E-05	ALEACH(24)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(24)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(26)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(26,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(26)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.296E-02	ALEACH(26)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(26)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(27)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(27,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(27)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.296E-02	ALEACH(27)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(27)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(29)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(29,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(29)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.296E-02	ALEACH(29)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(29)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.223E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.883E-04	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.525E-03	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.296E-02	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(12)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+02	---	DCNUCU(12,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+02	---	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.492E-03	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(18)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(18,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(18)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.268E-03	ALEACH(18)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(18)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(19)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(19,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(19)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.268E-03	ALEACH(19)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(19)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(21)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(21,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(21)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.084E-05	ALEACH(21)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(21)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(22)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(22,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(22)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.084E-05	ALEACH(22)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(22)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(23)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(23,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(23)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.084E-05	ALEACH(23)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(23)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(25)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(25,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(25)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.296E-02	ALEACH(25)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(25)
R016	Distribution coefficients for daughter U-236				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(28)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(28,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(28)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.296E-02	ALEACH(28)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(28)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	6.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	2.500E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	1.000E+00	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	not used	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	8.550E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	not used	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.080E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E 01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C 12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	suppressed
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	suppressed

Summary : Soil Project 25 mrem Industrial Shallow Layer no External
File : C:\RESRAD_FAMILY\RESRAD\USERFILES\CAU 370 NO EXTERNAL.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	100.00 square meters	Am-241	1.000E+00
Thickness:	0.05 meters	Co-60	1.000E+00
Cover Depth:	0.00 meters	Cs-137	1.000E+00
		Eu-152	1.000E+00
		Eu-154	1.000E+00
		Eu-155	1.000E+00
		Pu-238	1.000E+00
		Pu-239	1.000E+00
		Pu-240	1.000E+00
		Sr-90	1.000E+00
		Th-232	1.000E+00
		U-234	1.000E+00
		U-235	1.000E+00
		U-238	1.000E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.381E-02	3.305E-02	3.167E-02	2.690E-02	1.259E-02	0.000E+00	0.000E+00	0.000E+00
M(t):	1.352E-03	1.322E-03	1.267E-03	1.076E-03	5.035E-04	0.000E+00	0.000E+00	0.000E+00

Maximum TDOSE(t): 3.381E-02 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	3.353E-03	0.0992	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.091E-03	0.0323
Co-60	0.000E+00	0.0000	1.576E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.680E-06	0.0002
Cs-137	0.000E+00	0.0000	2.421E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.506E-05	0.0004
Eu-152	0.000E+00	0.0000	1.653E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.924E-06	0.0001
Eu-154	0.000E+00	0.0000	2.111E-06	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.798E-06	0.0001
Eu-155	0.000E+00	0.0000	2.966E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.350E-07	0.0000
Pu-238	0.000E+00	0.0000	2.998E-03	0.0887	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.711E-04	0.0287
Pu-239	0.000E+00	0.0000	3.294E-03	0.0974	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.079E-03	0.0319
Pu-240	0.000E+00	0.0000	3.293E-03	0.0974	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.078E-03	0.0319
Sr-90	0.000E+00	0.0000	9.823E-06	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.552E-05	0.0013
Th-232	0.000E+00	0.0000	1.261E-02	0.3730	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.588E-04	0.0254
U-234	0.000E+00	0.0000	1.007E-03	0.0298	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.568E-05	0.0025
U-235	0.000E+00	0.0000	9.385E-04	0.0278	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.098E-05	0.0024
U-238	0.000E+00	0.0000	9.005E-04	0.0266	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.135E-05	0.0024
Total	0.000E+00	0.0000	2.841E-02	0.8403	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.399E-03	0.1597

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.443E-03	0.1314
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.256E-06	0.0003
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.530E-05	0.0005
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.577E-06	0.0001
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.909E-06	0.0001
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.317E-07	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.969E-03	0.1174
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.372E-03	0.1293
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.372E-03	0.1293
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.535E-05	0.0016
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.347E-02	0.3984
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.093E-03	0.0323
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.020E-03	0.0302
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.819E-04	0.0290
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.381E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	3.176E-03	0.0961	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.033E-03	0.0313
Co-60	0.000E+00	0.0000	1.353E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.594E-06	0.0002
Cs-137	0.000E+00	0.0000	2.318E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.442E-05	0.0004
Eu-152	0.000E+00	0.0000	1.536E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.788E-06	0.0001
Eu-154	0.000E+00	0.0000	1.910E-06	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.532E-06	0.0001
Eu-155	0.000E+00	0.0000	2.525E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.704E-07	0.0000
Pu-238	0.000E+00	0.0000	2.913E-03	0.0882	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.437E-04	0.0286
Pu-239	0.000E+00	0.0000	3.226E-03	0.0976	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.056E-03	0.0320
Pu-240	0.000E+00	0.0000	3.226E-03	0.0976	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.056E-03	0.0320
Sr-90	0.000E+00	0.0000	9.198E-06	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.263E-05	0.0013
Th-232	0.000E+00	0.0000	1.245E-02	0.3766	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.950E-04	0.0271
U-234	0.000E+00	0.0000	9.741E-04	0.0295	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.287E-05	0.0025
U-235	0.000E+00	0.0000	9.080E-04	0.0275	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.839E-05	0.0024
U-238	0.000E+00	0.0000	8.710E-04	0.0264	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.868E-05	0.0024
Total	0.000E+00	0.0000	2.775E-02	0.8398	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.293E-03	0.1602

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.209E-03	0.1274
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.946E-06	0.0002
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.465E-05	0.0004
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.324E-06	0.0001
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.442E-06	0.0001
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.229E-07	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.857E-03	0.1167
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.282E-03	0.1296
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.282E-03	0.1296
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.183E-05	0.0016
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.334E-02	0.4037
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.057E-03	0.0320
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.863E-04	0.0298
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.497E-04	0.0287
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.305E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	2.845E-03	0.0898	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.257E-04	0.0292
Co-60	0.000E+00	0.0000	9.957E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.853E-06	0.0002
Cs-137	0.000E+00	0.0000	2.121E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.320E-05	0.0004
Eu-152	0.000E+00	0.0000	1.326E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.542E-06	0.0000
Eu-154	0.000E+00	0.0000	1.562E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.070E-06	0.0001
Eu-155	0.000E+00	0.0000	1.828E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.681E-07	0.0000
Pu-238	0.000E+00	0.0000	2.747E-03	0.0868	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.900E-04	0.0281
Pu-239	0.000E+00	0.0000	3.091E-03	0.0976	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.012E-03	0.0320
Pu-240	0.000E+00	0.0000	3.090E-03	0.0976	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.012E-03	0.0319
Sr-90	0.000E+00	0.0000	8.054E-06	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.733E-05	0.0012
Th-232	0.000E+00	0.0000	1.223E-02	0.3862	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.573E-04	0.0302
U-234	0.000E+00	0.0000	9.100E-04	0.0287	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.742E-05	0.0024
U-235	0.000E+00	0.0000	8.488E-04	0.0268	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.337E-05	0.0023
U-238	0.000E+00	0.0000	8.137E-04	0.0257	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.351E-05	0.0023
Total	0.000E+00	0.0000	2.659E-02	0.8396	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.080E-03	0.1604

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.771E-03	0.1191
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.849E-06	0.0002
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.341E-05	0.0004
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.868E-06	0.0001
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.632E-06	0.0001
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.509E-07	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.637E-03	0.1149
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.103E-03	0.1296
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.102E-03	0.1295
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.538E-05	0.0014
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.319E-02	0.4164
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.874E-04	0.0312
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.221E-04	0.0291
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.872E-04	0.0280
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.167E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	1.907E-03	0.0709	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.205E-04	0.0231
Co-60	0.000E+00	0.0000	3.354E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.635E-06	0.0001
Cs-137	0.000E+00	0.0000	1.531E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.526E-06	0.0004
Eu-152	0.000E+00	0.0000	7.781E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.054E-07	0.0000
Eu-154	0.000E+00	0.0000	7.604E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.008E-06	0.0000
Eu-155	0.000E+00	0.0000	5.806E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.516E-08	0.0000
Pu-238	0.000E+00	0.0000	2.203E-03	0.0819	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.138E-04	0.0265
Pu-239	0.000E+00	0.0000	2.619E-03	0.0973	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.576E-04	0.0319
Pu-240	0.000E+00	0.0000	2.617E-03	0.0973	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.569E-04	0.0319
Sr-90	0.000E+00	0.0000	4.981E-06	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.308E-05	0.0009
Th-232	0.000E+00	0.0000	1.127E-02	0.4191	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E-03	0.0378
U-234	0.000E+00	0.0000	7.061E-04	0.0262	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.007E-05	0.0022
U-235	0.000E+00	0.0000	6.605E-04	0.0245	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.734E-05	0.0021
U-238	0.000E+00	0.0000	6.313E-04	0.0235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.703E-05	0.0021
Total	0.000E+00	0.0000	2.263E-02	0.8410	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.277E-03	0.1590

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.528E-03	0.0940
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.970E-06	0.0001
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.679E-06	0.0004
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.684E-06	0.0001
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.768E-06	0.0001
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.432E-07	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.917E-03	0.1084
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.477E-03	0.1292
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.474E-03	0.1291
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.806E-05	0.0010
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.229E-02	0.4569
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.662E-04	0.0285
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.178E-04	0.0267
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.883E-04	0.0256
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.690E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	4.787E-04	0.0380	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.557E-04	0.0124
Co-60	0.000E+00	0.0000	1.178E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.743E-08	0.0000
Cs-137	0.000E+00	0.0000	4.749E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.954E-06	0.0002
Eu-152	0.000E+00	0.0000	1.337E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.555E-07	0.0000
Eu-154	0.000E+00	0.0000	7.648E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.013E-07	0.0000
Eu-155	0.000E+00	0.0000	1.725E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.530E-09	0.0000
Pu-238	0.000E+00	0.0000	9.227E-04	0.0733	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.989E-04	0.0237
Pu-239	0.000E+00	0.0000	1.284E-03	0.1020	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.204E-04	0.0334
Pu-240	0.000E+00	0.0000	1.281E-03	0.1017	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.194E-04	0.0333
Sr-90	0.000E+00	0.0000	9.928E-07	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.601E-06	0.0004
Th-232	0.000E+00	0.0000	5.914E-03	0.4698	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.727E-04	0.0455
U-234	0.000E+00	0.0000	2.691E-04	0.0214	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.289E-05	0.0018
U-235	0.000E+00	0.0000	2.550E-04	0.0203	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.240E-05	0.0018
U-238	0.000E+00	0.0000	2.405E-04	0.0191	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.173E-05	0.0017
Total	0.000E+00	0.0000	1.065E-02	0.8457	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.942E-03	0.1543

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.344E-04	0.0504
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.922E-08	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.002E-06	0.0002
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.892E-07	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.778E-07	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.255E-09	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.222E-03	0.0970
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.704E-03	0.1354
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.700E-03	0.1351
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.593E-06	0.0004
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.487E-03	0.5153
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.920E-04	0.0232
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.774E-04	0.0220
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.622E-04	0.0208
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.259E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	4.443E-03	4.209E-03	3.771E-03	2.528E-03	6.344E-04	0.000E+00	0.000E+00	0.000E+00
Am-241	Np-237+D	1.000E+00	8.772E-10	2.543E-09	5.495E-09	1.239E-08	1.277E-08	0.000E+00	0.000E+00	0.000E+00
Am-241	U-233	1.000E+00	2.609E-16	1.770E-15	8.700E-15	5.911E-14	1.802E-13	0.000E+00	0.000E+00	0.000E+00
Am-241	Th-229+D	1.000E+00	9.807E-20	1.430E-18	1.565E-17	3.245E-16	3.105E-15	0.000E+00	0.000E+00	0.000E+00
Am-241	äDSR(j)		4.443E-03	4.209E-03	3.771E-03	2.528E-03	6.344E-04	0.000E+00	0.000E+00	0.000E+00
Co-60	Co-60	1.000E+00	9.256E-06	7.946E-06	5.849E-06	1.970E-06	6.922E-08	0.000E+00	0.000E+00	0.000E+00
Cs-137+D	Cs-137+D	1.000E+00	1.530E-05	1.465E-05	1.341E-05	9.679E-06	3.002E-06	0.000E+00	0.000E+00	0.000E+00
Eu-152	Eu-152	7.208E-01	2.578E-06	2.396E-06	2.067E-06	1.214E-06	2.085E-07	0.000E+00	0.000E+00	0.000E+00
Eu-152	Eu-152	2.792E-01	9.986E-07	9.281E-07	8.007E-07	4.701E-07	8.075E-08	0.000E+00	0.000E+00	0.000E+00
Eu-152	Gd-152	2.792E-01	1.680E-18	4.834E-18	1.028E-17	2.197E-17	2.018E-17	0.000E+00	0.000E+00	0.000E+00
Eu-152	äDSR(j)		9.986E-07	9.281E-07	8.007E-07	4.701E-07	8.075E-08	0.000E+00	0.000E+00	0.000E+00
Eu-154	Eu 154	1.000E+00	4.909E-06	4.442E-06	3.632E-06	1.768E-06	1.778E-07	0.000E+00	0.000E+00	0.000E+00
Eu-155	Eu-155	1.000E+00	7.317E-07	6.229E-07	4.509E-07	1.432E-07	4.255E-09	0.000E+00	0.000E+00	0.000E+00
Pu-238	Pu-238	1.840E-09	7.303E-12	7.097E-12	6.693E-12	5.367E-12	2.248E-12	0.000E+00	0.000E+00	0.000E+00
Pu-238	Pu-238	1.000E+00	3.969E-03	3.857E-03	3.637E-03	2.917E-03	1.222E-03	0.000E+00	0.000E+00	0.000E+00
Pu-238	U-234	1.000E+00	1.543E-09	4.503E-09	9.871E-09	2.337E-08	2.714E-08	0.000E+00	0.000E+00	0.000E+00
Pu-238	Th-230	1.000E+00	1.124E-14	7.685E-14	3.846E-13	2.785E-12	1.010E-11	0.000E+00	0.000E+00	0.000E+00
Pu-238	Ra-226+D	1.000E+00	2.132E-19	3.122E-18	3.446E-17	7.366E-16	7.638E-15	0.000E+00	0.000E+00	0.000E+00
Pu-238	Pb-210+D	1.000E+00	6.737E-21	2.028E-19	4.782E-18	2.895E-16	7.792E-15	0.000E+00	0.000E+00	0.000E+00
Pu-238	äDSR(j)		3.969E-03	3.857E-03	3.637E-03	2.917E-03	1.222E-03	0.000E+00	0.000E+00	0.000E+00
Pu-239	Pu-239	1.000E+00	4.372E-03	4.282E-03	4.103E-03	3.477E-03	1.704E-03	0.000E+00	0.000E+00	0.000E+00
Pu-239	U-235+D	1.000E+00	5.013E-13	1.468E-12	3.244E-12	7.898E-12	9.969E-12	0.000E+00	0.000E+00	0.000E+00
Pu-239	Pa-231	1.000E+00	4.483E-17	3.060E-16	1.527E-15	1.093E-14	3.832E-14	0.000E+00	0.000E+00	0.000E+00
Pu-239	Ac-227+D	1.000E+00	1.515E-18	2.191E-17	2.352E-16	4.558E-15	3.666E-14	0.000E+00	0.000E+00	0.000E+00
Pu-239	äDSR(j)		4.372E-03	4.282E-03	4.103E-03	3.477E-03	1.704E-03	0.000E+00	0.000E+00	0.000E+00
Pu-240	Pu-240	4.950E-08	2.164E-10	2.119E-10	2.030E-10	1.719E-10	8.416E-11	0.000E+00	0.000E+00	0.000E+00
Pu-240	Pu-240	1.000E+00	4.372E-03	4.282E-03	4.102E-03	3.474E-03	1.700E-03	0.000E+00	0.000E+00	0.000E+00
Pu-240	U-236	1.000E+00	1.530E-11	4.481E-11	9.899E-11	2.410E-10	3.039E-10	0.000E+00	0.000E+00	0.000E+00
Pu-240	Th-232	1.000E+00	3.240E-21	2.220E-20	1.117E-19	8.236E-19	3.147E-18	0.000E+00	0.000E+00	0.000E+00
Pu-240	Ra-228+D	1.000E+00	3.391E-24	4.851E-23	5.089E-22	9.190E-21	6.581E-20	0.000E+00	0.000E+00	0.000E+00
Pu-240	Th-228+D	1.000E+00	1.409E-24	3.947E-23	8.006E-22	3.017E-20	3.241E-19	0.000E+00	0.000E+00	0.000E+00
Pu-240	äDSR(j)		4.372E-03	4.282E-03	4.102E-03	3.474E-03	1.700E-03	0.000E+00	0.000E+00	0.000E+00
Sr-90+D	Sr-90+D	1.000E+00	5.535E-05	5.183E-05	4.538E-05	2.806E-05	5.593E-06	0.000E+00	0.000E+00	0.000E+00

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Th-232	Th-232	1.000E+00	1.342E-02	1.315E-02	1.261E-02	1.071E-02	5.287E-03	0.000E+00	0.000E+00	0.000E+00
Th-232	Ra-228+D	1.000E+00	2.754E-05	7.669E-05	1.521E-04	2.637E-04	1.716E-04	0.000E+00	0.000E+00	0.000E+00
Th-232	Th-228+D	1.000E+00	1.860E-05	1.119E-04	4.242E-04	1.317E-03	1.028E-03	0.000E+00	0.000E+00	0.000E+00
Th-232	äDSR(j)		1.347E-02	1.334E-02	1.319E-02	1.229E-02	6.487E-03	0.000E+00	0.000E+00	0.000E+00
U-234	U-234	1.000E+00	1.093E-03	1.057E-03	9.874E-04	7.660E-04	2.918E-04	0.000E+00	0.000E+00	0.000E+00
U-234	Th-230	1.000E+00	1.193E-08	3.493E-08	7.721E-08	1.882E-07	2.384E-07	0.000E+00	0.000E+00	0.000E+00
U-234	Ra-226+D	1.000E+00	3.013E-13	2.059E-12	1.029E-11	7.429E-11	2.667E-10	0.000E+00	0.000E+00	0.000E+00
U-234	Pb-210+D	1.000E+00	1.188E-14	1.729E-13	1.882E-12	3.830E-11	3.475E-10	0.000E+00	0.000E+00	0.000E+00
U-234	äDSR(j)		1.093E-03	1.057E-03	9.874E-04	7.662E-04	2.920E-04	0.000E+00	0.000E+00	0.000E+00
U-235+D	U-235+D	1.000E+00	1.019E-03	9.859E-04	9.211E-04	7.145E-04	2.722E-04	0.000E+00	0.000E+00	0.000E+00
U-235+D	Pa-231	1.000E+00	1.365E-07	3.975E-07	8.674E-07	2.020E-06	2.235E-06	0.000E+00	0.000E+00	0.000E+00
U-235+D	Ac-227+D	1.000E+00	6.132E-09	4.111E-08	1.969E-07	1.223E-06	2.953E-06	0.000E+00	0.000E+00	0.000E+00
U-235+D	äDSR(j)		1.020E-03	9.863E-04	9.221E-04	7.178E-04	2.774E-04	0.000E+00	0.000E+00	0.000E+00
U-238	U-238	5.400E-05	5.278E-08	5.105E-08	4.769E-08	3.700E-08	1.410E-08	0.000E+00	0.000E+00	0.000E+00
U-238+D	U-238+D	9.999E-01	9.818E-04	9.496E-04	8.872E-04	6.882E-04	2.622E-04	0.000E+00	0.000E+00	0.000E+00
U-238+D	U-234	9.999E-01	1.540E-09	4.486E-09	9.789E-09	2.279E-08	2.522E-08	0.000E+00	0.000E+00	0.000E+00
U-238+D	Th-230	9.999E-01	1.123E-14	7.665E-14	3.825E-13	2.739E-12	9.631E-12	0.000E+00	0.000E+00	0.000E+00
U-238+D	Ra-226+D	9.999E-01	2.130E-19	3.115E-18	3.432E-17	7.275E-16	7.370E-15	0.000E+00	0.000E+00	0.000E+00
U-238+D	Pb-210+D	9.999E-01	6.732E-21	2.025E-19	4.766E-18	2.866E-16	7.566E-15	0.000E+00	0.000E+00	0.000E+00
U-238+D	äDSR(j)		9.818E-04	9.496E-04	8.872E-04	6.883E-04	2.622E-04	0.000E+00	0.000E+00	0.000E+00

The DSR includes contributions from associated (half life ó 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	5.627E+03	5.940E+03	6.629E+03	9.890E+03	3.941E+04	*3.431E+12	*3.431E+12	*3.431E+12
Co-60	2.701E+06	3.146E+06	4.274E+06	1.269E+07	3.612E+08	*1.132E+15	*1.132E+15	*1.132E+15
Cs-137	1.634E+06	1.707E+06	1.865E+06	2.583E+06	8.329E+06	*8.704E+13	*8.704E+13	*8.704E+13
Eu-152	6.990E+06	7.520E+06	8.717E+06	1.485E+07	8.644E+07	*1.765E+14	*1.765E+14	*1.765E+14
Eu-154	5.093E+06	5.628E+06	6.882E+06	1.414E+07	1.406E+08	*2.639E+14	*2.639E+14	*2.639E+14
Eu-155	3.417E+07	4.013E+07	5.544E+07	1.746E+08	5.875E+09	*4.652E+14	*4.652E+14	*4.652E+14
Pu-238	6.299E+03	6.482E+03	6.873E+03	8.570E+03	2.046E+04	*1.712E+13	*1.712E+13	*1.712E+13
Pu-239	5.718E+03	5.838E+03	6.093E+03	7.191E+03	1.467E+04	*6.214E+10	*6.214E+10	*6.214E+10
Pu-240	5.718E+03	5.839E+03	6.095E+03	7.197E+03	1.470E+04	*2.278E+11	*2.278E+11	*2.278E+11
Sr-90	4.517E+05	4.824E+05	5.509E+05	8.908E+05	4.470E+06	*1.365E+14	*1.365E+14	*1.365E+14
Th-232	1.856E+03	1.874E+03	1.896E+03	2.034E+03	3.854E+03	*1.097E+05	*1.097E+05	*1.097E+05
U-234	2.288E+04	2.365E+04	2.532E+04	3.263E+04	8.561E+04	*6.247E+09	*6.247E+09	*6.247E+09
U-235	2.452E+04	2.535E+04	2.711E+04	3.483E+04	9.012E+04	*2.161E+06	*2.161E+06	*2.161E+06
U-238	2.546E+04	2.633E+04	2.818E+04	3.632E+04	9.534E+04	*3.361E+05	*3.361E+05	*3.361E+05

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Am-241	1.000E+00	0.000E+00	4.443E-03	5.627E+03	4.443E-03	5.627E+03
Co-60	1.000E+00	0.000E+00	9.256E-06	2.701E+06	9.256E-06	2.701E+06
Cs-137	1.000E+00	0.000E+00	1.530E-05	1.634E+06	1.530E-05	1.634E+06
Eu-152	1.000E+00	0.000E+00	3.577E-06	6.990E+06	3.577E-06	6.990E+06
Eu-154	1.000E+00	0.000E+00	4.909E-06	5.093E+06	4.909E-06	5.093E+06
Eu-155	1.000E+00	0.000E+00	7.317E-07	3.417E+07	7.317E-07	3.417E+07
Pu-238	1.000E+00	0.000E+00	3.969E-03	6.299E+03	3.969E-03	6.299E+03
Pu-239	1.000E+00	0.000E+00	4.372E-03	5.718E+03	4.372E-03	5.718E+03
Pu-240	1.000E+00	0.000E+00	4.372E-03	5.718E+03	4.372E-03	5.718E+03
Sr-90	1.000E+00	0.000E+00	5.535E-05	4.517E+05	5.535E-05	4.517E+05
Th-232	1.000E+00	0.000E+00	1.347E-02	1.856E+03	1.347E-02	1.856E+03
U-234	1.000E+00	0.000E+00	1.093E-03	2.288E+04	1.093E-03	2.288E+04
U-235	1.000E+00	0.000E+00	1.020E-03	2.452E+04	1.020E-03	2.452E+04
U-238	1.000E+00	0.000E+00	9.819E-04	2.546E+04	9.819E-04	2.546E+04

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Am 241	Am-241	1.000E+00	4.443E-03	4.209E-03	3.771E-03	2.528E-03	6.344E-04	0.000E+00	0.000E+00	0.000E+00
Np-237	Am-241	1.000E+00	8.772E-10	2.543E-09	5.495E-09	1.239E-08	1.277E-08	0.000E+00	0.000E+00	0.000E+00
U-233	Am-241	1.000E+00	2.609E-16	1.770E-15	8.700E-15	5.911E-14	1.802E-13	0.000E+00	0.000E+00	0.000E+00
Th-229	Am-241	1.000E+00	9.807E-20	1.430E-18	1.565E-17	3.245E-16	3.105E-15	0.000E+00	0.000E+00	0.000E+00
Co-60	Co-60	1.000E+00	9.256E-06	7.946E-06	5.849E-06	1.970E-06	6.922E-08	0.000E+00	0.000E+00	0.000E+00
Cs-137	Cs-137	1.000E+00	1.530E-05	1.465E-05	1.341E-05	9.679E-06	3.002E-06	0.000E+00	0.000E+00	0.000E+00
Eu-152	Eu-152	7.208E-01	2.578E-06	2.396E-06	2.067E-06	1.214E-06	2.085E-07	0.000E+00	0.000E+00	0.000E+00
Eu-152	Eu-152	2.792E-01	9.986E-07	9.281E-07	8.007E-07	4.701E-07	8.075E-08	0.000E+00	0.000E+00	0.000E+00
Eu-152	äDOSE(j)		3.577E-06	3.324E-06	2.868E-06	1.684E-06	2.892E-07	0.000E+00	0.000E+00	0.000E+00
Gd-152	Eu-152	2.792E-01	1.680E-18	4.834E-18	1.028E-17	2.197E-17	2.018E-17	0.000E+00	0.000E+00	0.000E+00
Eu-154	Eu-154	1.000E+00	4.909E-06	4.442E-06	3.632E-06	1.768E-06	1.778E-07	0.000E+00	0.000E+00	0.000E+00
Eu-155	Eu-155	1.000E+00	7.317E-07	6.229E-07	4.509E-07	1.432E-07	4.255E-09	0.000E+00	0.000E+00	0.000E+00
Pu-238	Pu-238	1.840E-09	7.303E-12	7.097E-12	6.693E-12	5.367E-12	2.248E-12	0.000E+00	0.000E+00	0.000E+00
Pu-238	Pu-238	1.000E+00	3.969E-03	3.857E-03	3.637E-03	2.917E-03	1.222E-03	0.000E+00	0.000E+00	0.000E+00
Pu-238	äDOSE(j)		3.969E-03	3.857E-03	3.637E-03	2.917E-03	1.222E-03	0.000E+00	0.000E+00	0.000E+00
U-234	Pu-238	1.000E+00	1.543E-09	4.503E-09	9.871E-09	2.337E-08	2.714E-08	0.000E+00	0.000E+00	0.000E+00
U-234	U-234	1.000E+00	1.093E-03	1.057E-03	9.874E-04	7.660E 04	2.918E-04	0.000E+00	0.000E+00	0.000E+00
U-234	U-238	9.999E-01	1.540E-09	4.486E-09	9.789E-09	2.279E-08	2.522E-08	0.000E+00	0.000E+00	0.000E+00
U-234	äDOSE(j)		1.093E-03	1.057E-03	9.874E-04	7.660E-04	2.918E-04	0.000E+00	0.000E+00	0.000E+00
Th-230	Pu-238	1.000E+00	1.124E-14	7.685E-14	3.846E-13	2.785E-12	1.010E-11	0.000E+00	0.000E+00	0.000E+00
Th-230	U-234	1.000E+00	1.193E-08	3.493E-08	7.721E-08	1.882E-07	2.384E-07	0.000E+00	0.000E+00	0.000E+00
Th-230	U-238	9.999E-01	1.123E-14	7.665E-14	3.825E-13	2.739E-12	9.631E-12	0.000E+00	0.000E+00	0.000E+00
Th-230	äDOSE(j)		1.193E-08	3.493E-08	7.721E-08	1.882E-07	2.385E-07	0.000E+00	0.000E+00	0.000E+00
Ra-226	Pu-238	1.000E+00	2.132E-19	3.122E-18	3.446E-17	7.366E-16	7.638E-15	0.000E+00	0.000E+00	0.000E+00
Ra-226	U-234	1.000E+00	3.013E-13	2.059E-12	1.029E-11	7.429E-11	2.667E-10	0.000E+00	0.000E+00	0.000E+00
Ra-226	U-238	9.999E-01	2.130E-19	3.115E-18	3.432E-17	7.275E-16	7.370E-15	0.000E+00	0.000E+00	0.000E+00
Ra-226	äDOSE(j)		3.013E-13	2.059E-12	1.029E-11	7.429E-11	2.667E-10	0.000E+00	0.000E+00	0.000E+00
Pb-210	Pu-238	1.000E+00	6.737E-21	2.028E-19	4.782E-18	2.895E-16	7.792E-15	0.000E+00	0.000E+00	0.000E+00
Pb-210	U-234	1.000E+00	1.188E-14	1.729E-13	1.882E-12	3.830E-11	3.475E-10	0.000E+00	0.000E+00	0.000E+00
Pb-210	U-238	9.999E-01	6.732E-21	2.025E-19	4.766E-18	2.866E-16	7.566E-15	0.000E+00	0.000E+00	0.000E+00
Pb-210	äDOSE(j)		1.188E-14	1.729E-13	1.882E-12	3.830E-11	3.475E-10	0.000E+00	0.000E+00	0.000E+00
Pu-239	Pu-239	1.000E+00	4.372E-03	4.282E-03	4.103E-03	3.477E-03	1.704E-03	0.000E+00	0.000E+00	0.000E+00
U-235	Pu-239	1.000E+00	5.013E-13	1.468E-12	3.244E-12	7.898E-12	9.969E-12	0.000E+00	0.000E+00	0.000E+00

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-235	U-235	1.000E+00	1.019E-03	9.859E-04	9.211E-04	7.145E-04	2.722E-04	0.000E+00	0.000E+00	0.000E+00
U-235	äDOSE(j)		1.019E-03	9.859E-04	9.211E-04	7.145E-04	2.722E-04	0.000E+00	0.000E+00	0.000E+00
Pa-231	Pu-239	1.000E+00	4.483E-17	3.060E-16	1.527E-15	1.093E-14	3.832E-14	0.000E+00	0.000E+00	0.000E+00
Pa-231	U-235	1.000E+00	1.365E-07	3.975E-07	8.674E-07	2.020E-06	2.235E-06	0.000E+00	0.000E+00	0.000E+00
Pa-231	äDOSE(j)		1.365E-07	3.975E-07	8.674E-07	2.020E-06	2.235E-06	0.000E+00	0.000E+00	0.000E+00
Ac-227	Pu-239	1.000E+00	1.515E-18	2.191E-17	2.352E-16	4.558E-15	3.666E-14	0.000E+00	0.000E+00	0.000E+00
Ac-227	U-235	1.000E+00	6.132E-09	4.111E-08	1.969E-07	1.223E-06	2.953E-06	0.000E+00	0.000E+00	0.000E+00
Ac-227	äDOSE(j)		6.132E-09	4.111E-08	1.969E-07	1.223E-06	2.953E-06	0.000E+00	0.000E+00	0.000E+00
Pu-240	Pu-240	4.950E-08	2.164E-10	2.119E-10	2.030E-10	1.719E-10	8.416E-11	0.000E+00	0.000E+00	0.000E+00
Pu-240	Pu-240	1.000E+00	4.372E-03	4.282E-03	4.102E-03	3.474E-03	1.700E-03	0.000E+00	0.000E+00	0.000E+00
Pu-240	äDOSE(j)		4.372E-03	4.282E-03	4.102E-03	3.474E-03	1.700E-03	0.000E+00	0.000E+00	0.000E+00
U-236	Pu-240	1.000E+00	1.530E-11	4.481E-11	9.899E-11	2.410E-10	3.039E-10	0.000E+00	0.000E+00	0.000E+00
Th-232	Pu-240	1.000E+00	3.240E-21	2.220E-20	1.117E-19	8.236E-19	3.147E-18	0.000E+00	0.000E+00	0.000E+00
Th-232	Th-232	1.000E+00	1.342E-02	1.315E-02	1.261E-02	1.071E-02	5.287E-03	0.000E+00	0.000E+00	0.000E+00
Th-232	äDOSE(j)		1.342E-02	1.315E-02	1.261E-02	1.071E-02	5.287E-03	0.000E+00	0.000E+00	0.000E+00
Ra-228	Pu-240	1.000E+00	3.391E-24	4.851E-23	5.089E-22	9.190E-21	6.581E-20	0.000E+00	0.000E+00	0.000E+00
Ra-228	Th-232	1.000E+00	2.754E-05	7.669E-05	1.521E-04	2.637E-04	1.716E-04	0.000E+00	0.000E+00	0.000E+00
Ra-228	äDOSE(j)		2.754E-05	7.669E-05	1.521E-04	2.637E-04	1.716E-04	0.000E+00	0.000E+00	0.000E+00
Th-228	Pu-240	1.000E+00	1.409E-24	3.947E-23	8.006E-22	3.017E-20	3.241E-19	0.000E+00	0.000E+00	0.000E+00
Th-228	Th-232	1.000E+00	1.860E-05	1.119E-04	4.242E-04	1.317E-03	1.028E-03	0.000E+00	0.000E+00	0.000E+00
Th-228	äDOSE(j)		1.860E-05	1.119E-04	4.242E-04	1.317E-03	1.028E-03	0.000E+00	0.000E+00	0.000E+00
Sr-90	Sr-90	1.000E+00	5.535E-05	5.183E-05	4.538E-05	2.806E-05	5.593E-06	0.000E+00	0.000E+00	0.000E+00
U-238	U-238	5.400E-05	5.278E-08	5.105E-08	4.769E-08	3.700E-08	1.410E-08	0.000E+00	0.000E+00	0.000E+00
U 238	U-238	9.999E-01	9.818E 04	9.496E-04	8.872E-04	6.882E-04	2.622E-04	0.000E+00	0.000E+00	0.000E+00
U-238	äDOSE(j)		9.819E-04	9.497E-04	8.872E-04	6.883E-04	2.622E-04	0.000E+00	0.000E+00	0.000E+00

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g						
		t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	1.000E+00	9.667E-01	9.035E-01	7.130E-01	3.624E 01	3.393E-02	3.908E-05	2.025E-15
Np-237	Am-241	1.000E+00	0.000E+00	3.181E-07	9.205E-07	2.712E-06	5.842E-06	7.686E-06	4.850E-06	8.281E-07
U-233	Am-241	1.000E+00	0.000E+00	6.967E-13	6.069E-12	6.021E-11	3.966E-10	1.662E-09	1.899E-09	3.469E-10
Th-229	Am-241	1.000E+00	0.000E+00	2.202E-17	5.801E-16	1.974E-14	4.219E-13	7.582E-12	4.517E-11	1.012E-10
Co-60	Co-60	1.000E+00	1.000E+00	8.762E-01	6.727E-01	2.667E-01	1.898E-02	1.823E-06	6.055E-18	0.000E+00
Cs-137	Cs-137	1.000E+00	1.000E+00	9.770E-01	9.326E-01	7.926E-01	4.979E-01	9.782E-02	9.360E-04	8.022E-11
Eu-152	Eu-152	7.208E-01	7.208E-01	6.837E-01	6.152E-01	4.252E-01	1.479E-01	3.675E-03	9.555E-08	8.562E-24
Eu-152	Eu-152	2.792E-01	2.792E-01	2.648E-01	2.383E-01	1.647E-01	5.730E-02	1.424E-03	3.701E-08	3.316E-24
Eu-152	äS(j):		1.000E+00	9.486E-01	8.535E-01	5.899E-01	2.052E-01	5.099E-03	1.326E-07	1.188E-23
Gd-152	Eu-152	2.792E-01	0.000E+00	1.745E-15	4.966E-15	1.386E-14	2.658E-14	3.167E-14	2.720E-14	1.567E-14
Eu-154	Eu-154	1.000E+00	1.000E+00	9.235E-01	7.877E-01	4.513E-01	9.194E-02	3.507E-04	4.314E-11	2.816E-35
Eu-155	Eu-155	1.000E+00	1.000E+00	8.689E-01	6.560E-01	2.453E-01	1.476E-02	7.882E-07	4.896E-19	0.000E+00
Pu-238	Pu-238	1.840E-09	1.840E-09	1.825E-09	1.795E-09	1.695E-09	1.438E-09	8.084E-10	1.560E-10	4.928E-13
Pu-238	Pu-238	1.000E+00	1.000E+00	9.918E-01	9.756E-01	9.210E-01	7.813E-01	4.393E-01	8.479E-02	2.678E-04
Pu-238	äS(j):		1.000E+00	9.918E-01	9.756E-01	9.210E-01	7.813E-01	4.393E-01	8.479E-02	2.678E-04
U-234	Pu-238	1.000E+00	0.000E+00	2.805E-06	8.239E-06	2.550E-05	6.194E-05	9.919E-05	3.848E-05	1.588E-07
U-234	U-234	1.000E+00	1.000E+00	9.871E-01	9.619E-01	8.784E 01	6.778E-01	2.735E-01	2.046E-02	2.343E-06
U-234	U-238	9.999E-01	0.000E+00	2.798E-06	8.180E-06	2.490E-05	5.764E-05	7.755E-05	1.741E-05	6.651E-09
U-234	äS(j):		1.000E+00	9.871E-01	9.619E-01	8.785E-01	6.779E-01	2.737E-01	2.052E-02	2.508E-06
Th-230	Pu-238	1.000E+00	0.000E+00	1.267E-11	1.124E-10	1.189E-09	9.319E-09	6.526E-08	1.917E-07	2.354E-07
Th-230	U-234	1.000E+00	0.000E+00	8.944E-06	2.649E-05	8.442E-05	2.237E-04	5.038E 04	6.771E-04	6.818E-04
Th-230	U-238	9.999E-01	0.000E+00	1.265E-11	1.119E-10	1.171E-09	8.897E-09	5.643E-08	1.362E-07	1.493E-07
Th-230	äS(j):		0.000E+00	8.944E-06	2.649E-05	8.442E-05	2.237E-04	5.040E-04	6.774E-04	6.822E-04
Ra-226	Pu-238	1.000E+00	0.000E+00	1.828E-15	4.861E-14	1.706E-12	3.954E-11	8.711E-10	6.137E-09	1.050E-08
Ra-226	U-234	1.000E+00	0.000E+00	1.935E-09	1.716E-08	1.809E-07	1.404E-06	9.519E-06	2.610E-05	3.050E-05
Ra-226	U-238	9.999E-01	0.000E+00	1.826E-15	4.844E-14	1.686E-12	3.818E-11	7.785E-10	4.597E-09	6.677E-09
Ra-226	äS(j):		0.000E+00	1.935E-09	1.716E-08	1.809E-07	1.404E-06	9.520E-06	2.611E-05	3.052E-05
Pb-210	Pu-238	1.000E+00	0.000E+00	1.412E-17	1.113E-15	1.250E-13	7.780E-12	4.096E-10	4.520E-09	8.686E-09
Pb-210	U-234	1.000E+00	0.000E+00	1.990E-11	5.215E-10	1.741E-08	3.530E-07	5.310E-06	2.049E-05	2.524E-05
Pb-210	U-238	9.999E-01	0.000E+00	1.411E-17	1.110E-15	1.238E-13	7.558E-12	3.716E-10	3.444E-09	5.525E-09
Pb-210	äS(j):		0.000E+00	1.990E-11	5.215E-10	1.741E-08	3.530E-07	5.311E-06	2.050E-05	2.526E-05
Pu-239	Pu-239	1.000E+00	1.000E+00	9.996E-01	9.989E-01	9.965E-01	9.894E-01	9.652E-01	8.993E-01	7.019E-01
U-235	Pu-239	1.000E+00	0.000E+00	9.783E-10	2.896E-09	9.220E-09	2.434E-08	5.403E-08	6.865E-08	5.483E-08

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-235	U-235	1.000E+00	1.000E+00	9.871E-01	9.619E-01	8.784E-01	6.778E-01	2.736E-01	2.048E-02	2.350E-06
U-235	äS(j):		1.000E+00	9.871E-01	9.619E-01	8.784E-01	6.778E-01	2.736E-01	2.048E-02	2.404E-06
Pa-231	Pu-239	1.000E+00	0.000E+00	1.033E-14	9.134E-14	9.549E-13	7.238E-12	4.543E-11	1.049E-10	9.186E-11
Pa-231	U-235	1.000E+00	0.000E+00	2.089E-05	6.105E-05	1.858E-04	4.301E-04	5.783E-04	1.296E-04	4.919E-08
Pa-231	äS(j):		0.000E+00	2.089E-05	6.105E-05	1.858E-04	4.301E-04	5.783E-04	1.296E-04	4.928E-08
Ac-227	Pu-239	1.000E+00	0.000E+00	1.081E-16	2.791E-15	8.872E-14	1.593E-12	1.821E-11	5.126E-11	4.590E-11
Ac-227	U-235	1.000E+00	0.000E+00	3.269E-07	2.772E-06	2.513E-05	1.309E-04	2.902E-04	7.547E-05	3.005E-08
Ac-227	äS(j):		0.000E+00	3.269E-07	2.772E-06	2.513E-05	1.309E-04	2.902E-04	7.547E-05	3.010E-08
Pu-240	Pu-240	4.950E-08	4.950E-08	4.948E-08	4.944E-08	4.929E-08	4.886E-08	4.741E-08	4.349E-08	3.216E-08
Pu-240	Pu-240	1.000E+00	1.000E+00	9.996E-01	9.987E-01	9.957E-01	9.871E-01	9.578E-01	8.787E-01	6.497E-01
Pu-240	äS(j):		1.000E+00	9.996E-01	9.987E-01	9.957E-01	9.871E-01	9.578E-01	8.787E-01	6.497E-01
U-236	Pu-240	1.000E+00	0.000E+00	2.941E-08	8.705E-08	2.770E-07	7.307E-07	1.616E-06	2.027E-06	1.535E-06
Th-232	Pu-240	1.000E+00	0.000E+00	7.270E-19	6.485E-18	6.986E-17	5.771E-16	4.873E-15	2.396E-14	8.523E-14
Th-232	Th-232	1.000E+00	1.000E+00	1.000E+00	1.000E+00	9.999E-01	9.997E-01	9.989E-01	9.968E-01	9.892E-01
Th-232	äS(j):		1.000E+00	1.000E+00	1.000E+00	9.999E-01	9.997E-01	9.989E-01	9.968E-01	9.892E-01
Ra-228	Pu-240	1.000E+00	0.000E+00	2.832E-20	7.134E-19	2.109E-17	3.361E-16	3.978E-15	2.153E-14	7.861E-14
Ra-228	Th-232	1.000E+00	0.000E+00	1.131E-01	2.995E-01	6.750E-01	9.095E-01	9.277E-01	9.257E-01	9.187E-01
Ra-228	äS(j):		0.000E+00	1.131E-01	2.995E-01	6.750E-01	9.095E-01	9.277E-01	9.257E-01	9.187E-01
Th-228	Pu-240	1.000E+00	0.000E+00	2.406E-21	1.612E-19	1.112E-17	2.722E-16	3.785E-15	2.128E-14	7.841E-14
Th-228	Th-232	1.000E+00	0.000E+00	1.859E-02	1.232E-01	5.473E-01	8.989E-01	9.277E-01	9.257E-01	9.187E-01
Th-228	äS(j):		0.000E+00	1.859E-02	1.232E-01	5.473E-01	8.989E-01	9.277E-01	9.257E-01	9.187E-01
Sr-90	Sr-90	1.000E+00	1.000E+00	9.557E-01	8.728E-01	6.354E-01	2.565E-01	1.072E-02	1.233E-06	2.010E-20
U-238	U-238	5.400E-05	5.400E-05	5.330E-05	5.194E-05	4.744E-05	3.660E-05	1.477E-05	1.106E-06	1.269E-10
U-238	U-238	9.999E-01	9.999E-01	9.871E-01	9.618E-01	8.784E-01	6.778E-01	2.736E-01	2.048E-02	2.349E-06
U-238	äS(j):		1.000E+00	9.871E-01	9.619E-01	8.784E-01	6.778E-01	2.736E-01	2.048E-02	2.350E-06

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 2.01 seconds

Appendix D

Closure Activity Summary
(Use Restriction)

D.1.0 Closure Activity Summary

Corrective Action was required for CAU 370, CAS 04-23-01 because radiological and lead contamination above FALs were identified at the site. Soil samples, TLD, and Bicron measurements were collected to characterize the presence and lateral extent of radiological contamination at this site.

The CAI determined that a TEDE of up to 220.5 mrem/yr (under an Industrial Area exposure scenario) is present near GZ (Section A.3.1.3). The extent of radiological contamination causing a TEDE exceeding the FAL of 25 mrem/yr was established based on dose measurements from five sample plots along each of the three sample vectors emanating radially from GZ. The fourth flyover survey isopleth encompasses the locations along each vector that exceeded the FAL (Figure D.1-1, blue dashed line) and was established as the corrective action boundary for the annular distribution (Figure D.1-1, red line).

An area of elevated radiological readings was also identified in a southeast wash within the RMA fence (Figure D.1-1, inset) and indicated in the corrective action boundary (Section A.3.4). This area was found to have a TEDE of 108 mrem/yr.

Several lead objects were also identified at various locations within the RMA (Section A.3.3). The lead objects that were identified during visual inspection of the site were removed and were submitted for recycling. The potential exists for other lead objects to remain within the CAS (e.g., buried lead bricks within the existing use restricted area for CAU 357 near the T-4 bunker) and an indication of lead shielding within the T-4 bunker. The potential also exists that soil in contact with lead bricks may be contaminated with lead.

A use restriction was established that encompasses the corrective action boundary established for the annular distribution area, the area of elevated radiological readings in the southeast wash, and the remaining lead objects (Section 3.0). The use restricted area is identified in the CAU use restriction (see Figure D.1-5). However, because this use restricted area is enclosed by an existing fence (the RMA boundary fence), the fence was used to post the use restriction signs. Additionally, a sign was posted where the 4-04 Road enters the RMA from both directions (east and west) to inform travelers

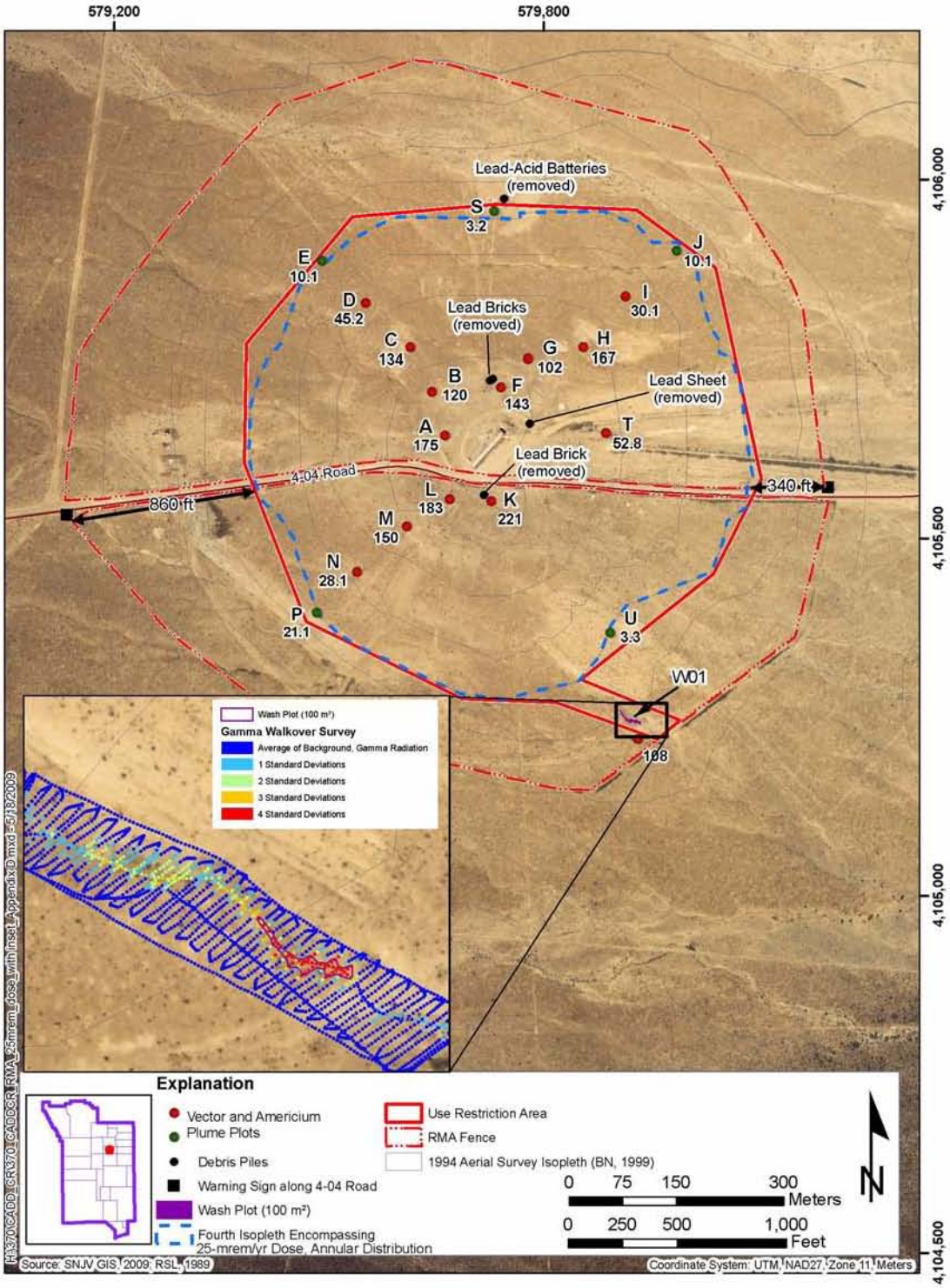

Figure D.1-1
Corrective Action Site 04-23-01, Areas Above 25-mrem/yr Dose

on the road of the presence of contamination at the site (i.e., beginning of the 25 mrem/yr boundary, 340 ft in from the east, and 860 ft in from the west).

The highest determined TEDE (220.5 mrem/yr at plot K; Figure 2-5) was used to derive a maximum hourly dose rate of 0.1 mrem/hr. At this rate, a worker exposed to the location of maximum dose would receive a 25-mrem/yr dose after a total exposure duration of 255 hours.

Activities such as the periodic maintenance of the 4-04 Road require workers' presence inside the use restriction boundary. Periodic road maintenance would likely consist of an infrequent, short-duration regrading of the road to address scalloping or erosion that can occur at any unpaved road at the NTS. Because regrading has the potential to generate significant levels of localized ambient dust, the potential for additional internal dose to a worker during work was also examined using the RESRAD computer code. The external dose component of the TEDE would remain unchanged.

An estimation of the dose received under a scenario involving road regrading was generated in RESRAD. Reasonable upper-bound values for the RESRAD parameters that are important to the inhalation and ingestion exposure pathways were selected from the RESRAD data collection handbook and input into the software. The resultant dose was found to be lower than the internal dose to a worker under the Industrial Area scenario due to a much shorter outdoor exposure time.

The 25-mrem/yr boundary is defined by the coordinates listed in the use restriction document. There are no plans to physically delineate the actual use restricted area as the larger RMA fence provides increased protection from exposure. Should the RMA fence be moved or removed due to a change in the RMA boundary, the use restriction warning signs may be moved but must encompass the boundary defined by the use restriction coordinates.

Use restriction signs (Figure D.1-2) were posted at approximately 200-ft intervals along the existing fence encompassing the RMA for the site. Additionally, two road signs, one at the east end of the RMA fencing (Figure D.1-3) and one at the west end of the RMA fencing (Figure D.1-4) along the 4-04 Road were installed to inform travelers on the road of the radiological dose present on the road from the surrounding area.

Figure D.1-2
Use Restriction Sign Posted for CAU 370, T-4 Atmospheric Test Site, CAS 04-23-01

Figure D.1-3
Warning Sign Installed Along the 4-04 Road at East End of the RMA Fencing

Figure D.1-4
Warning Sign Installed Along the 4-04 Road at West End of the RMA Fencing

CAU Use Restriction Information

CAU Number/Description: CAU 370, T-4 Atmospheric Test Site

Applicable CAS Number(s)/Description(s): CAS 04-23-01, Atmospheric Test Site T-4

Contact (organization/project): NNSA/NSO Soils Sub-Project Director

Surveyed Area (UTM, Zone 11, NAD 27, meters):

East/Southeast Corner:	E = 580038.93;N = 4105452.60
Southeast Corner:	E = 579852.08;N = 4105302.46
Southeast Extended Corner:	E = 579989.67;N = 4105245.87
South/Southeast Extended Corner:	E = 579958.13;N = 4105219.09
South/Southeast Corner:	E = 579816.45;N = 4105270.93
South Corner:	E = 579685.05;N = 4105275.66
Southwest Corner:	E = 579467.80;N = 4105384.33
West Corner:	E = 579381.57;N = 4105604.90
West/Northwest Corner:	E = 579383.82;N = 4105770.64
Northwest Corner:	E = 579532.07;N = 4105948.65
North/Northeast Corner:	E = 579928.88;N = 4105958.56
Northeast Corner:	E = 580040.10;N = 4105877.11
East Corner:	E = 580103.74;N = 4105583.29

Survey Date: January 2009 **Survey Method (GPS, etc):** Heads-up digitizing

Site Monitoring Requirements: Inspection of postings

Required Frequency (quarterly, annually?): Annual

If Monitoring Has Started, Indicate last Completion Date: Not Applicable

Use Restrictions

The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU Closure Report or other CAU 370 documentation, unless appropriate concurrence is obtained in advance.

Comments: This Use Restriction is to protect site workers from inadvertent exposure. This site was identified as containing lead sheeting/bricks that present a potential exposure to personnel. The maximum total dose to a worker from radiological contamination at the T-4 site was determined to be 220.5 mrem/yr. Based on this maximum dose, a worker could potentially receive a 25 mrem dose in 255 hours of exposure time or receive a maximum hourly dose rate of 0.1 mrem/hr. Major radionuclides present include americium-241, cesium-137, europium-152, plutonium-238, and plutonium-239/240. See the CADD/CR for CAU 370 for analytical results from samples collected at this site and additional information gathered during a corrective action investigation.

The use restricted area is established at the boundary identified by the coordinates listed above and depicted in the attached figure. The restricted area postings are placed at approximately 200-ft intervals on the existing fence line that encompasses the use restricted area. Annual post-closure inspections will be conducted to ensure postings are in place, intact, and readable. Personnel are restricted from performing work at this site that would require significant exposure to site contaminants. Restricted activities would include full-time work assignments, construction of facilities, or any activity that would result in a worker being assigned to a regular work station within the use restricted area. Permissible activities would include short duration activities such as site visits, travel along the 4-04 Road, maintenance of the fence and road, and retrieval of objects within the use restricted area. Restricted activities would require the prior approval from the NDEP.

Submitted By: **/s/ Tiffany Lantow** **Date:** **05/21/2009**

cc with copy of survey map (paper and digital (.dgn) formats):
CAU Files (2 copies)

The use restriction signs posted every 200 ft state the following information:

WARNING
Lead-Objects and Surface Radiological Contamination
FFACO Site CAU 370/CAS 04-23-01
Atmospheric Test Site T-4
No activities that may alter or modify the containment control are
permitted without U.S. Government permission.
Before working in this area,
Contact Real Estate Services at 295-2528

The posting located at the east entrance of the 4-04 Road to the site states the following information:

WARNING
Radiation Field Ahead Approximately 340 ft
FFACO Site CAU 370
Maximum dose: 0.1 mrem/hr
For information, contact Real Estate Services at 295-2528

The posting located at the west entrance of the 4-04 Road to the site states the following information:

WARNING
Radiation Field Ahead Approximately 860 ft
FFACO Site CAU 370
Maximum dose: 0.1 mrem/hr
For information, contact Real Estate Services at 295-2528

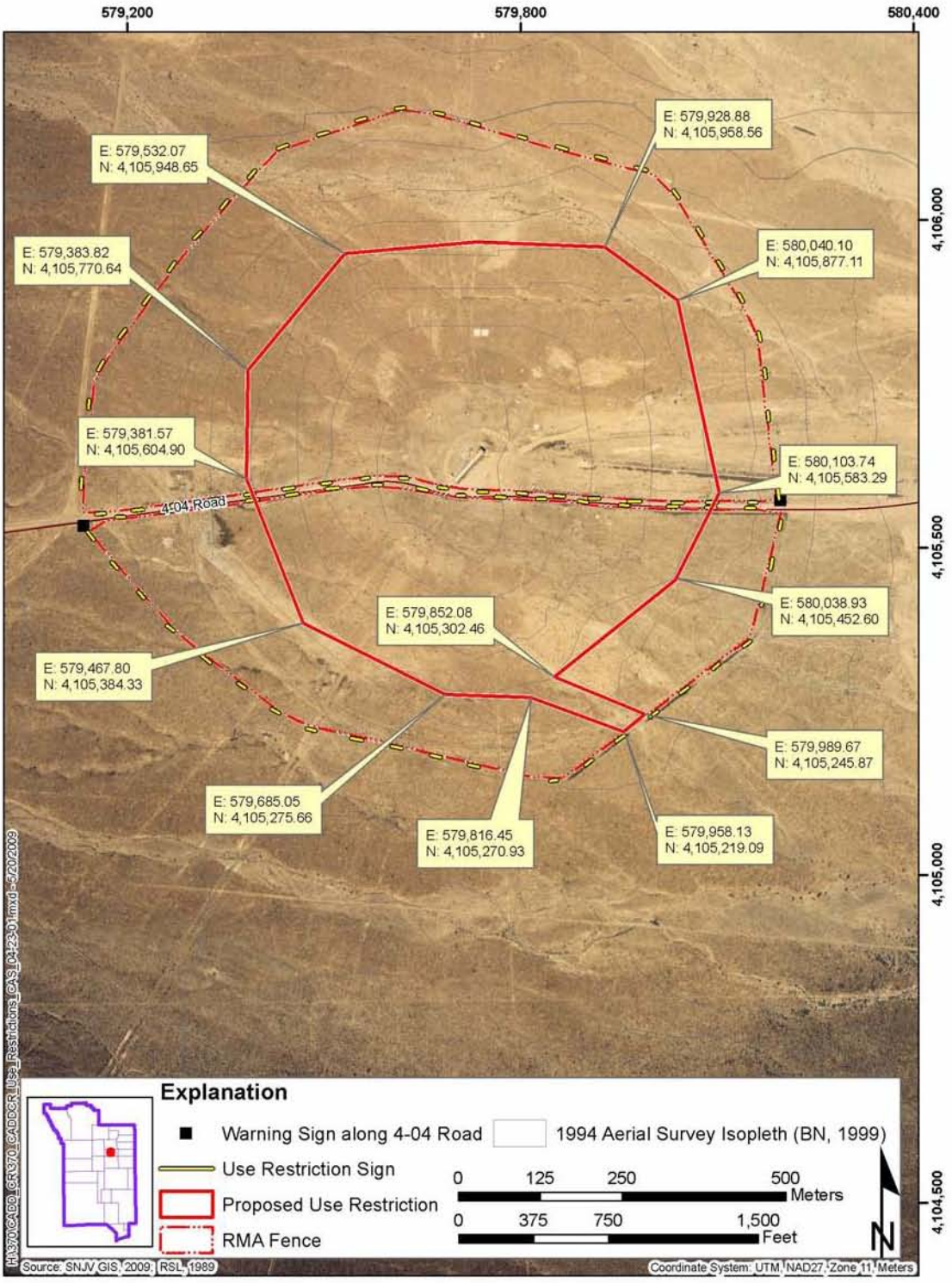

Figure D.1-5
Corrective Action Unit 370, T-4 Atmospheric Test Site,
CAS 04-23-01 Land Use Restriction Boundary

D.2.0 References

BN, see Bechtel Nevada.

Bechtel Nevada. 1999. *An Aerial Radiological Survey of the Nevada Test Site,* DOE/NV/11718--324. Prepared for the U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV: Remote Sensing Laboratory.

NNSA/NV, see U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office.

RSL, see Remote Sensing Laboratory.

SNJV GIS, see Stoller-Navarro Joint Venture Geographic Information Systems.

Remote Sensing Laboratory. 1989. Aerial Photograph "6613-075" September 23. Las Vegas, NV.

Stoller-Navarro Joint Venture Geographic Information Systems. 2009. ESRI ArcGIS Software.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2002. *Industrial Sites Quality Assurance Project Plan, Nevada Test Site, Nevada*, Rev. 4, DOE/NV--372. Las Vegas, NV.

Appendix E

Evaluation of Corrective Action Alternatives

E.1.0 Introduction

This appendix presents the corrective action objectives for CAU 370, describes the general standards and decision factors used to screen the various CAAs, and develops and evaluates a set of selected CAAs that will meet the corrective action objectives.

E.1.1 Corrective Action Objectives

The corrective action objective is to ensure that receptors are not subjected to an unacceptable risk from an exposure to a COC. A COC is defined as any contaminant exceeding a risk- or dose-based cleanup goal defined herein as a FAL. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006). Implementation of the corrective action will ensure that each release site will not pose an unacceptable risk to human health and the environment and that conditions at each site are in compliance with all applicable laws and regulations.

E.1.2 Screening Criteria

The screening criteria used to evaluate and select the preferred CAA are identified in the EPA *Guidance on RCRA Corrective Action Decision Documents* (EPA, 1991) and the *Final RCRA Corrective Action Plan* (EPA, 1994).

Corrective action alternatives are evaluated based on four general corrective action standards and five remedy selection decision factors. All CAAs must meet the four general standards to be selected for evaluation using the remedy selection decision factors.

The general corrective action standards are as follows:

- Protection of human health and the environment
- Compliance with media cleanup standards
- Control the source(s) of the release
- Comply with applicable federal, state, and local standards for waste management

The remedy selection decision factors are as follows:

- Short-term reliability and effectiveness
- Reduction of toxicity, mobility, and/or volume
- Long-term reliability and effectiveness
- Feasibility
- Cost

E.1.3 Corrective Action Standards

The following subsections describe the corrective action standards used to evaluate the CAAs.

Protection of Human Health and the Environment

Protection of human health and the environment is a general mandate of the RCRA statute (EPA, 1994). This mandate requires that the corrective action include any necessary protective measures. These measures may or may not be directly related to media cleanup, source control, or management of wastes.

Compliance with Media Cleanup Standards

The CAAs are evaluated for the ability to meet the proposed media cleanup standards. The media cleanup standards are the FALs.

Control the Source(s) of the Release

The CAAs are evaluated for the ability to stop further environmental degradation by controlling or eliminating additional releases that may pose a threat to human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will involve a perpetual cleanup. Therefore, each CAA must provide effective source control to ensure the long-term effectiveness and protectiveness of the corrective action.

Comply with Applicable Federal, State, and Local Standards for Waste Management

The CAAs are evaluated for the ability to be conducted in accordance with applicable federal and state regulations (e.g., 40 CFR 260-282, “Hazardous Waste Management” [CFR, 2006a]; 40 CFR 761 “Polychlorinated Biphenyls,” [CFR, 2006b]; and NAC 444.842 to 98, “Management of Hazardous Waste” [NAC, 2006]).

E.1.3.1 Remedy Selection Decision Factors

The following text describes the remedy selection decision factors used to evaluate the CAAs.

Short-Term Reliability and Effectiveness

Each CAA must be evaluated with respect to its effects on human health and the environment during implementation of the selected corrective action. The following factors will be addressed for each alternative:

- Protection of the community from potential risks associated with implementation, (e.g., fugitive dusts, transportation of hazardous materials, and explosion).
- Protection of workers during implementation.
- Environmental impacts that may result from implementation.
- The amount of time until the corrective action objectives are achieved.

Reduction of Toxicity, Mobility, and/or Volume

Each CAA must be evaluated for its ability to reduce the toxicity, mobility, and/or volume of the contaminated media. Reduction in toxicity, mobility, and/or volume refers to changes in one or more characteristics of the contaminated media by using corrective measures that decrease the inherent threats associated with that media.

Long-Term Reliability and Effectiveness

Each CAA must be evaluated in terms of risk remaining at the CAU after the CAA has been implemented. The primary focus of this evaluation is on the extent and effectiveness of the control that may be required to manage the risk posed by treatment of residuals and/or untreated wastes.

Feasibility

The feasibility criterion addresses the technical and administrative feasibility of implementing a CAA and the availability of services and materials needed during implementation. Each CAA must be evaluated for the following criteria:

- Construction and Operation – The feasibility of implementing a CAA given the existing set of waste and site-specific conditions.

- Administrative Feasibility – The administrative activities needed to implement the CAA (e.g., permits, use restrictions, public acceptance, rights-of-way, off-site approval).

- Availability of Services and Materials – The availability of adequate offsite and onsite treatment, storage capacity, disposal services, necessary technical services and materials, and prospective technologies for each CAA.

Cost

Costs for each alternative are estimated for comparison purposes only. The cost estimate for each CAA includes both capital, and operation and maintenance costs, as applicable, and are provided in Section E.3.0. The following is a brief description of each component:

- Capital Costs – Include direct costs that may consist of materials, labor, construction materials, equipment purchase and rental, excavation and backfilling, sampling and analysis, waste disposal, demobilization, and health and safety measures. Indirect costs are separate and not included in the estimates.

- Operation and Maintenance – Are separate costs that include labor, training, sampling and analysis, maintenance materials, utilities, and health and safety measures. These costs are not included in the estimates.

E.1.4 Development of Corrective Action Alternatives

This section identifies and briefly describes the viable corrective action technologies and the CAAs considered for CAS 04-23-01. Based on the review of existing data, future use, and current operations at the NTS, the following alternatives have been developed for consideration at CAU 370:

- Alternative 1 – No Further Action
- Alternative 2 – Clean Closure
- Alternative 3 – Close in Place

E.1.4.1 Alternative 1 – No Further Action

Under the no further action alternative, no corrective action activities will be implemented. This alternative is a baseline case with which to compare and assess the other CAAs and their ability to meet the corrective action standards.

E.1.4.2 Alternative 2 – Clean Closure

Alternative 2 includes excavating and disposing of all impacted soil and debris containing COCs, including surface soil within the 25 mrem/yr TEDE boundary, the subsurface soil west of the T-4 bunker presently under the use restriction for CAU 357, CAS 04-26-03, and the lead shielding attached to the T-4 bunker. A visual inspection will be conducted to ensure that surface debris have been removed before the completion of the corrective action. Verification soil samples will also be collected and analyzed for the presence of COCs once the contaminated soil is removed.

Contaminated materials removed will be disposed of at an appropriate disposal facility. Excavated areas will be returned to surface conditions compatible with the intended future use of the site.

E.1.4.3 Alternative 3 – Close in Place

For contaminated surface and shallow subsurface soil (i.e., within the CAS 04-26-03 use restricted area) soil, Alternative 3 includes the implementation of a use restriction where lead contamination and radiological dose is present at levels that exceed the FALs. Administrative controls will restrict inadvertent contact with contaminated media by prohibiting any activity that would cause significant exposure of site occupants to the identified COCs.

E.1.5 Evaluation and Comparison of Alternatives

Each CAA presented in Section E.1.4 will be evaluated based on the general corrective action standards described in Section E.1.2. This evaluation is presented in Table E.1-1. Any CAA that does not meet the general corrective action standards will be removed from consideration.

Only CAAs 2 and 3 met the CAA standard and will be further evaluated based on the remedy selection decision factors described in Section E.1.2. This evaluation is presented in Table E.1-2. For each remedy selection decision factor, the CAAs are ranked relative to each other. The CAA with the least desirable impact on the remedy selection decision factor will be given a ranking of 1. The CAAs with increasingly desirable impacts on the remedy selection decision factor will receive increasing rank numbers. The CAAs that will have an equal impact on the remedy selection decision factor will receive an equal ranking number. The scoring listed in this table represents the sum of the remedy selection decision factor rankings for each CAA.

Table E.1-1
Evaluation of General Corrective Action Standards

CAS 04-23-01, Atmospheric Test Site T-4

CAA 1, No Further Action

Standard	Comply?	Explanation
Protection of Human Health and the Environment	No	COCs are present at concentrations that exceed the FALs.
Compliance with Media Cleanup Standards	No	COCs are present at concentrations that exceed the FALs.
Control the Source(s) of the Release	Yes	Mature vegetation in the wash has stabilized the soil.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.

CAA 2, Clean Closure

Standard	Comply?	Explanation
Protection of Human Health and the Environment	Yes	Contamination exceeding the risk-based action levels will be removed.
Compliance with Media Cleanup Standards	Yes	Contamination exceeding the risk-based action levels will be removed.
Control the Source(s) of the Release	Yes	Lead and radiological contamination will be removed.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	Excavated waste can be managed in compliance with all standards.

CAA 3, Close in Place with Administrative Controls

Standard	Comply?	Explanation
Protection of Human Health and the Environment	Yes	A use restriction will be implemented to protect site workers from contamination exceeding the risk-based action levels.
Compliance with Media Cleanup Standards	Yes	Although COCs will not be removed, site workers will not be exposed to COCs.
Control the Source(s) of the Release	Yes	Mature vegetation in the wash has stabilized the soil.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.

Table E.1-2
Evaluation of Remedy Selection Decision Factors

CAS 04-23-01, Atmospheric Test Site T-4		
CAA 1, No Further Action		
Factor	Rank	Explanation
Not evaluated as this CAA did not meet the General Corrective Action Standards		
CAA 2, Clean Closure		
Standard	Rank	Explanation
Short-Term Reliability and Effectiveness	1	This alternative is reliable and effective but involves increased short-term exposure of site workers to COCs during soil removal operations.
Reduction of Toxicity, Mobility, and/or Volume	2	This alternative will result in a decrease of toxicity and mobility but will generate significant waste volumes.
Long-Term Reliability and Effectiveness	2	This alternative is reliable and effective at protecting human health and the environment because removal of contaminated media will prevent future exposure of site workers to COCs.
Feasibility	1	This alternative is the most complicated of the CAAs.
Cost	1	The excavation and waste disposal costs for this alternative (estimated to be approximately $31,600,000).
Score	7	
CAA 3, Close in Place with Administrative Controls		
Standard	Rank	Explanation
Short-Term Reliability and Effectiveness	2	This alternative is reliable and effective in providing increased protection of human health by preventing contact with COCs.
Reduction of Toxicity, Mobility, and/or Volume	1	This alternative will not reduce toxicity or mobility of the COCs that are present but will not generate excavation waste volumes.
Long-Term Reliability and Effectiveness	1	This alternative is reliable in the long term with ongoing maintenance. It is effective in providing increased protection of human health by preventing contact with COCs.
Feasibility	2	This alternative is easily implemented but requires maintenance.
Cost	2	The installation and ongoing maintenance costs for this alternative (estimated to be minimal).
Score	8	

E.2.0 Recommended Alternative

Three CAAs were evaluated for CAS 04-23-01: No Further Action (CAA 1); Clean Closure (CAA 2); and Close in Place (CAA 3). Only CAA 2 and CAA 3 met all requirements for general corrective action standards (Section E.1.2). In general, for the Clean Closure alternative, lead and radiological contamination would be removed from the site to levels below FALs, with no PSM remaining. For the Close in Place alternative, potential worker exposure to lead and radiological contamination would be controlled administratively. Both CAAs would, therefore, be protective of human health and the environment, comply with media cleanup standards, and control the source of release. As supported by the following discussion, further examination of the two CAAs by the five EPA remedy selection decision factors resulted in the selection of Close in Place as the preferred CAA for CAS 04-23-01, Atmospheric Test Site T-4.

The five EPA remedy selection decision factors are short-term reliability and effectiveness; reduction of toxicity, mobility, and/or volume; long-term reliability and effectiveness; feasibility; and cost. These factors are provided in Table E.1-2.

The first remedy selection decision factor, short-term reliability and effectiveness, is a qualitative measure of the impacts on human health and the environment during implementation of the CAA. While Clean Closure is both reliable and effective in the short-term, this alternative involves increased, short-term exposure of site workers to lead and radiological contamination during soil and debris removal. In contrast, Close in Place does not require removal of soil and there is no short-term exposure of site workers; signs are posted on existing fencing, and disturbance of contaminated soil and debris is not necessary.

The second remedy selection decision factor, reduction of toxicity, mobility, and/or volume, is a qualitative measure of changes in characteristics of contaminated media that result from implementation of the CAA. Under Clean Closure, contaminated media that exceed FALs would be removed from the area, thereby eliminating both mobility and the onsite volume of contaminated media. In contrast, Close in Place does not reduce toxicity, mobility, or volume.

The third remedy selection decision factor, long-term reliability and effectiveness, is a qualitative evaluation of performance following site closure, and into the future. Removal of contaminated media for Clean Closure provides long-term reliability and effectiveness; Close in Place does not.

The fourth remedy selection decision factor, feasibility, includes an evaluation of the requirements for construction and operation as well as administrative constraints. For the Close in Place alternative, no construction, little maintenance, and administrative constraints are required. For the Clean Closure alternative, substantial construction, operation, and administrative actions consistent with soil removal and management of generated wastes are needed.

The fifth remedy selection decision factor, cost, includes assessment of both capital (direct) costs of implementation and costs for operation and maintenance of the corrective action. As shown in Table E.1-2, the estimated costs for Clean Closure exceed $31,000,000, while the costs for Closure in Place are limited to those derived from acquiring, hanging, inspecting, and occasionally replacing, use restriction and road signs.

Based upon the five remedy selection decision factors, Clean Closure received an overall score of 7 (less desirable), whereas Close in Place received an overall score of 8 (more desirable). This result was not only the product of an examination of the two CAAs, by the five remedy selection decision factors, but also in consideration of the current NTS administrative controls (e.g. NTS access restrictions and control of site activities), the present-day stability of the contaminated soil at the T-4 site through the evolution of a mature plant community, the development of soil surface durability (i.e., soil crust) and limited lateral migration of contamination in washes.

Therefore, selecting the preferred corrective action alternative of Close in Place for CAS 04-23-01 is consistent with past practices for CASs that contain COCs and where there would be significant costs and short-term health risks to workers involved in clean-up activities.

E.3.0 Cost Estimates

The cost estimate for clean closure is $31,584,982 to conduct the following activities:

- Preparation and procurement
- Grub surface contamination
- Excavate, load, and dispose contaminated soil (approximately 148,000 cubic yards)
- Remove lead bricks
- Demolish, process, and dispose of the T-4 bunker
- Equipment decontamination
- Microencapsulation of mixed waste

E.4.0 References

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2006a. Title 40 CFR Parts 260 - 282, "Hazardous Waste Management." Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2006b. Title 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce and Prohibitions." Washington, DC: U.S. Government Printing Office.

EPA, see U.S. Environmental Protection Agency.

NAC, see *Nevada Administrative Code*.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

Nevada Administrative Code. 2006. NAC 445A, "Water Controls." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 13 December 2007.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2006. *Industrial Sites Project Establishment of Final Action Levels,* Rev. 0, DOE/NV--1107. Las Vegas, NV.

U.S. Environmental Protection Agency. 1991. *Guidance on RCRA Corrective Action Decision Documents,* EPA/540/G-91/011. Washington, DC: Office of Research and Development.

U.S. Environmental Protection Agency. 1994. *Final RCRA Corrective Action Plan,* EPA/520-R-94-004. Washington, DC: Office of Solid Waste and Emergency Response.

Appendix F

Composite Sample Plot Analytical Data

F.1.0 Composite Sample Analytical Data

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample plots in CAS 04-23-01 that were detected above MDCs are presented in the following tables. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Vector 1 Sample Plots (A, B, C, D, and E):

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot A are presented in Tables F.1-1 through F.1-3.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot B are presented in Tables F.1-4 through F.1-6.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot C are presented in Tables F.1-7 through F.1-9.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot D are presented in Tables F.1-10 through F.1-12.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot E are presented in Tables F.1-13 through F.1-15.

Table F.1-1
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot A

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)								
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thallium-208
A1	370A001	0.0 - 5.0	1.15	81.5	1.12	95	90 (J)	3.22 (J)	1.48 (J)	1.17 (J)	0.51
A2	370A002	0.0 - 5.0	2.17	80.2	1.07	90	90 (J)	3.5 (J)	1.46 (J)	1.55 (J)	0.47
A3	370A003	0.0 - 5.0	1.11	72.1	1.01	90	83.8 (J)	2.76 (J)	1.17 (J)	1.03 (J)	0.58
A4	370A004	0.0 - 5.0	1.28	68.8	1	85.8	96 (J)	3.76 (J)	1.66 (J)	1.3 (J)	0.55

J = Estimated value

Table F.1-2
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot A

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
A1	370A001	0.0 - 5.0	65.2 (J)
A2	370A002	0.0 - 5.0	43.8 (J)
A3	370A003	0.0 - 5.0	81 (J)
A4	370A004	0.0 - 5.0	57.7 (J)

J = Estimated value

Table F.1-3
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot A

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
A1	370A001	0.0 - 5.0	95 (J)	341 (J)	13.1	0.83	0.96
A2	370A002	0.0 - 5.0	66.3 (J)	232 (J)	14.6	1.12	0.79
A3	370A003	0.0 - 5.0	109 (J)	378 (J)	11.1	1.24	0.93
A4	370A004	0.0 - 5.0	70 (J)	253 (J)	10.2	1.2	0.99

J = Estimated value

Table F.1-4
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot B

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)								
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thallium-208
B1	370B001	0.0 - 5.0	1.66	40.7	0.549	73.7	32.3 (J)	1.25 (J)	1.48 (J)	0.99 (J)	0.47
B2	370B002	0.0 - 5.0	1.46	51.7	0.595	84.6	33.8 (J)	1.26 (J)	1.49 (J)	1.17 (J)	0.52
B3	370B003	0.0 - 5.0	1.3	48.8	0.591	79.4	37.8 (J)	1.49 (J)	1.49 (J)	1.23 (J)	0.41
B4	370B004	0.0 - 5.0	1.31	39	0.543	66.7	37.5 (J)	1.73 (J)	1.47 (J)	1.07 (J)	0.56

J = Estimated value

Table F.1-5
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot B

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
B1	370B001	0.0 - 5.0	40.6 (J)
B2	370B002	0.0 - 5.0	67.3 (J)
B3	370B003	0.0 - 5.0	39.9 (J)
B4	370B004	0.0 - 5.0	24.7 (J)

J = Estimated value

Table F.1-6
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot B

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
B1	370B001	0.0 - 5.0	57.7 (J)	224 (J)	5.5	1.05	0.71
B2	370B002	0.0 - 5.0	96 (J)	381 (J)	5.3	1.25	0.99
B3	370B003	0.0 - 5.0	63.6 (J)	251 (J)	8.9	1.13	0.97
B4	370B004	0.0 - 5.0	44.8 (J)	180 (J)	6.7	1.17	0.96

J = Estimated value

Table F.1-7
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot C

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)									
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thorium-234	Thallium-208
C1	370C001	0.0 - 5.0	1.52	28.5	0.633	60	58.3	2.41	1.72	1.53 (J)	--	0.56
C2	370C002	0.0 - 5.0	1.82	24.3	0.582	57	60.4	2.11	1.64	1.34 (J)	--	0.62
C3	370C003	0.0 - 5.0	1.65	28	0.64	50.4	61	2.02	1.74	1.48 (J)	4.3	0.68
C4	370C004	0.0 - 5.0	1.13	45.8	0.71	80	57.4 (J)	1.91 (J)	1.51 (J)	1.6 (J)	--	0.65

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-8
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot C

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
C1	370C001	0.0 - 5.0	20.8 (J)
C2	370C002	0.0 - 5.0	19 (J)
C3	370C003	0.0 - 5.0	17.7 (J)
C4	370C004	0.0 - 5.0	55.2 (J)

J = Estimated value

Table F.1-9
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot C

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
C1	370C001	0.0 - 5.0	42.5 (J)	192 (J)	2.7	1.56	0.94
C2	370C002	0.0 - 5.0	43.2 (J)	180 (J)	3.3	1.25	1.18
C3	370C003	0.0 - 5.0	32.5 (J)	139 (J)	2.51	1.42	1.14
C4	370C004	0.0 - 5.0	92 (J)	349 (J)	3.18	1.4	0.89

J = Estimated value

Table F.1-10
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot D

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)								
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thallium-208
D1	370D001	0.0 - 5.0	1.77	2.56	0.153	8.6	19.1	0.93	1.72	1.39 (J)	0.65
D2	370D002	0.0 - 5.0	1.77	--	0.181	10.2	19.7	--	1.98	1.54 (J)	0.65
	370D003	0.0 - 5.0	2.14	2	0.193	10.3	20.2	0.96	2.01	1.55 (J)	0.69
D3	370D004	0.0 - 5.0	1.4	2.36	0.17	12.2	18.6	1.35	1.74	1.31 (J)	0.558
D4	370D005	0.0 - 5.0	1.93	--	0.153	9.9	19.1	0.94	1.93	1.35 (J)	0.62

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-11
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot D

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
D1	370D001	0.0 - 5.0	0.66 (J)
D2	370D002	0.0 - 5.0	0.68 (J)
	370D003	0.0 - 5.0	1.78 (J)
D3	370D004	0.0 - 5.0	2.02 (J)
D4	370D005	0.0 - 5.0	0.91 (J)

J = Estimated value

Table F.1-12
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot D

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
D1	370D001	0.0 - 5.0	1.72 (J)	12.4 (J)	1.19	1.07	0.97
D2	370D002	0.0 - 5.0	2.24 (J)	16.3 (J)	--	0.98	1.01
	370D003	0.0 - 5.0	5.06 (J)	36.7 (J)	1.51	1.18	1
D3	370D004	0.0 - 5.0	6.5 (J)	45 (J)	1.39	1.28	0.91
D4	370D005	0.0 - 5.0	3.68 (J)	26.8 (J)	--	0.87	0.87

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-13
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot E

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)						
			Actinium-228	Americium-241	Cesium-137	Europium-152	Lead-212	Lead-214	Thallium-208
E1	370E001	0.0 - 5.0	1.66	0.83	5.07	6.06	1.63	1.24 (J)	0.514
E2	370E002	0.0 - 5.0	1.62	--	5.58	5.69	1.73	1.32 (J)	0.612
E3	370E003	0.0 - 5.0	1.65	1.01	5.62	5.8	1.68	1.24 (J)	0.562
E4	370E004	0.0 - 5.0	1.78	1.13	5.93	5.97	1.79	1.19 (J)	0.58

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-14
Sample Results for Americium-241 Detected above
Minimum Detectable Concentrations at Sample Plot E

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
E1	370E001	0.0 - 5.0	0.68 (J)
E2	370E002	0.0 - 5.0	0.45 (J)
E3	370E003	0.0 - 5.0	0.53 (J)
E4	370E004	0.0 - 5.0	0.66 (J)

J = Estimated value

Table F.1-15
Sample Results for Isotopes Detected above
Minimum Detectable Concentrations at Sample Plot E

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)			
			Plutonium-238	Plutonium-239/240	Uranium-234	Uranium-238
E1	370E001	0.0 - 5.0	1.68 (J)	11.3 (J)	0.96	0.85
E2	370E002	0.0 - 5.0	1.39 (J)	9.8 (J)	0.95	0.88
E3	370E003	0.0 - 5.0	1.26 (J)	9.1 (J)	1.04	1.07
E4	370E004	0.0 - 5.0	2.45 (J)	17.9 (J)	0.96	0.93

J = Estimated value

Vector 2 Sample Plots (F, G, H, I, and J):

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot F are presented in Tables F.1-16 through F.1-18.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot G are presented in Tables F.1-19 through F.1-21.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot H are presented in Tables F.1-22 through F.1-24.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot I are presented in Tables F.1-25 through F.1-27.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot J are presented in Tables F.1-28 through F.1-30.

Table F.1-16
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot F

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)								
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thallium-208
F1	370F001	0.0 - 5.0	1.73	59.7	0.91	74.9	73.6	2.82	1.3	1.43 (J)	0.51
F2	370F002	0.0 - 5.0	1.52	42.3	0.78	53.4	79.9	3.47	1.32	1.3 (J)	0.66
F3	370F003	0.0 - 5.0	1.53	53.9	0.85	75.4	71.7	2.39	1.77	1.4 (J)	0.54
F4	370F004	0.0 - 5.0	1.31	58.5	0.83	70.6	70.9	1.95	1.57	1.17 (J)	0.47

J = Estimated value

Table F.1-17
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot F

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
F1	370F001	0.0 - 5.0	54.8 (J)
F2	370F002	0.0 - 5.0	25.6 (J)
F3	370F003	0.0 - 5.0	64.5 (J)
F4	370F004	0.0 - 5.0	30.2 (J)

J = Estimated value

Table F.1-18
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot F

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
F1	370F001	0.0 - 5.0	75 (J)	260 (J)	4.2	1.11	0.99
F2	370F002	0.0 - 5.0	41.4 (J)	150 (J)	3	1.13	0.84
F3	370F003	0.0 - 5.0	76 (J)	262 (J)	4.3	1	1.03
F4	370F004	0.0 - 5.0	51.3 (J)	180 (J)	3.4	1.09	0.85

J = Estimated value

Table F.1-19
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot G

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)								
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thallium-208
G1	370G001	0.0 - 5.0	1.12	74.1	1.13	119	78.4	3.32	1.63	0.83 (J)	0.42
G2	370G002	0.0 - 5.0	1.39	80.4	0.98	119	58.3	2.26	1.4	1.13 (J)	0.51
G3	370G003	0.0 - 5.0	1.44	68.2	0.98	105	81.7	3.69	1.54	1.45 (J)	0.57
G4	370G004	0.0 - 5.0	1.46	62	0.84	98	59.7	2.81	1.45	1.34 (J)	0.39

J = Estimated value

Table F.1-20
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot G

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
G1	370G001	0.0 - 5.0	41.4 (J)
G2	370G002	0.0 - 5.0	59.8 (J)
G3	370G003	0.0 - 5.0	71 (J)
G4	370G004	0.0 - 5.0	68 (J)

J = Estimated value

Table F.1-21
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot G

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
G1	370G001	0.0 - 5.0	88 (J)	512 (J)	9.4	2.13	1.13
G2	370G002	0.0 - 5.0	92 (J)	349 (J)	5.9	1.12	0.85
G3	370G003	0.0 - 5.0	92 (J)	360 (J)	4.9	1.6	1.05
G4	370G004	0.0 - 5.0	101 (J)	388 (J)	5.2	1.4	1.06

J = Estimated value

Table F.1-22
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot H

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)								
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thallium-208
H1	370H001	0.0 - 5.0	1.83	12.8	0.525	50	50.6	1.85	1.93	1.34 (J)	0.59
H2	370H002	0.0 - 5.0	2.15	9.8	0.474	41.9	55.9 (J)	2.27	2.12 (J)	1.58 (J)	0.72
H3	370H003	0.0 - 5.0	1.64	10.1	0.465	38.3	53.6	2.21	1.99	1.65 (J)	0.62
H4	370H004	0.0 - 5.0	1.32	13.1	0.63	56	50.5	2.23	1.79	1.68 (J)	0.57

J = Estimated value

Table F.1-23
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot H

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
H1	370H001	0.0 - 5.0	7.6 (J)
H2	370H002	0.0 - 5.0	4.15 (J)
H3	370H003	0.0 - 5.0	5.91 (J)
H4	370H004	0.0 - 5.0	13.5 (J)

J = Estimated value

Table F.1-24
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot H

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
H1	370H001	0.0 - 5.0	16.7 (J)	132 (J)	2.59	1.66	0.85
H2	370H002	0.0 - 5.0	8.5 (J)	85 (J)	--	1.26	1.09
H3	370H003	0.0 - 5.0	13.4 (J)	104 (J)	3.5	1.21	0.9
H4	370H004	0.0 - 5.0	27.1 (J)	228 (J)	2.66	2.08	1.21

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-25
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot I

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)									
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thorium-234	Thallium-208
I1	370I001	0.0 - 5.0	1.94	1.18	--	5.79	15.8	--	1.95	1.32 (J)	2.05	0.65
	370I002	0.0 - 5.0	1.99	--	0.118	4.99	15.7	--	2	1.29 (J)	--	0.611
I2	370I003	0.0 - 5.0	2.17	--	0.105	6.66	17 (J)	0.94	2.44 (J)	1.55 (J)	--	0.75
I3	370I004	0.0 - 5.0	2.05	--	--	5.37	16.3	0.75	2.16	1.47 (J)	--	0.65
I4	370I005	0.0 - 5.0	2.03	1.32	--	6.27	16.3 (J)	--	2.01 (J)	1.51 (J)	--	0.63

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-26
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot I

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
I1	370I001	0.0 - 5.0	0.96 (J)
	370I002	0.0 - 5.0	0.61 (J)
I2	370I003	0.0 - 5.0	0.8 (J)
I3	370I004	0.0 - 5.0	0.68 (J)
I4	370I005	0.0 - 5.0	0.93 (J)

J = Estimated value

Table F.1-27
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot I

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)			
			Plutonium-238	Plutonium-239/240	Uranium-234	Uranium-238
I1	370I001	0.0 - 5.0	2.8 (J)	16 (J)	1.15	0.94
	370I002	0.0 - 5.0	2.92 (J)	18.7 (J)	0.97	0.93
I2	370I003	0.0 - 5.0	2.35 (J)	17.3 (J)	1.17	1.12
I3	370I004	0.0 - 5.0	1.86 (J)	15 (J)	1.07	1.05
I4	370I005	0.0 - 5.0	3.09 (J)	19 (J)	1.19	1.13

J = Estimated value

Table F.1-28
Sample Results for Gamma-Emitting Radionuclides Detected above Minimum Detectable Concentrations at Sample Plot J

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)						
			Actinium-228	Americium-241	Cesium-137	Europium-152	Lead-212	Lead-214	Thallium-208
J1	370J001	0.0 - 5.0	1.34	--	3.35	3.5 (J)	1.41 (J)	1.01 (J)	0.446
J2	370J002	0.0 - 5.0	1.45	1.41	6.51	4.01 (J)	1.5 (J)	1.07 (J)	0.424
J3	370J003	0.0 - 5.0	1.5	--	3.9	3.87 (J)	1.58 (J)	1.08 (J)	0.484
J4	370J004	0.0 - 5.0	1.57	--	3.33	3.62 (J)	1.55 (J)	1.04 (J)	0.503

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-29
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot J

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
J1	370J001	0.0 - 5.0	0.73 (J)
J2	370J002	0.0 - 5.0	0.62 (J)
J3	370J003	0.0 - 5.0	0.42 (J)
J4	370J004	0.0 - 5.0	0.241 (J)

J = Estimated value

Table F.1-30
Sample Results for Isotopes Detected above
Minimum Detectable Concentrations at Sample Plot J

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Uranium-234	Uranium-235	Uranium-238
J1	370J001	0.0 - 5.0	1.55 (J)	10.8 (J)	0.78	--	0.72
J2	370J002	0.0 - 5.0	1.61 (J)	11.6 (J)	0.76	0.085	0.67
J3	370J003	0.0 - 5.0	1 (J)	10 (J)	0.87	0.06	0.84
J4	370J004	0.0 - 5.0	0.93 (J)	5.73 (J)	0.84	--	0.79

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Vector 3 Sample Plots (K, L, M, N, and P):

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot K are presented in Tables F.1-31 through F.1-33.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot L are presented in Tables F.1-34 through F.1-36.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot M are presented in Tables F.1-37 through F.1-39

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot N are presented in Tables F.1-40 through F.1-42.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot P are presented in Tables F.1-43 through F.1-45.

Table F.1-31
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot K

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)								
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thallium-208
K1	370K001	0.0 - 5.0	1.6	42.2	0.67	90	59	2.27	1.49	1.37 (J)	0.59
K2	370K002	0.0 - 5.0	1.12	55.2	0.79	114	55.6	2.19	1.55	1.3 (J)	0.5
K3	370K003	0.0 - 5.0	1.04	66.3	0.81	118	57.4	2.31	1.24	1.5 (J)	0.64
K4	370K004	0.0 - 5.0	1.34	46.5	0.72	94	57.9	1.76	1.48	1.25 (J)	0.45

J = Estimated value

Table F.1-32
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot K

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
K1	370K001	0.0 - 5.0	57
K2	370K002	0.0 - 5.0	59
K3	370K003	0.0 - 5.0	69
K4	370K004	0.0 - 5.0	53.2

Table F.1-33
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot K

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
K1	370K001	0.0 - 5.0	83	359	10.3	1.83	0.95
K2	370K002	0.0 - 5.0	85	346	15.8	1.55	0.89
K3	370K003	0.0 - 5.0	97	412	23.6	1.32	1.04
K4	370K004	0.0 - 5.0	65	282	9.3	1.63	1.12

Table F.1-34
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot L

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)								
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thallium-208
L1	370L001	0.0 - 5.0	1.44	141	1.21	218	32	1.34	1.51	1.17 (J)	0.54
L2	370L002	0.0 - 5.0	1.3	164	1.3	246	31.5	2.22	1.55	1 (J)	--
L3	370L003	0.0 - 5.0	1.51	182	1.39	248	34.2	--	1.35	1.22 (J)	0.59
L4	370L004	0.0 - 5.0	1.7	159	1.32	254	29	1.71	1.48	1.19 (J)	0.56

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-35
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot L

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
L1	370L001	0.0 - 5.0	196
L2	370L002	0.0 - 5.0	185 (J)
L3	370L003	0.0 - 5.0	174
L4	370L004	0.0 - 5.0	376

J = Estimated value

Table F.1-36
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot L

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
L1	370L001	0.0 - 5.0	228	920	27.9	1.4	1.16
L2	370L002	0.0 - 5.0	248 (J)	930 (J)	21.9	2.15	1.52
L3	370L003	0.0 - 5.0	252	910	26	1.42	1.02
L4	370L004	0.0 - 5.0	394	1450	25	2.05	1.46

J = Estimated value

Table F.1-37
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot M

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)								
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thallium-208
M1	370M001	0.0 - 5.0	1.81	77.9	0.89	106	40.3	1.2	1.8	1.39 (J)	0.65
	370M002	0.0 - 5.0	1.49	80.3	0.88	109	40.3	1.48	1.77	1.5 (J)	0.59
M2	370M003	0.0 - 5.0	1.29	83.8	0.85	110	37.2	3.05	1.57	1.2 (J)	0.57
M3	370M004	0.0 - 5.0	1.62	76.9	0.86	112	36.8	1.7	1.31	1.31 (J)	0.54
M4	370M005	0.0 - 5.0	1.47	98	1.05	131	37.7	1.7	1.6	1.17 (J)	0.45

J = Estimated value

Table F.1-38
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot M

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
M1	370M001	0.0 - 5.0	184
	370M002	0.0 - 5.0	82
M2	370M003	0.0 - 5.0	106
M3	370M004	0.0 - 5.0	136
M4	370M005	0.0 - 5.0	77

Table F.1-39
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot M

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
M1	370M001	0.0 - 5.0	194	750	4.4	1.81	0.63
	370M002	0.0 - 5.0	97	438	3.8	1.42	0.94
M2	370M003	0.0 - 5.0	129	530	6.9	1.75	1
M3	370M004	0.0 - 5.0	165	690	5.8	1.72	0.84
M4	370M005	0.0 - 5.0	108	422	7.6	1.59	0.78

Table F.1-40
Sample Results for Gamma-Emitting Radionuclides
Detected above Minimum Detectable Concentrations at Sample Plot N

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)								
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Europium-154	Lead-212	Lead-214	Thallium-208
N1	370N001	0.0 - 5.0	1.91	1.48	0.145	6.44	14.2	0.77	1.79	1.37 (J)	0.57
N2	370N002	0.0 - 5.0	1.79	1.63	0.13	8.15	13.8	--	1.84	1.28 (J)	0.533
N3	370N003	0.0 - 5.0	1.74	1.52	--	6.72	14.9	--	2.02	1.29 (J)	0.62
N4	370N004	0.0 - 5.0	1.86	1.53	0.132	5.18	14.5	0.79	1.91	1.31 (J)	0.587

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-41
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot N

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
N1	370N001	0.0 - 5.0	1.01
N2	370N002	0.0 - 5.0	1.17
N3	370N003	0.0 - 5.0	0.82
N4	370N004	0.0 - 5.0	1.71

Table F.1-42
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot N

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Uranium-234	Uranium-235	Uranium-238
N1	370N001	0.0 - 5.0	2.5	14.7	0.75	--	0.71
N2	370N002	0.0 - 5.0	2.58	19.6	0.82	--	0.81
N3	370N003	0.0 - 5.0	1.62	12.9	0.76	--	0.69
N4	370N004	0.0 - 5.0	3.34	20.5	0.93	0.063	0.84

-- = Not detected above minimum detectable concentrations.

Table F.1-43
Sample Results for Gamma-Emitting Radionuclides Detected above Minimum Detectable Concentrations at Sample Plot P

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)							
			Actinium-228	Americium-241	Cesium-137	Europium-152	Lead-212	Lead-214	Thorium-234	Thallium-208
P1	370P001	0.0 - 5.0	1.93	1.6	5.22	4.97	1.94	1.42 (J)	1.98	0.59
P2	370P002	0.0 - 5.0	2.01	--	3.23	4.91	2.16	1.35 (J)	--	0.586
P3	370P003	0.0 - 5.0	2.03	0.414	1.77	4.82	1.92	1.44 (J)	2.19	0.617
P4	370P004	0.0 - 5.0	1.73	--	4.47	4.83	2.05	1.34 (J)	--	0.613

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-44
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot P

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
P1	370P001	0.0 - 5.0	0.51
P2	370P002	0.0 - 5.0	0.69
P3	370P003	0.0 - 5.0	0.257
P4	370P004	0.0 - 5.0	1.81

Table F.1-45
Sample Results for Isotopes Detected above
Minimum Detectable Concentrations at Sample Plot P

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Uranium-234	Uranium-235	Uranium-238
P1	370P001	0.0 - 5.0	1.55	10.4	0.97	--	0.74
P2	370P002	0.0 - 5.0	1.53	9.8	0.78	0.11	0.99
P3	370P003	0.0 - 5.0	0.71	4.67	0.83	--	0.83
P4	370P004	0.0 - 5.0	2.79	13.9	0.93	--	0.8

-- = Not detected above minimum detectable concentrations.

Americium Plume and Wash Sample Plots (S, T, U, W01, and W02):

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at americium plume sample plot S are presented in Tables F.1-46 through F.1-48.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot T are presented in Tables F.1-49 through F.1-51.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plot U are presented in Tables F.1-52 through F.1-54.

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at sample plots W01 and W02 are presented in Tables F.1-55 through F.1-57.

Table F.1-46
Sample Results for Gamma-Emitting Radionuclides Detected above Minimum Detectable Concentrations at Sample Plot S

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)							
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Lead-212	Lead-214	Thallium-208
S1	370S001	0.0 - 5.0	1.58	2.64	0.108	14.2	6.86	1.75	1.34 (J)	0.553
S2	370S002	0.0 - 5.0	1.73	2	0.135	15	6.84	1.82	1.09 (J)	0.525
S3	370S003	0.0 - 5.0	1.8	2.16	0.133	11.6	7.58	1.74	1.21 (J)	0.553
S4	370S004	0.0 - 5.0	1.88	2.86	0.119	11.9	7.59	2.02	1.25 (J)	0.56

J = Estimated value

Table F.1-47
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot S

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
S1	370S001	0.0 - 5.0	1.11
S2	370S002	0.0 - 5.0	1.1
S3	370S003	0.0 - 5.0	1.65
S4	370S004	0.0 - 5.0	0.54

Table F.1-48
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot S

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)			
			Plutonium-238	Plutonium-239/240	Uranium-234	Uranium-238
S1	370S001	0.0 - 5.0	5.32	35.7	1.04	0.75
S2	370S002	0.0 - 5.0	4.87	35.4	0.91	0.88
S3	370S003	0.0 - 5.0	6.2	34.5	1.07	0.73
S4	370S004	0.0 - 5.0	3.04	22.2	1.07	0.88

Table F.1-49
Sample Results for Gamma-Emitting Radionuclides Detected above Minimum Detectable Concentrations at Sample Plot T

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)							
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Lead-212	Lead-214	Thallium-208
T1	370T001	0.0 - 5.0	1.68	82.2	0.632	95	7.46 (J)	1.7 (J)	1.13 (J)	0.54
T2	370T002	0.0 - 5.0	1.7	100	0.681	122	8.7 (J)	1.79 (J)	1.16 (J)	0.54
T3	370T003	0.0 - 5.0	1.82	112	0.74	133	7.43 (J)	1.64 (J)	1.51 (J)	0.53
T4	370T004	0.0 - 5.0	1.82	135	0.93	155	9 (J)	1.69 (J)	1.05 (J)	0.49

J = Estimated value

Table F.1-50
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot T

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
T1	370T001	0.0 - 5.0	26.5
T2	370T002	0.0 - 5.0	71
T3	370T003	0.0 - 5.0	95
T4	370T004	0.0 - 5.0	195

Table F.1-51
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot T

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
T1	370T001	0.0 - 5.0	71	259	8.3 (J)	1.31	1
T2	370T002	0.0 - 5.0	113	396	10.1 (J)	1.51	1.05
T3	370T003	0.0 - 5.0	138	481	18.9 (J)	1.57	1.23
T4	370T004	0.0 - 5.0	215	760	9.5 (J)	1.94	1.22

J = Estimated value

Table F.1-52
Sample Results for Gamma-Emitting Radionuclides Detected above Minimum Detectable Concentrations at Sample Plot U

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)							
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Lead-212	Lead-214	Thallium-208
U1	370U001	0.0 - 5.0	1.7	7.1	--	13.9	2.2 (J)	1.79 (J)	1.18 (J)	0.546
U2	370U002	0.0 - 5.0	1.72	11.2	0.112	20	3.02 (J)	1.62 (J)	1.22 (J)	0.55
U3	370U003	0.0 - 5.0	1.72	7.7	--	15.1	2.49 (J)	1.66 (J)	1.18 (J)	0.518
U4	370U004	0.0 - 5.0	1.66	4.77	--	10.4	2.08 (J)	1.84 (J)	1.03 (J)	0.532

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-53
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plot U

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
U1	370U001	0.0 - 5.0	2.18
U2	370U002	0.0 - 5.0	4.24
U3	370U003	0.0 - 5.0	3.67
U4	370U004	0.0 - 5.0	1.55

Table F.1-54
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plot U

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
U1	370U001	0.0 - 5.0	6.2	28.3	1.4 (J)	0.94	0.83
U2	370U002	0.0 - 5.0	11.2	49.8	2.04 (J)	1.05	0.86
U3	370U003	0.0 - 5.0	9.4	42.3	1.35 (J)	0.94	0.97
U4	370U004	0.0 - 5.0	4.19	21.9	--	0.88	0.84

-- = Not detected above minimum detectable concentrations.
J = Estimated value

Table F.1-55
Sample Results for Gamma-Emitting Radionuclides Detected above Minimum Detectable Concentrations at Sample Plots W01 and W02

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)							
			Actinium-228	Americium-241	Cobalt-60	Cesium-137	Europium-152	Lead-212	Lead-214	Thallium-208
W01	370W001	0.0 - 5.0	1.53	14.6	0.461	77.1	9.1 (J)	1.84 (J)	1.42 (J)	0.46
W02	370W002	0.0 - 5.0	1.49	7.7	0.234	44.2	5.55 (J)	1.5 (J)	1.33 (J)	0.471

J = Estimated value

Table F.1-56
Sample Results for Americium-241 Detected above Minimum Detectable Concentrations at Sample Plots W01 and W02

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)
			Americium-241
W01	370W001	0.0 - 5.0	9.9
W02	370W002	0.0 - 5.0	4.12

Table F.1-57
Sample Results for Isotopes Detected above Minimum Detectable Concentrations at Sample Plots W01 and W02

Sample Location	Sample Number	Depth (cm)	Contaminants of Potential Concern (pCi/g)				
			Plutonium-238	Plutonium-239/240	Strontium-90	Uranium-234	Uranium-238
W01	370W001	0.0 - 5.0	21.7	249 (J)	2.74	1.56	1.09
W02	370W002	0.0 - 5.0	10.9	104 (J)	2.03	1.17	0.73

J = Estimated value

Appendix G

Sample Location Coordinates

G.1.0 Sample Location Coordinates

Sample plot (i.e., composite samples), and the individual sample location (biased), coordinates for the CAI sampling were determined using a Trimble GeoXT GPS Unit with submeter-level accuracy. These coordinates identify the CAU 370 Decision I and II sampling locations (easting and northing positions) at CAU 370. Sample plot coordinates are listed for the southwest corner of the plot in Tables G.1-1.

Each set of sample aliquot locations were derived using the random start, systematic triangular grid pattern for sample placement. Parameters used in VSP for the determination of sample locations were systematic grid sampling using a triangular grid with nine samples.

The sample aliquot locations for each composite sample are in a tabular format in terms of east and north distances from the southwest corner stake at each plot (Tables G.1-2 through G.1-5).

A number of aliquot locations were moved due to surface/subsurface obstructions or conditions (e.g., rocks, debris, center of brush, excavations, animal burrows, and shallow caliche). These offsets (distance and direction) of each aliquot location were recorded in the project files.

Table G.1-1
Sample Plot/Location Coordinates for CAS 04-23-01[a]

Easting[b]	Northing[b]	Sample Plot
Vector 1		
579659.6	4105635	A
579638.3	4105699	B
579607.9	4105761	C
579546.2	4105822	D
579485.7	4105882	E
Vector 2		
579735.5	4105704	F
579774.1	4105745	G
579850.5	4105761	H
579907.9	4105831	I
579980.1	4105894	J
Vector 3		
579721.6	4105546	K
579664.5	4105548	L
579604.0	4105512	M
579535.5	4105448	N
579478.2	4105390	P
Americium Plumes		
579726.2	4105950	S
579881.5	4105643	T
579888.2	4105363	U
Washes and Stained Soil		
579905.1	4105240	W01 (wash)
579969.3	4105183	W02 (wash)
579343.2	4105521	X (stained area)

[a]All coordinates listed are for the southwest corner of the sample plot except location X (single sample location)
[b]Universal Transverse Mercator (UTM) Zone 11, North American Datum (NAD) 1927 (U.S. Western) in meters.

Table G.1-2
Sample Plot Location Distances (Vector 1) in Meters

Sample Plot A			Sample Plot B			Sample Plot C			Sample Plot D			Sample Plot E		
Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)
	2.5	1.6		0.5	0.8		1.9	1.4		1.8	0.9		2.0	1.4
	6.0	1.6		4.1	0.8		5.5	1.4		5.4	0.9		5.6	1.4
	9.6	1.6		7.7	0.8		9.0	1.4		9.0	0.9		9.2	1.4
	0.7	4.7		2.3	3.9		0.1	4.5		0.0	4.0		0.2	4.5
A1	4.2	4.7	B1	5.9	3.9	C1	3.7	4.5	D1	3.6	4.0	E1	3.8	4.5
	7.8	4.7		9.5	3.9		7.2	4.5		7.2	4.0		7.4	4.5
	2.5	7.8		0.5	7.0		1.9	7.6		1.8	7.1		2.0	7.6
	6.0	7.8		4.1	7.0		5.5	7.6		5.4	7.1		5.6	7.6
	9.6	7.8		7.7	7.0		9.0	7.6		9.0	7.1		9.2	7.6
	2.7	2.0		2.4	1.8		1.8	2.9		2.5	1.8		1.9	3.0
	6.3	2.0		5.9	1.8		5.4	2.9		6.1	1.8		5.5	3.0
	9.9	2.0		9.5	1.8		9.0	2.9		9.7	1.8		9.1	3.0
	0.9	5.1		0.6	4.9		0.0	6.0		0.7	4.9		0.1	6.1
A2	4.5	5.1	B2	4.1	4.9	C2	3.6	6.0	D2	4.3	4.9	E2	3.7	6.1
	8.1	5.1		7.7	4.9		7.2	6.0		7.9	4.9		7.3	6.1
	2.7	8.2		2.4	8.0		1.8	9.1		2.5	8.0		1.9	9.2
	6.3	8.2		5.9	8.0		5.4	9.1		6.1	8.0		5.5	9.2
	9.9	8.2		9.5	8.0		9.0	9.1		9.7	8.0		9.1	9.2
	1.9	2.8		2.5	3.1		2.5	0.9		0.9	0.8		2.5	1.6
	5.5	2.8		6.0	3.1		6.1	0.9		4.5	0.8		6.1	1.6
	9.1	2.8		9.6	3.1		9.7	0.9		8.0	0.8		9.7	1.6
	0.1	5.9		0.7	6.2		0.7	4.0		2.7	3.9		0.7	4.7
A3	3.7	5.9	B3	4.2	6.2	C3	4.3	4.0	D3	6.2	3.9	E3	4.3	4.7
	7.3	5.9		7.8	6.2		7.9	4.0		9.8	3.9		7.9	4.7
	1.9	9.0		2.5	9.3		2.5	7.1		0.9	7.0		2.5	7.8
	5.5	9.0		6.0	9.3		6.1	7.1		4.5	7.0		6.1	7.8
	9.1	9.0		9.6	9.3		9.7	7.1		8.0	7.0		9.7	7.8
	0.2	1.4		1.9	3.0		2.8	3.1		2.3	3.1		2.1	2.8
	3.8	1.4		5.5	3.0		6.4	3.1		5.9	3.1		5.7	2.8
	7.4	1.4		9.1	3.0		9.9	3.1		9.5	3.1		9.2	2.8
	2.0	4.5		0.1	6.1		1.0	6.2		0.5	6.2		0.3	5.9
A4	5.6	4.5	B4	3.7	6.1	C4	4.6	6.2	D4	4.1	6.2	E4	3.9	5.9
	9.2	4.5		7.3	6.1		8.1	6.2		7.7	6.2		7.4	5.9
	0.2	7.6		1.9	9.2		2.8	9.3		2.3	9.3		2.1	9.0
	3.8	7.6		5.5	9.2		6.4	9.3		5.9	9.3		5.7	9.0
	7.4	7.6		9.1	9.2		9.9	9.3		9.5	9.3		9.2	9.0

Note: Coordinate distance is measured from the southwest (SW) corner of the sample plot to the east (X-coordinate) and to the north (Y-coordinate) (e.g., at Sample Plot A1, measure 2.5 m to the east of the SW corner, and 1.6 m to the north for the first location).

Table G.1-3
Sample Plot Location Distances (Vector 2) in Meters

Sample Plot F			Sample Plot G			Sample Plot H			Sample Plot I			Sample Plot J		
Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)
	2.7	1.1		2.8	2.7		2.4	2.8		2.2	2.0		1.9	1.1
	6.3	1.1		6.4	2.7		5.9	2.8		5.8	2.0		5.5	1.1
	9.9	1.1		10.0	2.7		9.5	2.8		9.3	2.0		9.1	1.1
	0.9	4.2		1.0	5.8		0.6	5.9		0.4	5.1		0.1	4.2
F1	4.5	4.2	G1	4.6	5.8	H1	4.1	5.9	I1	4.0	5.1	J1	3.7	4.2
	8.1	4.2		8.2	5.8		7.7	5.9		7.6	5.1		7.3	4.2
	2.7	7.3		2.8	8.9		2.4	9.0		2.2	8.2		1.9	7.3
	6.3	7.3		6.4	8.9		5.9	9.0		5.8	8.2		5.5	7.3
	9.9	7.3		10.0	8.9		9.5	9.0		9.3	8.2		9.1	7.3
	0.6	2.3		0.7	0.7		0.9	0.9		1.9	2.9		0.8	1.2
	4.2	2.3		4.3	0.7		4.5	0.9		5.4	2.9		4.3	1.2
	7.8	2.3		7.9	0.7		8.1	0.9		9.0	2.9		7.9	1.2
	2.4	5.4		2.5	3.8		2.7	4.0		0.1	6.0		2.6	4.3
F2	6.0	5.4	G2	6.1	3.8	H2	6.3	4.0	I2	3.7	6.0	J2	6.1	4.3
	9.5	5.4		9.7	3.8		9.9	4.0		7.2	6.0		9.7	4.3
	0.6	8.5		0.7	6.9		0.9	7.1		1.9	9.1		0.8	7.4
	4.2	8.5		4.3	6.9		4.5	7.1		5.4	9.1		4.3	7.4
	7.8	8.5		7.9	6.9		8.1	7.1		9.0	9.1		7.9	7.4
	2.1	1.7		1.0	3.1		2.3	1.4		0.0	2.9		2.2	0.8
	5.7	1.7		4.6	3.1		5.9	1.4		3.6	2.9		5.7	0.8
	9.3	1.7		8.2	3.1		9.5	1.4		7.2	2.9		9.3	0.8
	0.3	4.8		2.8	6.2		0.6	4.5		1.8	6.0		0.4	3.9
F3	3.9	4.8	G3	6.4	6.2	H3	4.1	4.5	I3	5.4	6.0	J3	4.0	3.9
	7.5	4.8		10.0	6.2		7.7	4.5		9.0	6.0		7.5	3.9
	2.1	7.9		1.0	9.3		2.3	7.6		0.0	9.1		2.2	7.0
	5.7	7.9		4.6	9.3		5.9	7.6		3.6	9.1		5.7	7.0
	9.3	7.9		8.2	9.3		9.5	7.6		7.2	9.1		9.3	7.0
	0.2	2.9		2.4	1.1		0.2	2.2		0.2	1.5		2.7	1.6
	3.8	2.9		5.9	1.1		3.8	2.2		3.8	1.5		6.3	1.6
	7.3	2.9		9.5	1.1		7.4	2.2		7.3	1.5		9.9	1.6
	2.0	6.0		0.6	4.2		2.0	5.3		2.0	4.6		0.9	4.7
F4	5.6	6.0	G4	4.2	4.2	H4	5.6	5.3	I4	5.5	4.6	J4	4.5	4.7
	9.1	6.0		7.7	4.2		9.2	5.3		9.1	4.6		8.1	4.7
	0.2	9.1		2.4	7.3		0.2	8.4		0.2	7.7		2.7	7.8
	3.8	9.1		5.9	7.3		3.8	8.4		3.8	7.7		6.3	7.8
	7.3	9.1		9.5	7.3		7.4	8.4		7.3	7.7		9.9	7.8

Note: Coordinate distance is measured from the SW corner of the sample plot to the east (X-coordinate) and to the north (Y-coordinate) (e.g., at Sample Plot F1, measure 2.7 m to the east of the SW corner, and 1.1 m to the north for the first location).

Table G.1-4
Sample Plot Location Distances (Vector 3) in Meters

Sample Plot K			Sample Plot L			Sample Plot M			Sample Plot N			Sample Plot P		
Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)
	1.8	0.9		0.4	2.4		0.8	0.7		2.1	0.9		2.7	3.0
	5.4	0.9		4.0	2.4		4.3	0.7		5.7	0.9		6.2	3.0
	9.0	0.9		7.5	2.4		7.9	0.7		9.3	0.9		9.8	3.0
	0.0	4.0		2.2	5.5		2.6	3.8		0.4	4.0		0.9	6.1
K1	3.6	4.0	L1	5.7	5.5	M1	6.1	3.8	N1	3.9	4.0	P1	4.5	6.1
	7.2	4.0		9.3	5.5		9.7	3.8		7.5	4.0		8.0	6.1
	1.8	7.1		0.4	8.6		0.8	6.9		2.1	7.1		2.7	9.2
	5.4	7.1		4.0	8.6		4.3	6.9		5.7	7.1		6.2	9.2
	9.0	7.1		7.5	8.6		7.9	6.9		9.3	7.1		9.8	9.2
	2.5	1.8		1.8	1.1		0.7	1.0		0.8	1.3		0.6	2.3
	6.1	1.8		5.4	1.1		4.2	1.0		4.4	1.3		4.2	2.3
	9.7	1.8		9.0	1.1		7.8	1.0		8.0	1.3		7.8	2.3
	0.7	4.9		0.0	4.2		2.4	4.1		2.6	4.4		2.4	5.4
K2	4.3	4.9	L2	3.6	4.2	M2	6.0	4.1	N2	6.2	4.4	P2	6.0	5.4
	7.9	4.9		7.2	4.2		9.6	4.1		9.8	4.4		9.5	5.4
	2.5	8.0		1.8	7.3		0.7	7.2		0.8	7.5		0.6	8.5
	6.1	8.0		5.4	7.3		4.2	7.2		4.4	7.5		4.2	8.5
	9.7	8.0		9.0	7.3		7.8	7.2		8.0	7.5		7.8	8.5
	0.9	0.8		0.4	1.6		0.7	1.5		2.6	3.0		0.1	2.7
	4.5	0.8		4.0	1.6		4.3	1.5		6.2	3.0		3.7	2.7
	8.0	0.8		7.6	1.6		7.9	1.5		9.8	3.0		7.3	2.7
	2.7	3.9		2.2	4.7		2.5	4.6		0.8	6.1		1.9	5.9
K3	6.2	3.9	L3	5.8	4.7	M3	6.1	4.6	N3	4.4	6.1	P3	5.5	5.9
	9.8	3.9		9.4	4.7		9.7	4.6		8.0	6.1		9.1	5.9
	0.9	7.0		0.4	7.8		0.7	7.7		2.6	9.2		0.1	9.0
	4.5	7.0		4.0	7.8		4.3	7.7		6.2	9.2		3.7	9.0
	8.0	7.0		7.6	7.8		7.9	7.7		9.8	9.2		7.3	9.0
	2.3	3.1		0.2	2.3		2.4	1.0		0.5	2.2		2.8	1.8
	5.9	3.1		3.8	2.3		6.0	1.0		4.1	2.2		6.4	1.8
	9.5	3.1		7.4	2.3		9.6	1.0		7.7	2.2		10.0	1.8
	0.5	6.2		2.0	5.4		0.6	4.1		2.3	5.3		1.0	4.9
K4	4.1	6.2	L4	5.6	5.4	M4	4.2	4.1	N4	5.9	5.3	P4	4.6	4.9
	7.7	6.2		9.2	5.4		7.8	4.1		9.5	5.3		8.2	4.9
	2.3	9.3		0.2	8.5		2.4	7.2		0.5	8.4		2.8	8.0
	5.9	9.3		3.8	8.5		6.0	7.2		4.1	8.4		6.4	8.0
	9.5	9.3		7.4	8.5		9.6	7.2		7.7	8.4		10.0	8.0

Note: Coordinate distance is measured from the SW corner of the sample plot to the east (X-coordinate) and to the north (Y-coordinate) (e.g., at Sample Plot K1, measure 1.8 m to the east of the SW corner, and 0.9 m to the north for the first location).

Table G.1-5
Sample Plot Location Distances (Americium Plumes and Wash) in Meters

Sample Plot S			Sample Plot T			Sample Plot U			Sample Plots W01 and W02		
Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)	Composite Number	X-Coordinate Distance (m)	Y-Coordinate Distance (m)
	1.0	2.9		0.7	1.6		2.8	2.9		15.3	3.2
	4.6	2.9		4.3	1.6		6.3	2.9		22.5	3.2
	8.2	2.9		7.9	1.6		9.9	2.9		26.1	3.2
	2.8	6.0		2.5	4.7		1.0	6.0		29.6	3.2
S1	6.4	6.0	T1	6.1	4.7	U1	4.6	6.0	W01	9.9	6.3
	10.0	6.0		9.6	4.7		8.1	6.0		13.5	6.3
	1.0	9.1		0.7	7.8		2.8	9.1		17.1	6.3
	4.6	9.1		4.3	7.8		6.3	9.1		24.3	6.3
	8.2	9.1		7.9	7.8		9.9	9.1		8.2	9.4
	0.1	2.2		2.4	2.3		0.3	2.9		17.9	3.5
	3.6	2.2		6.0	2.3		3.9	2.9		16.1	6.6
	7.2	2.2		9.5	2.3		7.4	2.9		16.1	12.8
	1.9	5.3		0.6	5.4		2.1	6.0		14.3	15.8
S2	5.4	5.3	T2	4.2	5.4	U2	5.6	6.0	W02	12.5	18.9
	9.0	5.3		7.8	5.4		9.2	6.0		10.8	22.0
	0.1	8.4		2.4	8.5		0.3	9.1		7.2	28.1
	3.6	8.4		6.0	8.5		3.9	9.1		5.4	31.2
	7.2	8.4		9.5	8.5		7.4	9.1		1.9	37.3
	2.2	1.1		2.0	1.0		1.8	0.8			
	5.8	1.1		5.6	1.0		5.4	0.8			
	9.4	1.1		9.2	1.0		9.0	0.8			
	0.4	4.2		0.2	4.1		0.0	3.9			
S3	4.0	4.2	T3	3.8	4.1	U3	3.6	3.9			
	7.6	4.2		7.4	4.1		7.2	3.9			
	2.2	7.3		2.0	7.2		1.8	7.0			
	5.8	7.3		5.6	7.2		5.4	7.0			
	9.4	7.3		9.2	7.2		9.0	7.0			
	0.3	1.3		0.7	2.5		2.6	2.3			
	3.9	1.3		4.3	2.5		6.2	2.3			
	7.5	1.3		7.9	2.5		9.8	2.3			
	2.1	4.4		2.5	5.6		0.9	5.4			
S4	5.7	4.4	T4	6.1	5.6	U4	4.4	5.4			
	9.3	4.4		9.7	5.6		8.0	5.4			
	0.3	7.5		0.7	8.7		2.6	8.5			
	3.9	7.5		4.3	8.7		6.2	8.5			
	7.5	7.5		7.9	8.7		9.8	8.5			

Note: Coordinate distance is measured from the SW corner of the sample plot to the east (X-coordinate) and to the north (Y-coordinate) (e.g., at Sample Plot S1, measure 1.0 m to the east of the SW corner, and 2.9 m to the north for the first location).

Appendix H

Nevada Division of Environmental Protection Comments

(14 Pages)

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Closure Report for CAU 370: T-4 Atmospheric Test Site, Nevada Test Site, Nevada	**2. Document Date:**	3/30/2009
3. Revision Number:	0	**4. Originator/Organization:**	Stoller-Navarro
5. Responsible NNSA/NSO Federal Sub-Project Director:	Kevin J. Cabble	**6. Date Comments Due:**	
7. Review Criteria:			
8. Reviewer/Organization/Phone No:	Jeff MacDougall, NDEP, 702-486-2850 ext. 233	**9. Reviewer's Signature:**	

10. Comment Number/Locatio	11. Type*	12. Comment	13. Comment Response	14. Accept
1.) Section 3.0	Mandatory	Provide additional details and information which clearly define the use restriction, as well as the dimensions of the area that comprises the 25 mrem/year boundary. In addition, discuss any administrative controls and maintenance/post-closure requirements and activities that will apply to the site after closure.	The two paragraphs in Section 3.0 have been replaced to include the additional information requested. The section now reads as follows: "No further corrective action is required for CAU 370 based upon implementation of a corrective action of closure in place with a use restriction for radiological dose and lead contamination. The 25 mrem/yr boundary is defined by the coordinates listed in the use restriction document (see Appendix D). As an radioactive material area (RMA) fence currently exists that encompasses the use restricted area, the use restriction warning signs were posted on the RMA fence. The larger area encompassed by the RMA fence provides increased protection from exposure. Should the RMA fence be moved or removed due to a change in the RMA boundary, the use restriction warning signs may be moved but must encompass the boundary defined by the use restriction coordinates listed. The area being controlled by the use restriction is a polygon shape, and is approximately 399,592 m2 (98.74 acres) in size. The use restricted area, including the extension for the southeast wash and the larger RMA fence, is depicted in Figure 3-1. The use restriction is recorded in the FFACO database, the	

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	Mandatory		DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Facility Information Management System, and the NNSA/NSO CAU/CAS files. Permission to conduct the following restricted activities within this footprint (site) requires prior approval from the NDEP: • Full-time work assignments to the site • Construction of facilities at the site • Any activity that would result in a worker being assigned to a regular work station within the use restricted area Permissible activities, without prior approval, include short duration activities such as: • Site visits • Travel along the 4-04 Road • Maintenance of the fence and road • Limited entry for non-intrusive activities in support of site operations. Annual inspections are required of the use restriction and road sign postings. The NNSA/NSO requests that the NDEP issue a Notice of Completion for this CAU and approve moving the CAU from Appendix III to Appendix IV of the FFACO.”	

NEVADA ENVIRONMENTAL RESTORATION PROJECT
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10. Comment Number/Locatio	11. Type*	12. Comment	13. Comment Response	14. Accept
2.) Section E.2.0	Mandatory	In addition to stating that closure in place is the preferred corrective action for the T-4 site, provide details as to why it is the appropriate corrective action (i.e., provide the rationale which supports the selection of this corrective action alternative). This may include a discussion which summarizes Table E.1-2, and provide explanation of the information presented in the Table (i.e., rank, explanation).	The two paragraphs in Section E.2.0 have been replaced to include the additional information requested. The section now reads as follows: "Three CAAs were evaluated for CAS 04-23-01: No Further Action (CAA 1); Clean Closure (CAA 2); and Close in Place (CAA 3). Only CAA 2 and CAA 3 met all requirements for general corrective action standards (Section E.1.2). In general, for the Clean Closure alternative, lead and radiological contamination would be removed from the site to levels below FALs, with no PSM remaining. For the Close in Place alternative, potential worker exposure to lead and radiological contamination would be controlled administratively. Both CAAs would, therefore, be protective of human health and the environment, comply with media cleanup standards, and control the source of release. As supported by the following discussion, further examination of the two CAAs by the five Environmental Protection Agency (EPA) remedy selection decision factors resulted in the selection of Close in Place as the preferred CAA for CAS 04-23-01, Atmospheric Test Site T-4. The five EPA remedy selection decision factors are short-term reliability and effectiveness; reduction of toxicity, mobility, and/or volume; long-term reliability and effectiveness; feasibility; and cost. These factors are provided in Table E.1-2.	

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10. Comment Number/Locatio	11. Type*	12. Comment	13. Comment Response	14. Accept
	Mandatory		The first remedy selection decision factor, short-term reliability and effectiveness, is a qualitative measure of the impacts on human health and the environment during implementation of the CAA. While Clean Closure is both reliable and effective in the short-term, this alternative involves increased, short-term exposure of site workers to lead and radiological contamination during soil and debris removal. In contrast, Close in Place does not require removal of soil and there is no short-term exposure of site workers; signs are posted on existing fencing, and disturbance of contaminated soil and debris is not necessary. The second remedy selection decision factor, reduction of toxicity, mobility, and/or volume, is a qualitative measure of changes in characteristics of contaminated media that result from implementation of the CAA. Under Clean Closure, contaminated media that exceed FALs would be removed from the area, thereby eliminating both mobility and the onsite volume of contaminated media. In contrast, Close in Place does not reduce toxicity, mobility, or volume. The third remedy selection decision factor, long-term reliability and effectiveness, is a qualitative evaluation of performance following site closure, and into the future. Removal of contaminated media for Clean Closure provides long-term reliability and effectiveness; Close in Place does not.	

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	Mandatory		The fourth remedy selection decision factor, feasibility, includes an evaluation of the requirements for construction and operation as well as administrative constraints. For the Close in Place alternative, no construction, little maintenance, and administrative constraints are required. For the Clean Closure alternative, substantial construction, operation, and administrative actions consistent with soil removal and management of generated wastes are needed. The fifth remedy selection decision factor, cost, includes assessment of both capital (direct) costs of implementation and costs for operation and maintenance of the corrective action. As shown in Table E.1-2, the estimated costs for Clean Closure exceed $31,000,000, while the costs for Closure in Place are limited to those derived from acquiring, hanging, inspecting, and occasionally replacing, use restriction and road signs. Based upon the five remedy selection decision factors, Clean Closure received an overall score of 7 (less desirable), whereas Close in Place received an overall score of 8 (more desirable). This result was not only the product of an examination of the two CAAs, by the five remedy selection decision factors, but also in consideration of the current NTS administrative controls (e.g. NTS access restrictions and control of site activities), the present-day stability of the contaminated soil at the T-4 site through the evolution of a	

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	Mandatory		mature plant community, the development of soil surface durability (i.e., soil crust) and limited lateral migration of contamination in washes. Therefore, selecting the preferred corrective action alternative of Close in Place for CAS 04-23-01 is consistent with past practices for CASs that contain COCs and where there would be significant costs and short-term health risks to workers involved in clean-up activities."	
3.) Section H.1.5.2	Mandatory	"... until further confidence is established in the aerial surveys..."; This statement is excessively subjective and would benefit from modification along the lines of describing the benefits of the aerial surveys and grid surveys. Also, a discussion of any shortfalls and deficiencies of aerial and grid surveys, if any, would be additionally beneficial. We suggest the removal of all references to performing/not performing these surveys at future investigation sites. Corrective actions for other soil sites (CAUs) should be evaluated independently of results and rationale presented for CAU 370.	Appendix H has been removed from the document and will be submitted separately. The comment will be addresssed in the new document.	

NEVADA ENVIRONMENTAL RESTORATION PROJECT
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10. Comment Number/Locatio	11. Type*	12. Comment	13. Comment Response	14. Accept
4.) General	Mandatory	The road bisecting the site is adjacent to the highest radiation level readings. Is the 230 hour estimate provided in the Use Restriction Information (D-3) calculated from the highest radiological readings gathered (plot K)? The same question applies for the 0.1 mrem/hr verbiage noted on the warning signs.	Yes, the calculations were based on the highest radiological reading at plot K. To clarify the text in the closure summary, and correct an error, the following two paragraphs were added after the last paragraph on page D-1: "The highest determined TEDE (220.5 mrem/yr at plot K; Figure 2-5) was used to derive a maximum hourly dose rate of 0.1 mrem/hr. At this rate, a worker exposed to the location of maxium dose would receive a 25-mrem/yr dose after a total of 255 hours. The 25 mrem/yr boundary is defined by the coordinates listed in the use restriction document. There are no plans to physically delineate the actual use restricted area as the larger RMA fence provides increased protection from exposure. Should the RMA fence be moved or removed due to a change in the RMA boundary, the use restriction warning signs may be moved but must encompass the boundary defined by the use restriction coordinates." To clarify the restriction, in the Comment section of the Use Restriction on page D-3, the value of “230 hours” was corrected in the third sentence to “255 hours”, and the third sentence, which currently reads “This site was identified as containing radiological contamination in the surface soil that can cause a dose to a site worker of up to 25 mrem/yr during an exposure period of approximately 230 hours.” was revised to read “The maximum total dose to a worker from	

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	Mandatory		radiological contamination at the T-4 site was determined to be 220.5 mrem/yr. Based on this maximum dose, a worker could potentially receive a 25 mrem dose in 255 hours of exposure time or receive a maximum hourly dose rate of 0.1 mrem/hr."	
5.) General	Mandatory	Is it planned for the 25 mrem/yr boundary to be delineated, in any way, inside the larger fenced area?	To clarify the approach to delineation of the 25 mrem/yr boundary, changes were made to Sections 3.0 and D.1.0 as incorporated into the resolutions of Comments 1 and 4.	
6.) General	Mandatory	Correction. The discussion of the results for the two samples taken from the southeast wash W01 and W02 in Section 2.2.1.1 references table A.3-8. The reference should be to table A.3-7.	The reference has been corrected to read "Table A.3-7."	

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5. Responsible NNSA/NSO Federal Sub-Project Director:	Kevin J. Cabble	**6. Date Comments Due:**	
7. Review Criteria:			
8. Reviewer/Organization/Phone No:	Jeff MacDougall, NDEP, 702-486-2850 ext. 233	**9. Reviewer's Signature:**	

10. Comment Number/Locatio	11. Type*	12. Comment	13. Comment Response	14. Accept
7.) General	Mandatory	Comment. Please show the location of these two samples on one of the figures. Section 2.2.1.1 states that sample W01 was collected 160 feet inside the initial CAS boundary - the RMA fence. Table A.3-9 shows that the sample W02 was collected approximately 83 meter down wash from W01 or approximately 112 feet outside the RMA fence. Was sample W02 collected from the area of highest gamma readings located outside the RMA fence? Figure 2-2 seems to indicate that contamination spreads down the wash outside the RMA fence. Are you confident that W02 is representative of the wash area outside the fence? Why was only one sample collected from the area outside the fence given that the gamma survey (Figure 2-2) indicated elevated contamination spreading approximately 150 feet down the wash outside the fence?	The following changes were made to the figures: The names for the two wash plots, W01 and W02, have been added to Figure 2-2 and Figure A.2-6, both of which present close-up aerial views of the southeast wash, and to Figure A.3-5, which was also revised to include all plot names. The wash plots were also added to Figures 2-5, A.3-2 and B.1-1. Additionally, plot W01, which exceeded the radiological FAL, was added to Figure D.1-1, which shows the boundary for the use restriction and which was also revised to include the lead object locations. Both wash plots were judgmentally established as polygons by GIS to include as many contiguous points of the highest radiological readings in the wash as feasible. The resultant polygons were then imported into Visual Sample Plan 5.1. One composite sample comprised of 9 aliquots was generated by VSP using a random start, systematic triangular grid pattern, for each wash plot polygon. To clarify the positioning of the wash plots, the following text was added or revised in the document: The text that refers to Figure 2-2 and Figure A.2-6 was revised to explain how the plots were adjusted to include the areas of elevated radiological readings in the wash. In Section 2.1.1 on page 11, the second sentence of the last paragraph which read "The areas of anomalous readings were established as 100-m2 sample plots (Figure 2-2)." was revised to read "The areas of anomalous readings were established as 100-m2	

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	Mandatory		polygon-shaped sample plots adjusted to encompass the areas of highest elevated readings (Figure 2-2)." In Section A.2.4, on page A-17, the second sentence of the second paragraph on page A-17 was also revised to now read "The areas of anomalous readings were established as 100-m2 polygon-shaped sample plots adjusted to encompass the areas of highest elevated readings (Figure A.2-6)." In response to the portion of the comment asking whether W02 is representative of the wash area outside the fence: W02 is not representative of that area. W02 was taken from the area of maximum detected radioactivity. Although only one sample was collected from the area down the wash, the sample was collected from the area with the highest reading as detected in the gamma survey. The result from this sample was below actions levels, so no additional samples were necessary.	
8.) General	Mandatory	Comment. Has the CAB reviewed and commented on the CADD/CR? What are your plans with regard to this?	Based on historic practice, the CAB was not given the draft CAU 370 CADD/CR and typically is not provided any draft document or final document directly. All final documents are distributed to the public reading rooms where the CAB or any member of the general public can read the document. The CAB is notified of all submittals to the reading rooms. If requested by the CAB, DOE will supply a document directly to them. In addition, progress on all documents is communicated to the CAB via monthly reports.	

NEVADA ENVIRONMENTAL RESTORATION PROJECT
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9.) General	Mandatory	Provide a discussion about the potential risk to the worker during road maintenance activities.	A discussion regarding the potential risk to workers during road maintenance was inserted between the two new paragraphs in Section D.1.0 (Response to Comment #4) as follows: "Activities such as the periodic maintenance of the 4-04 Road require workers' presence inside the use restriction boundary. Periodic road maintenance would likely consist of an infrequent, short-duration regrading of the road to address scalloping or erosion that can occur at any unpaved road at the NTS. Because regrading has the potential to generate significant levels of localized ambient dust, the potential for additional internal dose to a worker during work was also examined using the RESRAD computer code. The external dose component of the TEDE would remain unchanged. An estimation of the dose received under a scenario involving road regrading was generated in RESRAD. Reasonable upper-bound values for the RESRAD parameters that are important to the inhalation and ingestion exposure pathways were selected from the RESRAD data collection handbook and input into the software. The resultant dose was found to be lower than the internal dose to a worker under the Industrial Area scenario due to a much shorter outdoor exposure time."	

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10.) General	Mandatory	Provide a brief discussion of TED v.s. TEDE.	The CAU 370 CAIP expressed the FAL for CAU 370 as a Total Effective Dose Equivalent (TEDE) of 25 mrem-per-year under the Industrial Area exposure scenario. The term "TEDE" can be found in 10 CFR Part 835, defined as the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). In June 2007 10 CFR Part 835 was revised. The revision incorporated new terminology for internal and external dosimetry, including a transition from the term "Total Effective Dose Equivalent" (TEDE) to the term "Total Effective Dose" (TED). The Nevada Test Site (NTS) Tennant Organizations (TOs) are currently in the process of implementation of the various changes in 10 CFR Part 835, and full compliance is not yet due. Based solely upon the desire to reflect the most current terminology contained within 10 CFR Part 835, the CAU 370 draft CADD/CR was prepared using the term "Total Effective Dose" (TED). Unfortunately, this shift in terms was premature. The Residual Radioactive Material Guidelines (RRMGs) for CAU 370 were calculated via the RESRAD computer code using dose conversion factors that were consistent with the TEDE terminology and not the newer dose conversion factors that would reflect the TED terminology. This issue was identified during document review, and the term "TED" was replaced throughout the	

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	Mandatory		document with the correct term "TEDE" for the work at CAU 370. Future soils work will utilize the term TED, and updated RRMGs will be calculated in RESRAD using the newer dose conversion factors. To clarify the use of the TEDE in the CADD/CR the third and fourth full paragraphs in Section 2.1 on page 9 were revised to read as follows: "The final action level (FAL) that was established in the CAU 370 CAIP (NNSA/NSO, 2008) was expressed as a radiological dose of 25-millirem per year (mrem/yr) total effective dose equivalent (TEDE) under the Industrial Area exposure scenario. The TEDE is defined in 10 Code of Federal Regulations (CFR) Part 835 (CFR, 2009) as the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). The potential internal exposures at each CAU 370 sampling plot were determined by comparing the laboratory analytical results of soil samples taken at each plot to Residual Radioactive Material Guidelines (RRMGs) that were calculated with the Residual Radioactive (RESRAD) computer code (see Appendix C, Attachment 1). The potential external exposures at each planned sampling plot were determined by staging a thermoluminescent dosimeter (TLD) at a height of 1 m in the center of each plot	

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	Mandatory		for about 94 days. The potential external exposures at the americium plumes and plots in the wash were determined via dose-rate measurements with a Bicron micro-REM per hour (see Section A.2.4). The Bicron measurements were adjusted to match the 2,250 hours of the Industrial Area exposure scenario and normalized to the TLD data."	
11.) Figure A.3-4	Mandatory	There is a typo (legend should reference 25 mrem/yr and not .25 mrem/yr TED). This estimated point should be referenced as deriving from the linear curves given in Figure A.3-3.	The typo has been corrected so that the explanation of the symbol reads “Distance equivalent to 25 mrem/yr TEDE boundary”. A footnote has been added to the explanation of the figure that reads “Estimated points derived from linear curves depicted in Figure A.3-3.”	

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